SSHCP South Sacramento Habitat Conservation Plan

FINAL SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

PLAN PARTNERS

County of Sacramento

City of Rancho Cordova

City of Galt

Sacramento County Water Agency

Southeast Connector Joint Powers Authority

VOLUME II
APPENDICES

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APPENDIX A

Glossary and Acronyms

APPENDIX A1

Glossary of Terms

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Glossary of Terms

A

Adaptive management: A scientific approach to resource management that combines management, monitoring and research to effectively manage complex ecosystems in the face of uncertainty. Adaptive management addresses uncertainty about the system by identifying clear objectives, identifying areas of uncertainty and alternative hypotheses, testing critical assumptions, monitoring to provide feedback about the ecosystem and actions, learning from the ecosystem as actions are taken to manage it, and incorporating what is learned into future actions. Often includes development of conceptual models of the ecosystem or species. As described in the Five-Point Policy, adaptive management is "an integrated method for addressing uncertainty in natural resource management."[1] See Chapter 8 of the SSHCP.

Agencies: See definitions for "Wildlife Agencies" and "Permitting Agencies."

Agricultural-residential development: In the 2010 Sacramento County General Plan (County of Sacramento 2011), low-density, single-family residential is defined as a land use area meant to allow the keeping of animals and the raising of crops for personal or income supplementation purposes.[2]

Applicant: See "Plan Permittees."

Aquatic land cover: Aquatic land covers are a subset of the SSHCP land cover types defined in Chapter 3. There are 11 aquatic land cover types: (1) vernal pool grassland, (2) vernal pool, (3) swale, (4) seasonal wetland, (5) freshwater marsh, (6) streams/creeks (vernal pool invertebrate habitat), (7) streams/creeks, (8) open water, (9) mixed riparian woodland, (10) mixed riparian scrub, and (11) mine tailing riparian woodland.

Aquatic resource: Aquatic resources are defined as waters including wetlands, rivers, streams, lakes, marine, and estuarine systems. Also see definition of Waters of U.S.

Arterial roads: In Sacramento County, these are roads that provide linkages between thoroughfares and collectors. Arterials can also provide for mobility and direct access within commercial and retail corridors through two-way left-turn lanes.[3] As described in Chapter 5,

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1 USFWS (U.S. Fish and Wildlife Service). 2000. Addendum to the HCP Handbook: 5-Point Policy. 65 FR 35242. June 1, 2000.

2 County of Sacramento. 2014. "Summary of Zoning Classifications." Accessed September 12, 2014. http://www.planning.saccounty.net/zc/docs/ZoningClassSummary.pdf.

3 County of Sacramento. 2009. "Circulation – Transportation Element." Sacramento County General Plan of 2005-2030. Amended November 9, 2011. Sacramento, California: Sacramento County Community Planning and Development Department. Accessed September 12, 2014. http://www.per.saccounty.net/PlansandProjectsIn-Progress/Pages/GeneralPlan.aspx.

Covered Activities, arterial roads are typically developed as four-lane roadways with a center two-way left-turn lane or a raised center median with adjacent Class I, Class II, or Class III bikeway facilities.

Authorized incidental take (authorized take): The amount of incidental take of covered species and amount of habitat modification or degradation in the Incidental Take Permits (ITPs) issued to Permittees pursuant to Section 10(a)(1)(B) of the federal Endangered Species Act (ESA), and the amount of take of covered species requested by the SSHCP Permittees for inclusion in the California Department of Fish and Wildlife (CDFW) ITP issued under the California Endangered Species Act (CESA) pursuant to California Fish and Game Code Section 2081. Also see definition of "Incidental Take."

Avoidance and Minimization Measures: Measures to avoid and minimize adverse effects resulting from covered activities described in Chapter 5 of the SSHCP. See Section 5.6. Includes the following AMM types:

- ***Best management practice (BMP):*** Measures to avoid and minimize impacts resulting from covered activities during and after construction. An approach to pollution control that is based on adopting methods that have been determined to be the most effective, practical means of preventing or reducing water pollution from non-point sources.[4]
- ***Low-impact development (LID):*** An approach to land development (or re-development) that employs principles such as preserving and establishing natural landscape features and minimizing effective imperviousness to manage water in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed.

B

Biological Resources Letter Report: Documents the biological resources present within a site that is proposed for development Covered Activities. Each report includes at a minimum 1) a map of SSHCP Land Cover Types based on a field investigation of the site, 2) descriptions of Covered Species habitat present on the site, 3) any observations of Covered Species and other species observed on the site during a general biological resources survey, 4) results of any required species-specific surveys, and 5) any site-specific conditions that should be applied to the proposed project to avoid or minimize take of Covered Species and habitat. Prepared as a part of the Project Application Package.

[4] A Dictionary of Environment and Conservation (2 ed.). Oxford University Press. 2013.

Biological opinion (BO): A document which includes: (1) the opinion of the USFWS or the National Marine Fisheries Service as to whether or not a Federal action is likely to jeopardize the continued existence of listed species, or result in the destruction or adverse modification of designated critical habitat; (2) a summary of the information on which the opinion is based; and (3) a detailed discussion of the effects of the action on listed species or designated critical habitat. [50 CFR §402.02, 50 CFR §402.14(h)].[5]

Bio-swale: Vegetated, mulched, or xeriscaped channels that provide treatment and retention as they move stormwater from one place to another. Vegetated swales slow, infiltrate, and filter stormwater flows. As linear features, vegetated swales are particularly suitable along streets and parking lots.

Buffer: A zone around a sensitive environmental feature (e.g., nest site) where human activity is restricted to minimize direct and indirect effects to the feature. For example, a buffer will be required between a nesting bird and construction activities.

Buffering: In GIS analysis, a polygon enclosing a point, line, or polygon at a specified distance. In the SSHCP, buffering was used to identify zones of avoidance such as stream or preserve setbacks where a waterway or preserve boundary was buffered by a given distance to create the area of avoidance.

C

California Natural Diversity Database (CNDDB): A CDFW program that inventories the locations and status of rare plants and animal occurrences within California.[6]

Changed circumstance: Changes in the circumstances affecting a species or geographic area covered by a conservation plan that can reasonably be anticipated by the plan developers and the Service and can be planned for (e.g., the listing of a new species, or a fire, flood, drought, or other natural catastrophic event in areas prone to such events (50 CFR 17.3). (Also see definitions for “Unforeseen Circumstance” and “No Surprises Policy/Assurances”).

Claypan: Dense, compact, slowly permeable layer with a high clay content.

Community plan: In Sacramento County, this is a development plan proposed by a land developer and approved by one of the SSHCP Permittees that sets forth policy and

[5] USFWS. 1998 . Endangered Species Consultation Handbook.
[6] CDFW. 2014. California Natural Diversity Database (CNDDB). Accessed September 18, 2014. http://www.dfg.ca.gov/biogeodata/cnddb/.

implementation strategies for such items as land use, transportation, urban design, parks, schools, and public services, in a defined development community.[7]

Compensatory mitigation: The restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved (33 CFR 332).

Conservation action(s): Specific SSHCP activities that will be carried out to meet the conservation needs of the covered species and natural communities in order to achieve the SSHCP biological goals and biological objectives.

Conservation Strategy: The SSHCP's overall and unified approach for achieving the SSHCP biological goals and biological objectives. Elements of the Conservation Strategy include preserve assembly guidelines, conditions on Covered Activities, avoidance and minimization measures (AMMs), habitat preservation, habitat re-establishment/establishment, habitat monitoring and management, and species monitoring and management. The SSHCP Conservation Strategy provides for conservation of 29 covered species and their habitats; avoids or minimizes impacts of covered activities; mitigates for the impacts of covered activities on the covered species and their habitats on the basis of species and habitat needs; provides a regional approach to the avoidance, minimization, and mitigation of impacts to the maximum extent practicable; provides protection to wetlands and waters of the Plan Area; and contributes to recovery of some listed Covered Species.

Conserve, Conservation: Under the federal ESA, "conservation," "conserve," and "conserving" means to use, and the use of all methods and procedures that are necessary to bring any listed species to the point at which the protection measures provided by the ESA are no longer necessary (also see definition of "Recovery" below). Such conservation methods and procedures may include, but are not limited to, all activities associated with scientific resources management such as species research, census, law enforcement, habitat acquisition, maintenance, propagation, live trapping, transplantation, and the regulated taking of individuals in extraordinary cases where population pressures within a given ecosystem cannot be otherwise relieved (ESA Section 3.(3)).[8]. The SSHCP, especially Chapters 5, 7, 8, 9, and 10, describes the methods and procedures by which the Permittees will conserve each SSHCP covered species within the boundaries of the Plan Area

7 County of Sacramento. 2014. "Specific Plans/Community Plans/Special Projects." MSA Planning and Community Development Department. Accessed September 18, 2014. http://www.planning.saccounty.net/plans-projects.html.

8 USFWS. 1998 . Endangered Species Consultation Handbook.

Conservation bank: See also definition of "mitigation bank."

Conservation Easement: A legally enforceable land preservation agreement that transfers certain use rights on a property from a landowner to a qualified third-party land protection organization, typically restricting future urban development, as well as several other activities and/or land uses on the property, and "running with" the property in perpetuity.

Construction monitoring: Monitoring by approved biologists of all ground-disturbing Covered Activities to ensure that required SSHCP Avoidance and Minimization Measures are implemented correctly, and to collect information on the effectiveness of the implemented SSHCP Avoidance and Minimization Measure.

Core preserve: A SSHCP habitat preserve that is at least 800 acres in size and contains extensive areas of contiguous habitat, including substantial areas of habitats that are representative of habitats found in the geographic region, and include populations of Covered Species considering the specific ecological needs of SSHCP Covered Species. Most SSHCP Core preserves are located in the UDA. See Section 7.4.1. See also definitions for "landscape preserve," "minor preserve," "linkage preserve," "satellite preserve," and "cropland preserve."

Covered Activity (Activities): The otherwise lawful activities and projects described in Chapter 5 of the SSHCP that are implemented in the Plan Area by the Plan Permittees, or implemented by third parties (e.g., project proponents or private developers) that are subject to the jurisdiction of a Plan Permittee. Species incidental take resulting from Covered Activities is covered under the ESA and CESA Incidental Take Permits (see definition for Incidental Take Permit [ITP]).

Covered Species: The species that will be listed on the CESA and federal ESA ITPs issued by the two Wildlife Agencies (USFWS and CDFW). The Plan addresses 29 species (21 wildlife and 8 plants), of which, 10 are currently listed as threatened or endangered under CESA or the federal ESA (see Table 1-2 for a complete list of species covered under this Plan).[9]

Critical Habitat : For federally-listed species Critical Habitat consists of: (1) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of the Act, on which are found those physical or biological features (constituent elements) (a) essential to the conservation of the species and (b) which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of the Act, upon a determination by the Secretary that such areas are

[9] Chapter 1.

essential for the conservation of the species.[10] [ESA §3 (5)(A)] Designated critical habitats are described in 50 CFR §17.

Constituent Elements: Also referred to as primary constituent elements. The physical and biological features of designated or proposed critical habitat essential to the conservation of the species, including, but not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and (5) habitats that are protected from disturbance or are representative of the historic geographic and ecological distributions of a species. [ESA §3(5)(A)(i), 50 CFR §424.12(b)][11]

Core Recovery Area: Core recovery areas are the specific sites identified by the USFWS as necessary to recover endangered or threatened species[12]. As discussed in Chapter 3, there are two Core Recovery Areas in the SSHCP Plan Area.

Cropland preserve: SSHCP Preserves consisting of existing croplands or irrigated pasture-grasslands that have been identified as uniquely important foraging, roosting, and nesting habitat in the Plan Area for some Covered Species, including Swainson's hawk, white-tailed kite, northern harrier, tricolored blackbird, and greater sandhill crane. See Chapter 7 of the SSHCP.

D

Depressional wetland: Depressional wetlands are confined to topographic basins or hollows that are either too small or too shallow to form lakes or reservoirs. This is a very large category of wetlands that includes vernal pools and natural as well as artificial ponds. There is no minimum or maximum size for depressional wetlands. They often depend on multiple water sources, including local runoff, groundwater, and direct precipitation. Their waters can be saline, alkaline, or fresh.[13] See definition of vernal pool crustacean habitat.

Detention: Water management practice or system that delays the downstream progress of stormwater by the use of temporary storage or metered outlets.[14]

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10 USFWS. 1998 . Endangered Species Consultation Handbook.
11 USFWS. 1998 . Endangered Species Consultation Handbook.
12 USFWS. 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon.
13 California Water Quality Monitoring Council: http://www.mywaterquality.ca.gov/eco_health/wetlands/extent/types/depressional.shtml.
14 Corps. 2014. "Glossary." Accessed September 18, 2014. http://chl.erdc.usace.army.mil/glossary.

Detention basin: An excavated area along waterways that collects stormwater runoff and gradually releases it in a controlled manner to prevent downstream areas from flooding or being eroded.

Development: See "Urban Development."

Discharge: The volume of stormwater that passes a given location within a given period of time, usually expressed in cubic feet per second.[15]

Distribution: The geographic area within which a species or other taxon of organisms occurs; the spatial pattern or arrangement of the members of a species, population, or other group of organisms.[16] See also "species range."

Duripan: Soil that is cemented by alluvial silica in a subsurface hardpan (see the definition of "hardpan."

E

Ecosystem/Ecological System: The natural interacting biotic and abiotic system in a given area, which includes all of the organisms (plants, animals, fungi, and micro-organisms) that live in particular habitat, along with their immediate physical environment. Examples include a lake, forest, or drainage basin. The term was first used by British ecologist Arthur Tansley in 1935, who visualized ecosystems as being composed of two parts, the biome and the habitat. In Tansley's view 'all parts of such an ecosystem—organic and inorganic, biome and habitat—may be regarded as interacting factors which, in a mature ecosystem, are in approximate equilibrium; it is through their interactions that the whole system is maintained'. Many ecologists regard ecosystems as the basic units of ecology because they are complex, interdependent, and highly organized, and because they are the basic building blocks of the biosphere.[17]

Edge effect: These are foreseeable permanent indirect effects to natural communities and species habitat resulting from development and increased human populations along the boundaries of open space areas, which result in chronic habitat degradation and decline or loss of species.

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15 USGS Water Science School. "Glossary of Terms." Accessed September 18, 2014. http://water.usgs.gov/edu/dictionary.html#main. Note, this differs from the definition of "discharge" according to the CWA.

16 Dictionary of Ecology, evolution, and systematics, second edition; Lincoln et al, Cambridge University Press.

17 A Dictionary of Environment and Conservation. Oxford University Press. 2013.

Effect(s): Covered Activities cause environmental stressors (see definition below) that result in direct, indirect or cumulative effects on covered species and species habitats. Effects are primarily discussed in Chapter 6 of the SSHCP.

- ***Direct effects*** result from removal, modification, or degradation of a land cover type that provides habitat for a SSHCP covered species; removes a species population, or a species occurrence (or portions of thereof); or directly harms, harasses, kills or injures an individual of any covered species. Direct effects occur at the time and place of the covered activity implementation (e.g., ground disturbance, vegetation removal, inundation). Direct effects can be either permanent or temporary (see definitions of permanent and temporary impacts immediately below).
- ***Indirect effects*** result from modification or degradation of species habitat over time, eventually partially or fully removing the value of the habitat for breeding, feeding, or sheltering. Indirect effects are defined by USFWS as "those that are caused by the proposed action and are later in time, but are still reasonably certain to occur" (50 CFR 402.02).
- ***Permanent effects*** are direct or indirect effects that result from permanent removal, modification, or degradation of covered-species habitat, or that affect habitat for more than one year during covered activity implementation and/or more than one year after completion of the covered activity (e.g., creating a new road through grassland). Permanent effects also include indirect impacts to land covers that result in a permanent (i.e., more than one year after completion of the covered activity) change to species habitat or habitat functions (e.g., development around a wetland that reduces the water supply to a wetland that subsequently results in a reduction in the size, hydrologic regime, or water quality of the wetland). Effects that result in reduction of long-term viability of a plant or animal occurrence are also considered permanent.
- ***Temporary effects*** are direct effects that alter land cover for less than one year and the disturbed area recovers or is restored to pre-project conditions within one year (e.g., prescribed burning, construction staging areas) of completing ground disturbance. For the purposes of this Plan, all effects associated with covered activities that have a duration exceeding one year or that take more than one year to restore immediately following construction will be considered permanent. For purposes of the SSHCP, all temporary effects associated with covered activities are assumed to occur within the permanent effect footprint and therefore separate acreages have not been calculated for temporary effects. It is also assumed that AMMs will avoid to the maximum extent feasible temporary effects to covered species.

- ***Cumulative effects*****:** Under the federal ESA, the effects of future state or private activities (non-federal activities) that are reasonably certain to occur within the action area of an action subject to consultation.

Emergent vegetation: Aquatic plants that grow with their roots under water but their leaves and stems above the surface of the water.[18]

Endemic species: A species whose distribution is restricted to a certain area or environmental feature (e.g., soil types, natural community). A native species found only within a given area.19

Enhance, Enhancement: The manipulation of the physical, chemical, or biological characteristics of a land cover or ecosystem to heighten, intensify, or improve a specific resource function, such as species habitat quality. "Enhancement" does not result in a gain in resource area.

- ***Habitat enhancement:*** The manipulation of an existing habitat for Covered Species that improves its value to one or more Covered Species for breeding, feeding, or sheltering.

Ephemeral stream (as a jurisdictional aquatic resource): A stream that has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.[20] (See also "intermittent stream" and "perennial stream.")

Environmental Stressor: The component(s) or action(s) of a Covered Activity that results in adverse effects to Covered Species.

Establishment (creation):[21] The manipulation of the physical, chemical, or biological characteristics present to develop a resource that did not previously exist. Establishment results in a gain in resource area and functions.

Eutrophication: A common form of water pollution which involves the enrichment of a body of freshwater with nutrients such as nitrate fertilizers (washed from the soil by rain) and phosphates (from fertilizers and detergents in municipal sewage). The pollution enriches the waterbody, and this encourages the rapid growth of aquatic plants and can cause excessive growth of algae

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18 A Dictionary of Environment and Conservation (2 ed.). Oxford University Press. 2013.

19 A Dictionary of Environment and Conservation. Oxford University Press. 2013.

20 This definition is consistent with that found in the 2012 NWPs (Federal Register, Vol. 77(34), February 21, 2012).

21 Note that in the context of this Plan and per 40 CFR 230, the word "establish" is synonymous with "create." See 73 FR 19594, "Compensatory Mitigation for Losses of Aquatic Resources."

(bloom) and vascular plants. This in turn reduces the availability of light and the aerobic decomposition of dead algae reduces dissolved oxygen, making the water uninhabitable for some species. Some of the algae and bacteria produce relatively large amounts of toxins, which further disrupt the aquatic ecosystem. Since the early 20th century such blooms have been a regular occurrence in the most heavily polluted parts of the Great Lakes in North America, but they have declined as water quality has improved as a result of improved pollution control and water quality management strategies. Lakes can be classified according to their nutrient content as oligotrophic (nutrient poor), mesotrophic (moderately productive), or eutrophic (very productive and fertile).[22]

Extirpated: Locally extinct, for example, a species that no longer survives in regions that were once part of its range, but that still exists elsewhere in the wild or in captivity.[23]

F

Fallow lands: Cropland and agricultural fields that are abandoned or deliberately rested for one full growing season.

Fee-title: Private ownership of real estate in which the owner has the right to control, use, and transfer the property at will. In the SSHCP, preserves could be established through acquisition of land in fee-title (also see "conservation easement").

Five-Point Policy: An addendum to the HCP Handbook, published by the USFWS and NMFS (2000), that provides additional requirements for preparing HCPs, including (1) biological goals and objectives, (2) adaptive management, (3) monitoring, (4) shorter permit duration, and (5) increased public participation.[24]

Flexible preserve: In the SSHCP, 500 acres of "flexible" preserve will be included in the SSHCP Preserve System inside the UDA to mitigate for anticipated take of vernal pool land covers. Flexible preserves must be located inside or within 1 mile of the Mather Core Recovery Area (MCRA) and contain vernal pool resources, and must be established in PPUs 1, 2, or 3. Flexible preserve could be of any combination of minor or satellite-sized SSHCP preserve (see Chapter 7). Also see "core preserve, minor preserve, satellite preserve, linkage preserve, landscape preserve, cropland preserve."

[22] A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.
[23] A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.
[24] USFWS. 2000. "The HCP Handbook Addendum." Accessed September 18, 2014. http://www.fws.gov/Midwest/Endangered/permits/documents/HCPAddendum.pdf.

Flood: A flow beyond the carrying capacity of a waterway channel (e.g., drainage, creek, stream, river).[25]

Floodplain: Normally dry land adjacent to a body of water such as a river or stream that is susceptible to inundation by floodwaters.[26]

Fossorial: Adapted for digging or burrowing into the ground.[27]

Fully protected species: Any species identified in California Fish and Game Code Sections 3511, 4700, 4800, 5050, or 5515. (See discussion of fully protected SSHCP covered species in Section 1.2.4).

G

General plan: A comprehensive policy document required for local land use authorities, usually a county or a city, for the purpose of providing guidance as to the location and type of land use that will be permitted to occur at any given location.[28]

Geographic information system (GIS): Computer-based mapping technology that manipulates geographic data in digital layers and enables one to conduct a wide array of environmental analyses.

Geomorphic provinces (regions): Areas in which distinct land forms and processes shaping such forms are present.[29]

Governing Authority (GA): In the SSHCP, Implementing Entity is a body of elected officials representing each of the Plan Permittees that is responsible for proper implementation of the HCP, ensuring compliance with the Implementing Agreement, monitoring the actions of the Plan Participants, managing fees collected by the Plan Participants, and informing the Plan Participants of changes in status of the HCP. See definition of Implementing Entity.

Governing Board: The Implementing Entity is overseen by a Governing Board that is ultimately responsible for ensuring implementation of the SSHCP. The Governing Board will make all decisions related to the governance and administration of the SSHCP, except where otherwise delegated to other commissions, committees or entities as the Governing Board sees fit.

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25 Corps. 2014. "Glossary." Accessed September 18, 2014. http://chl.erdc.usace.army.mil/glossary.
26 Corps. 2014. "Glossary." Accessed September 18, 2014. http://chl.erdc.usace.army.mil/glossary.
27 A Dictionary of Ecology, Evolution, and Systematics (2 ed.) Cambridge University Press 2013.
28 Fulton, William. 1999. *Guide to CA Planning*. 2nd ed. Point Arena, California: Solano Press Books.
29 Allaby, Michael, ed. 1994. *The Concise Oxford Dictionary of Ecology.* Oxford University Press. New York, 1994: 175.

The JPA Governing Board is limited to the three Land Use Authority Permittees because the Joint Exercise of Powers Act requires that a JPA can only exercise powers held by all the participating agencies.

Greenfield: Undeveloped land, usually either open space or agricultural land cover.

H

Habitat: The place or environment where a plant or animal naturally lives and grows (a group of particular environmental conditions).[30] Habitat may be occupied (i.e., individuals or a population of the species are or have recently been present) or unoccupied. See "Critical Habitat" definition.

Habitat connectivity: The degree to which a landscape facilitates or impedes movement of organisms, eggs, cysts, seeds, or pollen among different resource patches.

Habitat degradation: A notable reduction in the amount and/or quality of habitat.

Habitat fragmentation: Habitat fragmentation is the process by which habitat loss results in the division of large, continuous habitats into smaller, more isolated remnants (see "habitat patches" below). Habitat fragmentation is a landscape-level phenomenon, and patch-level processes (patch area, edge effects and patch shape complexity) can only be understood within a landscape context. A dominant effect of increasing habitat loss is a reduction in patch area, with resulting declines in population density and species richness, and significant alterations to community composition, species interactions and ecosystem functioning.[31]

Habitat patches (islands): Habitat areas that are physically or spatially isolated from other areas of similar habitat type.

Habitat preservation: A process that involves bringing land with Covered Species habitat under protective status through fee title (see "fee title") or conservation easement (see "conservation easement").

Hardline preservation process: This process is termed "hardline" because the exact locations and preserve boundaries are known at this time. Inside the Urban Development Area (UDA), some preserves have already been proposed by willing landowners, but the preserves have not

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[30] USFWS. 2008. Endangered Species: Glossary. Endangered Species Glossary. Last updated July 16, 2014. Accessed September 17, 2014. http://www.fws.gov/midwest/endangered/glossary/index.html.

[31] Didham, Raphael K(Nov 2010) Ecological Consequences of Habitat Fragmentation. In: ELS. John Wiley & Sons Ltd, Chichester. http://www.els.net [doi: 10.1002/9780470015902.a0021904].

been formally put under conservation easement by the SSHCP. These nine "hardline" preserve locations are in PPUs 1 and 2, and total approximately 1,740 acres (see Figures 7-2 to 7-5).

Hardpan: A hardened, impervious layer of soil, such as clay.

I

Implementation Commission: An Implementation Commission will be formed by the Governing Board. This commission will assume some of the duties of the Governing Board including, but not limited to, land or easement acquisition approval and approval of management and monitoring plans for the preserve system.

Implementing Agreement: An agreement that legally binds the permittee to the requirements and responsibilities of a conservation plan and section 10 permit. It may assign the responsibility for planning, approving, and implementing the mitigation measures under the HCP.[32]

Implementing Entity: The body that is responsible for implementation of a permitted HCP. The SSHCP Implementing Entity is composed of a Governing Board, Implementation Commission, various committees and staff who oversee management and administration of the Plan. See definition of "Implementing Agreement."

Implementing ordinance: The primary legal document that the SSHCP Permittees will develop, approve, and execute to formalize consistent and transparent implementation of the SSHCP, Implementing Agreement, and Permits.

Incidental take: Take that results from, but is not the purpose of, carrying out an otherwise lawful activity.[33] See definition of "take" below.

Incidental Take Permit(s) (ITP): A permit that exempts a permittee from the prohibition of take under 9 of the ESA and is issued by the USFWS pursuant to Section 10(a)(1)(B) (also called a Section 10 permit). CDFW may also authorize the incidental take of state-listed species under CESA through issuance of an Incidental Take Permit pursuant to Fish and Game Code Section 2081, subdivisions (b) and (c).

Infiltration: The flow of water downward from the land surface into and through the upper soil layers.[34]

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32 HCP Handbook 1998.

33 USFWS. 2008. Endangered Species: Glossary. Endangered Species Glossary. Last updated July 16, 2014. Accessed September 17, 2014. http://www.fws.gov/midwest/endangered/glossary/index.html.

34 Corps. 2014. "Glossary." Accessed September 18, 2014. http://chl.erdc.usace.army.mil/glossary.

Infiltration basin: A shallow earthen basin constructed in naturally pervious soils, designed for infiltrating stormwater by retaining runoff from development and allowing it to percolate into the underlying soils and into groundwater over a specified drawdown period.

Infiltration trench: A long, narrow trench constructed in naturally pervious soils and filled with gravel, designed for storing runoff until it infiltrates into the soil over a specified drawdown period.

Intermittent stream: A stream that has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow (see also "ephemeral stream" and "perennial stream").

Invasive species: Animals, plants or other organisms introduced by man into places out of their natural range of distribution, where they become established and disperse, generating a negative impact on the local ecosystem and species.[35][36]

J

Jeopardize the continued existence of: Under the federal ESA, an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.[37]

Jump-Start and Stay-Ahead: Provisions included in the SSHCP implementation schedule to ensure mitigation occurs prior to implementation of covered activities. See Chapter 9.

L

Laguna Creek Wildlife Corridor: An SSHCP-planned preserve along Laguna Creek in the northern portion of the Plan Area that is at least 300 feet wide except where existing constraints limit this width. This corridor is designed to maintain species movement, provide resident habitat for wildlife, preserving riparian habitat, and maintaining hydrologic connections between planned preserves inside the UDA. See definition for "SSHCP Preserves," "Wildlife Corridor," and "Stream Corridor."

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35 http://www.iucn.org/about/union/secretariat/offices/iucnmed/iucn_med_programme/species/invasive_species/.
36 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.
37 USFWS. 2008. Endangered Species: Glossary. Endangered Species Glossary. Last updated July 16, 2014. Accessed September 17, 2014. http://www.fws.gov/midwest/endangered/glossary/index.html.

Land cover type(s): The dominant feature of the land surface discernible from aerial photographs and defined by vegetation, water, or human uses. The SSHCP Land Cover types are described in Chapter 3.

Land dedication: Land that is donated by the owner to a qualified land protection organization, generally for open space or conservation use.

Land use: A general characterization of type(s) of uses allowable within a geographic area as determined by a local jurisdiction (e.g., City or County) general plan or zoning ordinance such as housing, business, industry, open space, agriculture, natural resources, recreation, education, public buildings and grounds, and other categories of public and private uses of land. Land use in the Plan Area is described in Chapter 4.

Land Use Authority Permittee(s): These entities have regulatory authority over zoning and entitlements within the Plan Area. Land Use Authority Permittees can extend incidental take coverage provided by the SSHCP ITPs to covered activities implemented by third-party project proponents that are under the jurisdiction of that Land Use Authority Permittee. Land Use Authority Permittees under the SSHCP are the County of Sacramento and the Cities of Galt and Rancho Cordova.

Landscape ecology: Principles and theories for understanding the structure, functioning, and change of landscapes and ecosystems over time.[38]

Landscape preserve: A SSHCP preserve that is at least 10,000 acres in size and containing extensive areas of contiguous natural land covers where natural ecological functions can continue to operate, typically without extensive land management activities. One Landscape preserve will be located outside the UDA. See Section 7.4.1.

LiDAR: Stands for "light detection and ranging." A remote sensing method used to measure ranges to the earth. Used in geographic information system (GIS) processes to create maps and models.[39] In the SSHCP LiDAR was used to developed detailed topographic maps of portions of the Plan Area containing vernal pools; analysis of that topography allowed for identification of microwatersheds.

Linkage Preserve: SSHCP preserves that are generally more linear-shaped landscape features that connect large habitat blocks (e.g., core and minor preserves) and are designed to provide for hydrological connectivity or dispersal and movement of species between preserve areas. See Section 7.4.1.

38 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.
39 NOAA (National Oceanic and Atmospheric Administration). 2014. "What is LIDAR?" Accessed September 15, 2014. http://oceanservice.noaa.gov/facts/lidar.html.

Listed species: A species (including a subspecies or a distinct population segment of a vertebrate species) that is listed as endangered or threatened under the federal ESA or CESA.

Loss of waters: Waters of the U.S. that are permanently adversely affected by filling, flooding, excavation, or drainage because of the regulated activity. Permanent adverse effects include permanent discharges of dredged or fill material that change an aquatic area to dry land, increase the bottom elevation of a waterbody, or change the use of a waterbody. Refer to "Waters of the U.S."

Low-Impact Compatible Land Use: Passive or active open space land uses that have limited indirect effects on wetlands and vernal pool species habitats within adjacent existing and planned preserves. Examples of these compatible adjacent land uses are parks, athletic fields, detention basins, and schools with athletic fields adjacent to preserves. The design and construction of these land uses does not impact the soil hardpan and perched aquifer of the open space area or the adjacent preserve, and does not allow increased runoff into the adjacent preserves. See "open space" below.

M

Mesic: A moderately moist habitat.[40]

Metapopulation: A set of partially isolated populations that belong to the same species, between which individuals can freely migrate.[41]

Microhabitat: The immediate environment in which an organism lives, where factors such as moisture and light may be different from those in the surrounding area.[42]

Minor preserve: SSHCP preserves that are between 250 and 800 acres in size that support populations that are important to the viability of a covered species, have unusually high biological diversity, and/or have a high concentration of sensitive biological resources. Most minor preserves are located in the UDA. See Section 7.4.1.

Mitigation: Any actions that are taken to avoid or minimize negative environmental impacts. This can take various forms, including avoiding the impact by not taking a certain action; minimizing impacts by limiting the scale of the action; rectifying the impact by repairing or

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[40] A Dictionary of Environment and Conservation (2[nd]); Park and Allaby 2013; Oxford University Press.
[41] A Dictionary of Environment and Conservation (2[nd]); Park and Allaby 2013; Oxford University Press.
[42] A Dictionary of Environment and Conservation (2[nd]); Park and Allaby 2013; Oxford University Press.

restoring the affected environment; reducing the impact by taking protective steps; and compensating for the impact by replacing or providing substitute resources.[43]

Mitigation bank: A site, or suite of sites, where aquatic resources (e.g., wetlands, streams, riparian areas) are restored, established, enhanced, and/or preserved for the purpose of providing compensatory mitigation for impacts authorized by USACE permits. In general, a mitigation bank sells compensatory mitigation credits to a USACE permittee whose obligation to provide compensatory mitigation is then transferred to the mitigation bank sponsor. The operation and use of a mitigation bank are governed by a banking enabling instrument[44]. Also see definition of conservation bank above.

Mitigation fee: The proposed fee for any Covered Activities that affect Covered Species or species habitat. These fees will fund the cost of implementing of the SSHCP including (1) land acquisition, (2) habitat establishment, re-establishment and enhancement, (3) monitoring and long-term management, and (4) plan administration components of the SSHCP.[45]

N

Native species: A species that is within its historical natural range, and occurs naturally in a given area or habitat, as opposed to an introduced species or invasive species.[46]

Natural Communities Conservation Plan (NCCP): A CDFW program designed to use an ecosystem approach to conserve natural communities at the ecosystem scale while accommodating compatible land use.

Naturalized habitats or vegetation: Result when non-native species establish new self-perpetuating populations within native habitats or vegetation communities, and undergo widespread dispersal and become permanently incorporated within the resident native habitat or vegetation community.

Navigable waters of the United States: Navigable waters of the United States are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination

43 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.
44 33 CFR Part 332.
45 CEQA Guidelines, Section 15126.4(a)(1).
46 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.

of navigability, once made, applies laterally over the entire surface of the waterbody, and is not extinguished by later actions or events that impede or destroy navigable capacity. [47]

Non-listed species: Means a species or subspecies that is not listed as endangered or threatened under the federal ESA or CESA.

No surprises policy/assurances: Assurances to Permit holders that if unforeseen circumstances arise, the USFWS will not require more land, water, or money or additional restrictions on the use of land, water, or other natural resources beyond the level stated in the Habitat Plan without the consent of the Permittee (63 FR 35, February 23, 1998). Applies as long as Permittee is implementing terms and conditions of the Habitat Plan properly. [48]

O

Occurrence: Plant taxa, animal taxa, and natural communities in the CDFW California Natural Diversity Database (CNDDB) are referred to as “elements.” An “element occurrence” or “occurrence” is a location record for a site which contains an individual, population, nest site, den, or stand of a special status element. Populations, individuals, or colonies located within 1/4 mile of each other generally constitute a single occurrence, sometimes with multiple “parts. An occurrence from a source other than the CNDDB is generally defined as a spatially discrete point location or database record for any particular resource (e.g., special-status plant or animal).

Open space land (rural and urban): The County of Sacramento General Plan (2011) defines rural and urban open space as follows:

- ***Rural open space:*** Open space areas are largely un-fragmented areas of undeveloped land that are set aside primarily to preserve and/or enhance the County’s wildlife habitat, agricultural productivity and recreational opportunities**.**
- ***Urban open space:*** Urban open space areas are typically undeveloped land within urbanized areas that are set aside to provide public recreational opportunities as well as the chance to experience natural areas and wildlife habitat. They may also be developed areas that are available to the public to provide a feeling of openness.

Ordinary High Water Mark (OHWM): A line on the shore or stream channel established by the fluctuations of water and indicated by physical characteristics or by other appropriate means that consider the characteristics of the surrounding area (see 33 CFR 328.3(e)).

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[47] 33 C.F.R. § 329.4.
[48] Santa Clara Valley Habitat Plan. August 2012.

P

Participating Special Entity: In the SSHCP defined as a public agency such as a water, school, irrigation, transportation, or other special district that is not subject to the jurisdiction of Plan Permittees but that requests and receives coverage under the SSHCP during implementation according to the terms of the SSHCP.[49]

Perched aquifer: Groundwater that is separated from the underlying main body of groundwater (aquifer) by a layer of impermeable clay, silica/iron complex or bedrock (aquiclude).[50] Perched water tables supporting vernal pools can exist for several months during the winter/spring months (drying out by late summer).

Perennial stream: A stream that normally contains flowing water at all times.[51] (see also "intermittent stream" and "ephemeral stream").

Performance standards: Under Section 404 of the CWA defined as observable or measurable physical (including hydrologic), chemical and/or biological attributes that are used to determine if a compensatory mitigation project meets its objectives.

Permit amendment: A change to the incidental take permit(s) issued by the USFWS or CDFW that necessitate a renegotiating and reissuing of the permit(s). Modifications and amendments are defined as follows.

- ***Administrative revisions:*** non-substantive changes or corrections to the Plan that do not require approval from the Permitting Agencies.
- ***Minor Modifications:*** changes that do not adversely affect the impact assessments or conservation strategy described in the Habitat Plan and do not adversely affect the ability of the Implementing Entity to achieve the conservation strategy commitments of the SSHCP.
- ***Amendments:*** revisions to the SSHCP, Aquatic Resources Program, or the Implementing Agreement that may affect an impact analysis, so would require a corresponding amendment to one or all of the SSHCP Permits.

Permitting Agencies: Agencies that are issuing permits for the SSHCP or developing programmatic agreements for the SSHCP. In the SSHCP the permitting agencies are: California Department of Fish & Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), U.S. Army

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49 "Glossary." Santa Clara Valley Habitat Plan. August 2012.
50 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.
51 Corps. 2014. "Glossary." Accessed September 18, 2014. http://chl.erdc.usace.army.mil/glossary.

Corps of Engineers (USACE), Regional Water Quality Control Board (RWQCB), and U.S. Environmental Protection Agency (EPA).

Plan Area: The area encompassed by the SSHCP permits within which the Plan Permittees have authorization from the Wildlife Agencies for the take of Covered Species and species habitat resulting from Covered Activities. See Chapter 1.

Plan Permittees: The SSHCP was prepared by six local jurisdictions, including the County of Sacramento, City of Galt, City of Rancho Cordova, Sacramento County Water Agency, Sacramento Regional County Sanitation District, and the Southeast Connector Joint Powers Authority. These six permit applicants and a (to be formed) SSHCP Implementing Entity are collectively referred to as the Plan Permittees.

Population: A group of individuals of the same species who are living in the same area at the same time and share a common gene pool, which makes it possible for them to interbreed.[52] Also see definition of "Occurrence."

Population size: The number of individuals in a given population.

Pre-Acquisition Preserve Documentation Report (PDR): A report that assesses the baseline inventory of SSHCP land cover types, species occurrences, and general ecological health and function of a property prior to the inclusion of the property in the SSHCP Preserve System and the acceptance of a land dedication, a fee title purchase, or an easement purchase.

Pre-construction survey: A survey that is conducted to identify Covered Species and/or their habitats on a given property or land area prior to the initiation of a ground-disturbing covered activity, to ensure that species and habitat avoidance and minimization measures can be effectively implemented during that activity. Specifics for pre-construction surveys are dictated by relevant species protocols.

Pre-design survey: Surveys that are required during preparation of the Project Application Package These surveys assess the location and quantity of modeled habitat and the potential for select Covered Species to be present at the project site. The surveys require land cover type mapping and wetland delineations. Based on land cover type mapping, the Land Use Authority Permittee or Implementing Entity will assess the potential for each covered species to be present on the project site and to be affected by the proposed action. The potential for presence is based on the presence of modeled habitat for a species. Depending on the land

52 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.

covers present, specific Covered Species surveys may be required as directed by Species AMMs (Section 5.2). See Chapter 10.

Preservation/Preserve (verb): For purposes of the SSHCP Conservation Strategy, preventing changes in land use from a natural state by, for example, purchasing land in fee title or establishing a conservation easement. For purposes of the ARP, the removal of a threat to, or preventing the decline of, aquatic resources by an action in or near those aquatic resources. This term includes activities commonly associated with the protection and maintenance of aquatic resources through the implementation of appropriate legal and physical mechanisms. Preservation does not result in a gain of aquatic resource area and functions.

Preserve (noun): A SSHCP Preserve is a discrete area of habitat acquired and managed for the benefit of Covered Species.

Preserve Assembly Guideline: The SSHCP preserve assembly guidelines (see Section 7.3.1) will be applied by the Implementing Entity in a manner that will assemble the SSHCP Preserve System described in Section 7.5, and will assure that all SSHCP Biological Goals and Measurable Objectives specifying preserve acquisition objectives are achieved. Because the exact locations and boundaries of the softline criteria-based preserves are unknown, the SSHCP Conservation Strategy presents and analyzes a conceptual Preserve System based on reasonable assumptions regarding potential acquisition areas.

Preserve Management Plan (PMP): A document prepared for individual SSHCP preserves that tiers from the Preserve System Management Plan (see below) . Each PMP will set forth the management actions to be employed on the property to benefit Covered Species and habitats to provide for meeting the SSHCP biological goals and objectives, identify habitat and species monitoring requirements on that preserve, and include criteria for implementing adaptive monitoring and management of the preserve.

Preserve Planning Unit (PPU): PPUs are geographic subdivisions of the Plan Area delineated to capture specific habitat or agricultural land cover types or areas identified as being important for a specific Covered Species. There are eight PPUs. See Chapter 1.

Preserve Setback: A setback of at least 50-feet established outward from the boundary of any existing and planned preserve within the UDA to reduce impacts that may result from adjacent urban development Covered Activities. The minimum 50-foot setback will remain in its natural state and function as a transition area between intensive development and preserves. See Section 5.2.7, Covered Activities in Preserve Setbacks,

Preserve System: The SSHCP Preserve System is composed of individual SSHCP Preserves (see "Preserve" above). The SSHCP Preserve System will connect with existing preserves to best conserve the natural/naturalized land covers, cropland, and irrigated pasture-grassland in the Plan Area.

Project: See Covered Activities above.

Project proponent: Means a person or entity (third-party) that has requested use of the SSHCP permits held by the one of the Land Use Authority Permittee or Implementing Entity for a proposed project or activity that is a SSHCP Covered Activity and that is subject to the land use or other regulatory authority of that Land Use Authority Permittee or Implementing Entity.

R

Range: The limits of the geographical distribution of a species; the entire geographical area over which a species occurs.

- ***Historic Range:*** The natural range or geographical areas that a particular species was known or believed to occupy in the past.[53]
- ***Known Range:*** The geographical area over which a species has lived naturally in recent times or is known to occur.[54]

Recharge: The flow to groundwater from the infiltration of surface water.

Recovery: Improvement in the status of a listed species to the point at which listing is no longer appropriate under the federal ESA listing criteria.[55] Also see definition of "Listed Species."

Recovery plan: A document authored by USFWS or NOAA Fisheries that serves as a guide for activities to be undertaken by federal, state, or private entities in helping to recover and conserve endangered or threatened species.[56]

Re-establishment: For the SSHCP Conservation Strategy, re-establishment means the act of replacing, restoring, or renovating habitat to close to its historical condition, such as the physical and vegetation structure and ecosystem functions of a damaged habitat. For the ARP, a form of restoration in which there is manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historical functions to a former aquatic resource or land cover type. Re-establishment results in rebuilding a former aquatic resource/land cover type,

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53 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.
54 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.
55 "USFWS Endangered Species Act Glossary." http://www.fws.gov/midwest/endangered/glossary/index.html. Accessed 09/11/08.
56 USFWS. 2008. Endangered Species: Glossary. Endangered Species Glossary. Last updated July 16, 2014. Accessed September 17, 2014. http://www.fws.gov/midwest/endangered/glossary/index.html.

and results in a gain in aquatic resource area/land cover type and functions. Also see SSHCP definition of establishment (creation).

Restrictive Layer (e.g., duripan, hardpan, claypan): A layer of impermeable clay, silica/iron complex or bedrock within the soil horizon that precludes infiltration to the groundwater aquifer. Also see "Perched Aquifer."

Right-of-way: A legal right of passage over private property, usually for roadways, railroads, or public utilities.

Rural collector roadways: Two-lane roads in rural areas of Sacramento County.[57] Also see definition for "Arterial Roadways."

S

Satellite preserve: SSHCP Preserves that are smaller than core and minor preserves (i.e., less than 250 acres), but that support populations that are important to the viability of a covered species in the Plan Area, or have a particularly high concentration of sensitive biological resources. Satellite preserves are inside the UDA. See Section 7.4.1.

Softline criteria-based preserve design: A strategy used to create future habitat preserves based on a set of guidelines and parameters for preserve system design, including a system of zones and sub-zones, to guide the process of land acquisition for the Preserve System over time. Also see definition for "hardline preserve design."

Species modeled habitat: Covered species suitable habitat was "modeled" based on the best available information on the life history and biology of each covered species, the species habitats needed for breeding and for feeding or sheltering at each life history stage, known occurrences within the Plan Area, associations between covered species and the SSHCP land cover types in the Plan Area, and when available information on range, soil type associations and elevation limits. Each species model was reviewed by local species-experts. This information was compiled using GIS to generate a map-based model of species suitable habitat within the Plan Area for each SSHCP covered species. See Chapter 3 of the SSHCP.

Species range: See "range."

[57] County of Sacramento. 2009. "Circulation – Transportation Element." Sacramento County General Plan of 2005-2030. Amended November 9, 2011. Sacramento, California: Sacramento County Community Planning and Development Department. Accessed September 12, 2014. http://www.per.saccounty.net/PlansandProjectsIn-Progress/Pages/GeneralPlan.aspx.

Specific plan: A plan developed by a Land Use Authority that sets forth policy and implementation strategies for such items as land use, transportation, urban design, parks, schools, and public services, in a defined geographic area, for the purpose of implementing a General Plan on an area-specific basis.[58]

Sphere of influence (SOI): A plan for the probable ultimate physical boundaries and service area of a city as determined by the local agency formation commission of each county.[59]

State-listed species: Species that are listed as threatened or endangered species, or a candidate for such status, under CESA.

Stay-Ahead and Jump-Start: Provisions included in the SSHCP implementation schedule (see Chapter 10) to ensure mitigation occurs prior to implementation of covered activities.

Stream Setback: Designated areas adjacent to streams within which only specified activities could occur in order to prevent or reduce impacts. See Section 5.2.6 Covered Activities in Stream Setbacks, See also "Preserve Setback" and "buffer."

Submergent vegetation: Vegetation that is inundated by water.

Substrate: The surface on which a plant or animal lives and grows; for example a rocky or sandy substrate.[60]

Suitable habitat: Specific SSHCP land cover types where the environmental and geographic conditions (i.e., biotic and abiotic conditions) are present for a given species to persist and survive. Essential habitat elements are present. Suitable habitat can be represented by specific areas on a geographic map when the distribution of environmental factors are known and/ or defined through criteria based upon the environmental conditions the species requires. Suitable habitat may be occupied (i.e., individuals or a population of the species are or have recently been present) or unoccupied. See "species modeled habitat."

Swale: Drainages typically found in flat to gently rolling valley grassland in association with vernal pool complexes on shallow soils with an impermeable clay or hardpan layer. They convey runoff through broad gently sloping ephemeral drainages during, and for short periods after, rainstorms. Soils may remain saturated during the early part of the growing season, but dry up by summer. Swales support several of the native plants commonly found in vernal pools. Swales

58 County of Sacramento. 2014. "Specific Plans/Community Plans/Special Projects." MSA Planning and Community Development Department. Accessed September 18, 2014. http://www.planning.saccounty.net/plans-projects.html.

59 Fulton, William. 1999. *Guide to CA Planning*. 2nd ed. Point Arena, California: Solano Press Books.

60 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.

associated with vernal pools may provide conduits for movement of covered plant and animal propagules (seeds, cysts, eggs, and spores) and adult California tiger salamanders and western spadefoots among vernal pools.

T

Take: Under the CESA and the California Fish and Game Code (Section 86), "take" is defined as "hunt, pursue, catch, capture, or kill," or an attempt to do any such act, and violations of CESA's take prohibition are criminal misdemeanors under State of California law (Fish and Game Code, Section 86, 12000)

Under the federal ESA, "Take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct; may include significant habitat modification or degradation if it kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering (16 U.S.C. 1532).

- ***Harass:*** Harass in the definition of "take" in the ESA means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3).
- ***Harm:*** Harm in the definition of "take" in the ESA means an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering (50 CFR 17.3).

Technical Advisory Committee (TAC): Part of the SSHCP Implementing Entity. The committee formed to inform the scientific decisions made by the Implementing Entity in implementing the SSHCP, as provided in Section 10.2.4 and as further described in Chapter 10.

Terrace: A relatively flat, natural surface along a river valley, above the level of the floodplain.[61]

Third-party project proponents: Individuals, landowners, other private parties, or Participating Special Entities P that are not Plan Permittees and that receive coverage under a Plan Permittees ITPs in accordance with Chapter 9.

Turbidity: The degree of cloudiness in water (or air) that is caused by the presence of suspended solids.[62]

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61 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.

U

Unforeseen circumstance: Changes in circumstances surrounding an HCP that were not or could not be anticipated by HCP participants and the USFWS that result in a substantial and adverse change in the status of a covered species.[63] Also see definitions of "changed circumstance" and "no surprises rule."

Unincorporated county: The area of Sacramento County not within the boundaries of an incorporated city.[64]

Upland habitat: Covered Species habitat for generally aquatic species that occurs within a terrestrial land cover type. The SSHCP identifies upland habitat for California tiger salamander, western spadefoot, giant gartersnake, and western pond turtle.

Urban Development Area (UDA): As defined in the SSHCP, an area that shows the potential extent of future development based on the anticipated expansion of infrastructure and areas designated for development by local jurisdictions, which may extend beyond the Urban Services Boundary (USB); those locations within the Plan Area that are also within the Sacramento County USB, and the incorporated Cities of Rancho Cordova, Galt, and Galt's sphere of influence (a.k.a. Urban Development Area).

Urban Policy Area (UPA): As identified in the County of Sacramento General Plan (2011), an area of Sacramento County capable of supplying a 20-year supply of developable land sufficient to accommodate projected growth; intended to direct growth in a logical manner and to identify areas where infrastructure, requiring large capital investments, will be needed in the near future.[65]

Urban Services Boundary (USB): As identified in the County of Sacramento General Plan (2011), the boundary demarcating the area within which long-range urbanization will occur in Sacramento County, and urban services, such as water and sewer, will be provided; attempts to limit urban sprawl, thereby protecting open space and agricultural areas outside the USB boundary.[66]

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62 A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.
63 USFWS. The HCP Handbook. Accessed September 18, 2014. http://www.fws.gov/endangered/esa-library/pdf/hcp.pdf.
64 Fulton, William. 1999. *Guide to CA Planning*. 2nd ed. Point Arena, California: Solano Press Books.
65 County of Sacramento. 2011. "Land Use Element." *Sacramento County General Plan*. November 2011. Accessed September 18, 2014. http://www.per.saccounty.net/LandUseRegulationDocuments/Documents/General-Plan/Land%20Use%20Element%20-%20Amended%2011.9.11.pdf.
66 County of Sacramento. 2011. "Land Use Element." *Sacramento County General Plan*. November 2011. Accessed September 18, 2014. http://www.per.saccounty.net/LandUseRegulationDocuments/Documents/General-Plan/Land%20Use%20Element%20-%20Amended%2011.9.11.pdf.

V

Vernal pool: Vernal pools are a type of depressional seasonal wetland that is characterized by an annual cycle of winter inundation and summer drought which result in a specific set of physical parameters and a unique assemblage of highly specialized endemic plants and animals. Vernal pools retain water seasonally due to a shallow, impermeable soil layer beneath the surface and the absence of a drainage outlet.[67] See “restrictive layer” and “perched aquifer” and “microwatershed.” See definition of SSHCP Vernal Pool land cover type in Chapter 3.

Vernal pool crustacean habitat: Typified by vernal pools, vernal pool crustacean habitat is a class of depressional wetlands ranging from well vegetated vernal pools and seasonal wetlands to sparsely to non-vegetated playa/alkali lakes and rock pools. Species have also been found in roadside ditches, tire ruts and other non-natural depressional areas. The most prominent feature of vernal pool crustacean habitat is the presence of a pronounced wet/dry hydrologic regime. The wet/dry cycle begins with a wet phase in which the pools inundate during the rainy season and a dry phase beginning in late spring or early summer. Vernal pool crustacean habitat may inundate and dry down more than once in a season. Vernal pools have highly specialized endemic wetland vegetative communities that are adapted to the distinct wet/dry hydrologic regime. The vegetative community can consist of both obligate (occur in inundated portion of wetland only) and facultative (may occur along saturated fringe and transition to upland) wetland species, but is predominantly endemic wetland obligate species. However, vernal pool crustacean habitat may include shallow depressional wetlands characterized by non-native plant species and wetland facultative plant species. Vernal pool crustacean habitat is strongly related to the hydrologic regime of the wetlands which can also be a function of the soils and underlying substrate. Most vernal pool crustacean habitat falls into one of two categories with regards to hydrology, a surface flow system or a perched aquifer/surface water system. Each system has characteristic hydrologic patterns and water quality characteristics. Vernal pool crustacean habitat is not currently identified as a SSHCP land cover type, however for the purposes of analysis and impact assessment all vernal pool land cover types are considered vernal pool crustacean habitat.

Vernal Pool Landscape: Vernal pool landscape is an aggregation of SSHCP land cover types consisting of vernal pools, swales, streams/creeks (vernal pool invertebrate habitat), and valley grassland. This aggregation was developed as a GIS overlay for the purposes of conducting impact analysis and developing the SSHCP Conservation Strategy based on conservation of vernal pool landscapes, including all the components of the vernal pool landscape ecosystem.

[67] USFWS. 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon.

W

Water quality: The chemical, physical, and biological characteristics of a water body, usually in respect to its suitability for habitat or another particular purpose.[68]

Waters of the U.S. The term waters of the United States means:

1. All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
2. All interstate waters including interstate wetlands;
3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
    a. Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
    b. (From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
    c. Which are used or could be used for industrial purposes by industries in interstate commerce;
4. All impoundments of waters otherwise defined as waters of the United States under this definition;
5. Tributaries of waters identified in paragraphs (s)(1) through (4) of this section;
6. The territorial sea;
7. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (s)(1) through (6) of this section; waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.11(m) which also meet the criteria of this definition) are not waters of the United States.

Watershed: In the ARP, a land area that drains to a common waterway, such as a stream, lake, estuary, wetland, or ultimately the ocean.[69]

[68] "USGS Water Science Glossary of Terms." USGS. http://ga.water.usgs.gov/edu/dictionary.html#U. Accessed 09/11/08.

Wildlife Agencies: In the SSHCP, the Wildlife Agencies are the United States Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW) in combination. Also see definition for "Permitting Agency."

Wildlife corridor: A linear landscape feature that facilitates the movement of plants and animals between two or more habitat patches. Sacramento County's Laguna Creek Wildlife Corridor is an important landscape feature in the Plan Area and will be an important component of the Plan-wide Preserve System for maintaining movement and resident habitat for wildlife, preserving riparian habitat, and maintaining hydrologic connections between preserves inside the UDA. Outside the UDA, the Cosumnes River/Deer Creek Corridor serves a similar function. See Section 7.4.1 and the definition for "stream corridor."

X

Xeric: Having very little moisture, tolerant of or adapted to dry conditions.[70]

[69] 33 CFR 332.2 [§ 230.92]. http://www.poa.usace.army.mil/Portals/34/docs/regulatory/33cfr332.pdf.
[70] A Dictionary of Environment and Conservation (2nd); Park and Allaby 2013; Oxford University Press.

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APPENDIX A2

Acronym List

APPENDIX A2
Acronym List

Acronym/Abbreviation	Definition
AMM	Avoidance and Minimization Measure
amsl	above mean sea level
APLIC	Avian Power Line Interaction Committee
ARB	California Air Resources Board
ARP	Aquatics Resource Program
ATV	all-terrain vehicle
BBS	Breeding Bird Survey
BCI	Body Condition Index
BGO	biological goal and objective
BMP	best management practice
BO	Biological Opinion
CAAQS	California Ambient Air Quality Standards
Cal-IPC	California Invasive Plant Council
CAS	Climate Adaptation Strategy
CCCI	California Construction Cost Index
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
CHU	Critical Habitat Unit
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CRAM	California Rapid Assessment Method
CRPR	California Rare Plant Rank
CWA	Clean Water Act
CWHR	California Wildlife Habitat Relationships
CWMW	California Wetland Monitoring Workgroup
DDT	dichlorodiphenyltrichloroethane
EBMUD	East Bay Municipal Utility District
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
ESA	federal Endangered Species Act
e-waste	electronic waste
FCAM	Condition Assessment Methods
FEMA	Federal Emergency Management Agency
FTE	full-time equivalent
GIS	geographic information system
HCP	habitat conservation plan
HUC	hydrologic unit code
I-5	Interstate 5
IA	Implementing Agreement

Acronym/Abbreviation	Definition
INRMP	Integrated Natural Resources Management Plan
IRT	Interagency Review Team
ITP	Incidental Take Permit
JPA	Joint Powers Authority
LAFCO	Local Agency Formation Commission
LAU	land area unit
LAWG	Local Agency Working Group
LID	low-impact development
LIDAR	Light detection and ranging
LOS	level of service
MBTA	Migratory Bird Treaty Act
MMP	Monitoring and Management Program
MS4	municipal separate storm sewer system
N-deposition	nitrogen deposition
NCCP	Natural Community Conservation Plan
NEPA	National Environmental Policy Act
NHD	National Hydrography Dataset
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Association
Nox	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NWR	National Wildlife Refuge
OHV	off-highway vehicle
OHWM	ordinary high-water mark
PAC	Public Advisory Committee
PAO	Proportion of Area Occupied
PCE	Primary Constituent Element
PDR	Preserve Documentation Report
PG&E	Pacific Gas & Electric
PMP	Preserve Management Plan
PPU	Preserve Planning Unit
PRMP	Preserve Resource Management Plan
RAWG	Regional Agency Working Group
RDM	residual dry matter
Regulatory Agencies	USFWS, CDFW, ACOE, and SWRCB
ROG	reactive organic gas
ROW	right-of-way
RWQCB	Regional Water Quality Control Board
SACOG	Sacramento Area Council of Governments
SAFCA	Sacramento Area Flood Control Agency
SASD	Sacramento Area Sewer District
SCWA	Sacramento County Water Agency

Acronym/Abbreviation	Definition
SOI	sphere of influence
SMAQMD	Sacramento Metropolitan Air Quality Management District
SMUD	Sacramento Municipal Utilities District
SR	State Route
SRCSD	Sacramento Regional County Sanitation District
SSHA	South Sacramento Habitat Agency
SSHCP	South Sacramento Habitat Conservation Plan
SSQP	Sacramento Stormwater Quality Partnership
SSURGO	Soil Survey Geologic Database
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
UDA	Urban Development Area
UPA	Urban Policy Area
USACE	United States Army Corps of Engineers
USB	Urban Services Boundary
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
VPIH	Vernal Pool Invertebrate Habitat
VWADI	vernal wetland acre/density index
Wildlife Agencies	USFWS and CDFW
WRAMP	Wetland and Riparian Area Monitoring Program

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APPENDIX B

Species Accounts

1 DWARF DOWNINGIA (DWDO)

Prepared by Dittes and Guardino Consulting (John Dittes and Josephine Guardino)

Dwarf Downingia (DWDO)
(Downingia pusilla)
Status USFWS: None

Status CDFG: None

Status CNPS:2.2

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1.1 Legal Status

Dwarf downingia (*Downingia pusilla*) is considered to be rare, threatened or endangered in California, but more common elsewhere, thus qualifying its designation as a list 2.2 species by the California Native Plant Society (CNPS), meaning it is fairly threatened in California with a moderate degree/immediacy of threat, but it is more common outside of California (CNPS 2010). It has been assigned an R-E-D Code of 1-2-1, meaning it is rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low at this time, it is endangered in a portion of its range, and it is more or less widespread outside of California.

Being a CNPS List 2 plant species, dwarf downingia meets the California Department of Fish and Game (CDFG) definition of a special plant though it has no formal protection status by the CDFG or United States Fish and Wildlife Service (USFWS).

1.2 Life History and Ecology

1.2.1 Species Description and Life History

1.2.1.1 Morphology

Dwarf downingia, a strict endemic of the vernal pool hydrologic regime, is an annual member of the Bellflower family (Campanulaceae). This inconspicuous species is variable with regard to stem length (Mason 1957). Single small-stature plants can be erect and less than three centimeters in height at maturity, or longer branched stems (up to 15 cm) can sprawl horizontally, forming relatively dense colonies, or mix with the other sprawling vernal pool species (Dittes pers. obs.). Small (five to ten millimeter-long) narrowly linear leaves are alternately arranged on the stems. Single flowers are borne in the leaf axils towards the tips of the stems.

Dwarf downingia possesses atypical flowers within the genus with regard to size and symmetry. Typical *Downingia* flowers, ranging from five to 19 millimeters in length, are bilaterally symmetrical, with two narrow "upper petals" and a broad, three-lobed "lower petal." These five corolla lobes, mostly blue or blue-purple with varying combinations of white and yellow, are united into a tube below their bases. The flower is borne at the apex of a long narrow stalk-like ovary (inferior ovary).

In comparison to characteristically showy *Downingia* flowers, the flowers of dwarf downingia are very small, ranging from only 2.5 to 5.4 millimeters in length. In addition, they lack the strong bilateral symmetry characteristic of other *Downingia* species; dwarf downingia flowers appear almost radial or star-like, with five narrow, triangular lobes that barely exceed the green calyx lobes. Dwarf downingia flowers can be white or blue, with two small yellow spots near the throat (Hickman 1993). This is a very inconspicuous plant and must be surveyed for while in flower, as there is no other way to identify this species.

1.2.1.2 Ecological Life Cycle

Other than field observations recorded in the California Natural Diversity Data Base (CNDDB) (CDFG 2010), basic taxonomy and biogeographic treatments, dwarf downingia remains mostly unstudied. Since all vernal pool plant species share similar environmental selective pressures, they likely also share similar adaptive traits. For this reason, studies addressing the life history and ecology of other more common vernal pool plant may species provide some insight into the life history and ecology of dwarf downingia.

Dwarf downingia shares the annual growth habit with the vast majority of other endemic vernal pool plants. This adaptive trait allows populations to persist through the regular and extreme summer drought that characterizes vernal pools and the Mediterranean Climate (Griggs and Jain 1983; Holland 1987; Stone et al. 1988; Zedler 1990).

1.2.1.3 Seed Germination

The specific timing of the germination of dwarf downingia seeds relative to the timing of the vernal pool inundation cycle has not been studied or described in detail. In general, *Downingia* seeds germinate during the early stages of vernal pool inundation (Zedler 1987). Studies involving germination of *Downingia cuspidata* have demonstrated a required pretreatment for germination at high percentages, although complete submersion was not required (Myers 1975).

Studies involving *D. concolor* have had erratic to poor germination results (Hoover 1937; Linhart 1972 as reported in Zedler 1987). Seeds of other more common *Downingia* spp. occurring in the Sacramento Valley (*D. bicornuta, D. ornatissima, D. cuspidata, D. bella*) germinate under water in pool basins or in inundated soil at shallow edges of filled pools (Dittes pers. obs.). Germination requirements and optima for dwarf downingia have not been investigated. Seed dormancy and required environmental cues for in-situ germination may exist, but are presently unknown.

1.2.1.4 Vegetative Growth

One of the challenges posed to many vernal pool plant species is optimization of photosynthesis and other metabolic processes in both the early season aquatic and later season terrestrial phases of the vernal pool cycle. *Downingia* and many other vernal pool species, being amphibious, possess differing aquatic and terrestrial growth forms. After germination, seedlings and young plants growing under water produce thickened, elongate, spongy stems with large air chambers, and narrowly linear leaves that lack waxy cuticle (Weiler 1962). Stems produced in the terrestrial phase are thinner with denser tissue, and leaves are somewhat wider, thicker and posses waxy cuticle. The air-filled aquatic stems hold the plant vertical in the water column and with the thinner leaves, facilitate light exposure and gas exchange. This in effect lengthens the growing season by maximizing growth while vernal pools are still inundated.

1.2.1.5 Reproduction

Dwarf downingia and other species in the genus flower and set seeds during the dry-down and terrestrial phase of the vernal pool hydrologic cycle, typically during March through May (CNPS 2010). The very small, reduced flowers and included anthers and stigma reflect a self-fertilizing breeding system for dwarf downingia, in contrast to the outcrossing strategy for almost all other Downingias (Weiler 1962; Zedler 1987; Thorp 1990). Once fertilized, the inferior ovary elongates into a narrow stalk like capsule that can reach two to three centimeters in length. The mature capsules produce numerous minute dust-like seeds that are released as the capsule disintegrates through the late spring, summer and fall months. Fecundity and variation in seed production have not been investigated in dwarf downingia.

1.2.1.6 Dispersal

In many other vernal pool species, seed dispersal is naturally limited, although this has not been stated specifically for *Downingia*. Limited seed dispersal in vernal pool species is thought to represent an adaptation to spatially unpredictable and limited vernal pool habitat (Griggs 1974, 1980). Natural dispersal of dwarf downingia seeds likely occurs via flowing water, transport on feet and feathers of waterfowl, and in mud on hooves and legs of livestock.

Evidence of dwarf downingia dispersal and colonization exists in occupancy of man-made topo-hydrologic features within occupied vernal pool landscapes (stock pond margins, roadside ditches, rutted tire tracks, gravel pits and scraped depressions (Witham 1991; CDFG 2010). As with all other vernal pool species, natural dispersal of seeds was likely a more frequent event when there were many more vernal pools, more pool interconnectivity, exceedingly larger waterfowl migrations and unfenced roaming ungulates (Griggs 1980). Dwarf downingia, and about 10-15 other vernal pool species occur both in Californian and South American vernal pool habitats (amphitropical); a distribution most likely resulting in historic long-distance dispersal by migratory waterfowl (Zedler 1987).

1.2.1.7 Seed Dormancy

The existence of a dormant soil seed bank is unknown for dwarf downingia. The presence of a persistent soil seed bank provides insurance against localized extirpation resulting from the unpredictable occurrence and duration of appropriate growing conditions. If total seed crop failure occurs in a given year or set of years (failure to germinate, loss to late season flooding or fire, excessive grazing by livestock or grasshopper herbivory), additional stored seeds are available for another year's effort.

1.2.1.8 Population Genetics

The population biology and genetics of dwarf downingia have not been investigated, so intra- and inter-population patterns of genetic variability are unknown. Elam (1998) provides a good overview of the myriad considerations in assessing the population genetics of vernal pool plants in the absence of empirical data for a given taxon. Given the limited number of occurrences and the scattered geographical distribution, all intra-pool dwarf downingia populations should be considered unique, and for the purposes of conservation, important genetic entities.

1.2.2 Habitat Requirements and Ecology

1.2.2.1 Biogeography and Landform Relations

It is generally held that many of the endemic vernal pool plant species, including downingias, are relatively recent evolutionary derivations of more common and widespread upland progenitors (Stebbins 1976; Stone 1990; Raven and Axlerod 1978; Thorne 1984). These neoendemic vernal pool species are thought to have evolved from terrestrial habitat into seasonally aquatic vernal pool habitat made available as the Mediterranean Climate developed and the inland Tertiary-age Sea dried.

Dwarf downingia occurrences are associated mainly with northern claypan vernal pools in central Sacramento County, with northern hardpan vernal pools in the foothills of the Sierra Nevada, and with vernal pools of the Interior Valleys of the Coast Range in Napa and Sonoma Counties (CDFG

2010). Throughout this area, the species occurs on a variety of landforms and soil associations. In Sacramento County, dwarf downingia occurs primarily on the Laguna and Riverbank.

1.2.2.2 Hydrology Relations

Dwarf downingia is a strict endemic of the vernal pool hydrologic cycle. It is of importance to conservation however, that in contrast to the "deeply-adapted" vernal pool grasses of the Orcuttiae Tribe, and legenere (*Legenere limosa*), dwarf downingia occupies more commonly occurring, smaller and/or shallower vernal pools with comparatively more "flashy" hydrology (CDFG 2010; Dittes pers. obs.). In a survey of eight dwarf downingia-occupied vernal pools at Beale Air Force Base, the mean vernal pool area was found to be 299 square meters (357.6 square yards) and the mean vernal pool depth was 20.8 centimeters (8.2 inches). These are reported as being of average area and depth among the pools measured in that study (Platenkamp 1998). Vernal pool dimensions or reference to size are not given for any of the other CDFG occurrences. Dwarf downingia is also known to occupy the margins of larger or deeper vernal pools, and the seasonally fluctuating vernal pool-like edges of more severely inundated systems, including seasonal marsh, slough and stock pond habitats.

1.2.2.3 Biological Community Relations

Floristic associations provide further indication of preference for less extreme (more typical) vernal pool hydrological cycles. Dwarf downingia grows in the same hydro-topographical position as more commonly occurring vernal pool associates, including Fremont's goldfields (*Lasthenia fremontii*), smooth goldfields (*L. glaberrima*), dwarf wooly marbles (*Psilocarphus brevissimus*), Oregon wooly marbles (*P. oregonus*), annual hairgrass (*Deschampsia danthonoides*), popcorn-flowers (*Plagiobothrys stipitatus* var. *micranthus, P. bracteatus),* double-horned downingia (*Downingia bicornuta*), mousetail (*Myosurus minimus*), American pillwort (*Pilularia americana*), quillwort (*Isoetes howellii*), coyote thistle (*Eryngium* spp.), and others. All species reported as associates of dwarf downingia in Sacramento County (CDFG 2010). Most of these are commonly occurring vernal pool species that inhabit small to medium size vernal pools and swales, and the slopes and margins of larger and/or deeper pools. It is interesting to note that at least one population has been reported as growing among deeper pool associations [e.g., smooth goldfields*,* common spikerush (*Eleocharis macrostachya*)*,* and water starwort (*Callitriche marginata)]*.

1.2.2.4 Non-Native Weed Relations

Hydrological stresses associated with vernal pools exclude the majority of non-native weedy species that characterize the present-day valley annual grassland, agricultural fields, and ruderal habitats. Italian wild rye (*Lolium multiflorum*) and Mediterranean barley (*Hordeum marinum* ssp, *gussoneanum*), two non-native facultative wetland species typically dominate disturbed wetlands and can be invasive in smaller, more ephemeral vernal pool types. Some suggest that built-up thatch from Italian wild rye, Mediterranean barley, Medusa-head grass (*Taeniatherum caput-medusae*), and other non-native upland species may indirectly affect vernal pool species as well by lessening the amount of water entering the system through surface and subsurface flow (Robins and Vollmar 2002).

Since dwarf downingia occupies the smaller to medium size, "more typical" vernal pool types and the margins of larger or deeper pools, it may be more susceptible to the effects of excessive growth of Italian wild rye and Mediterranean barley and thatch buildup than the Orcuttiae grasses, or the more deeply-adapted legenere.

Other weedy hydrophytic species reported as growing with dwarf downingia include lippia (*Phyla nodiflora*), and swamp pricklegrass (*Crypsis schoenoides*). Although none of the following are specifically reported to co-inhabit vernal pools with dwarf downingia, other non-native weedy hydrophytes may present future problems, including European mannagrass (*Glyceria declinata*), field bindweed (*Convolvulus arvensis*), Common unicorn plant (*Probiscidea louisianica*), Bermuda-grass (*Cynodon dactylon*) and paradox canary-grass (*Phalaris paradoxa*). Cocklebur (*Xanthium strumarium*), another native species, can also dominate vernal pools (Schlising, Unger pers. comms.).

1.2.2.5 Livestock Grazing Relations

Specific interactions between livestock grazing and dwarf downingia are largely unknown. In general, appropriately timed dry-pasture livestock grazing regimes are thought to be compatible with the development and persistence of vernal pool vegetation. Robins and Vollmer (2002) provide a review of information pertaining to livestock grazing in vernal pool ecosystems.

Many extant populations of dwarf downingia inhabit long-operating cattle ranches, so persistence indicates tolerance for at least some level of grazing. Timing of livestock grazing is likely more important than stocking rates in affecting persistence of dwarf downingia. During the period when pools are inundated and upland forage is still green and attractive, cattle tend to not congregate in pools and trampling and grazing pressures to vernal pool plant species in their seedling or juvenile aquatic phase are minimized. Once the upland forage cures and the vernal pools are in their flowering and seed-producing terrestrial phase, moist pools become more attractive to livestock and grazing and trampling pressures are increased. It should be noted however, as with many other vernal pool annuals, small stature and high plant densities ensure that in all but extreme cases, a portion of every year's cohort escapes destruction, matures and sets seed. Grazing in the summer and fall months, after seeds have set and plants have died likely has little negative effect on dwarf downingia.

1.2.2.6 Disturbance Response

Observations of field workers provide some evidence of the potential response of dwarf downingia populations to particular disturbance regimes. Several dwarf downingia populations persist despite periodic disking of the vernal pool substrates over decades (Kelsey pers. comm.; Dittes pers. obs.; CDFG 2010). It is very important to note that in these cases, disking is not so deep as to significantly affect the subtending impermeable layer or the vernal pool hydrological cycle. In addition, the disking is performed in the late summer or fall months in preparation for dryland winter grain crops, so vernal pool plants have set seed and dried. Persistence of populations in fall-disked and planted dryland winter wheat fields has also been noted for several of the Orcuttiae grasses (Hoover 1941; Crampton 1959; Stone et al. 1988). This has been observed for other more common vernal pool species as well (Ahart pers. comm. 2003).

If this disking occurs earlier in the growing season, before seeds are mature, over consecutive years, population extirpation is probable through exhaustion of soil seed bank. These are outstanding examples of the overriding selective force of the vernal pool hydrologic cycle in affecting floristic composition, and the importance of timing of management-related disturbances relative to specific life-history stages.

1.2.2.7 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for dwarf downingia are identified in Table DWDO-1 and have been derived from input from local species experts.

Table DWDO-1
Essential Habitat Elements for Dwarf Downingia

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, vernal pool, and vernal swale.	Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools, providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and non-native upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

1.3 Species Distribution and Population Trends

1.3.1 Species Distribution

Presently, dwarf downingia is recorded from 117 CNDDB occurrences in California (CDFG 2010). These are distributed primarily in the Great Central Valley from Fresno County in the south, to Tehama County in the north. Dwarf downingia also occurs at scattered sites in the interior valleys of the southern North Coast Ranges, in Napa and Sonoma Counties. These occurrences are all situated at sites ranging from 10 to 1,600 feet elevation above mean sea level (CNPS 2010), and lie within the California Floristic Province (Sacramento Valley and San Joaquin Valley Sub-regions of the Great Valley Region; Sierra Nevada Foothill Subregion of the Sierra Nevada Region; North Coast Range Subregion of the Northwest Region; Hickman 1993). At least two additional occurrences, not yet registered in the CNDDB, occur in Sacramento County (Gibson and Skordal 1994; TNC *date unknown*).

Throughout its range, dwarf downingia occupies a variety of landforms and numerous soil associations.

1.3.2 Central Valley Distribution

Dwarf downingia is known from three geographically defined population centers in the Central Valley. The northernmost is located in Tehama County, between the vicinity of Red Bluff in the north and Black Butte Lake in the south. The southernmost population center occupies a narrow band in the San Joaquin Valley along the eastern edge of Merced County and a single occurrence on the northern edge of Fresno County. The central population center, located in the southern Sacramento Valley, is comprised of occurrences within Solano, Placer, Sacramento, and Yuba Counties.

1.3.3 Range within the Plan Area

Of the 10 occurrences of dwarf downingia recorded from Sacramento County (eight CNDDB occurrences and two occurrences not-yet registered), five are located outside of the Plan Area (CNDDB occurrence #32, #56, #57, #58, and #59). Of the remaining five occurrences, three are located within the UDA in the City of Elk Grove (CNDDB occurrence #54, #55, and an occurrence not yet registered); and two occurrences are located outside of the UDA within the Plan Area. One of these is encompassed within the 16,420-acre The Nature Conservancy (TNC) Cosumnes River Preserve (CNDDB occurrence #53) and the other is located within the Howard Ranch preserve and is not yet registered with the CNDDB.

It is important to note that owing to its small stature, preference for small to medium-sized vernal pools and the area of remaining unsurveyed or partially surveyed habitat, moderate to high potential exists for discovery of additional populations within the Plan Area.

Table DWDO-2 shows the soil series, geological formation and landform associations for each known occurrence in Sacramento County. Generally, dwarf downingia is associated with Lower Unit Riverbank and old terrace remnant alluvial deposits of the Laguna Formation. For the purposes of the SSHCP, the range of dwarf downingia is considered to include all vernal habitats.

Table DWDO-2
Extant CNDDB Occurrence Numbers, Distribution, Associated Soil Series and Landform Formations for Dwarf downingia In Sacramento County

Occurrence #	Quadrangle	Soil Series	Geological Formation and Landform
32	Rio Linda	San Joaquin Fine Sandy Loam (0-3% slopes and 3-8% slopes)	Lower Unit Riverbank Formation
53	Galt	Adjacent to Clear Lake Clay, Partially Drained, 0-2% Slopes	Adjacent to Qfa
54	Elk Grove	Redding Gravelly Loam, 0-8% Slopes	Laguna
55	Elk Grove	Redding Gravelly Loam, 0-8% Slopes	Laguna
56	Florin	San Joaquin-Galt Complex, 0-3% Slopes	Lower Unit Riverbank Formation
57	Rio Linda	San Joaquin Fine Sandy Loam (0-3% Slopes and 3-8% Slopes)	Lower Unit Riverbank Formation
58	Rio Linda	San Joaquin Fine Sandy Loam (0-3% Slopes and 3-8% Slopes)	Lower Unit Riverbank Formation
59	Rio Linda	San Joaquin Fine Sandy Loam (0-3% Slopes and 3-8% Slopes)	Lower Unit Riverbank Formation

1.3.4 Population Levels and Trends

Dwarf downingia is known from a total of 117 CNDDB occurrences. Of the 117 CNDDB occurrences recorded, two are extirpated and one possibly extirpated from Sonoma County, one is extirpated from Napa County, one is extirpated and another possibly extirpated from Placer County, and one is extirpated from Sacramento County. Of the remaining 110 CNDDB occurrences presumed extant, 26 have not been revisited since before 1983 (CDFG 2010). Of the 84 CNDDB occurrences reported since 1983 and presumed extant, one is listed as experiencing a decreasing trend, and the rest are listed as trend "unknown" (CDFG 2010). It should be noted though, that the vast majority of these 84 occurrences are located on private lands and most are reported as being subject to one or more threats.

It is impossible to determine the number of historically occurring dwarf downingia populations or the acreage of suitable habitat lost to historic agricultural and urban land-use conversions, since so much had happened before these species first received attention. Investigators have made estimates as to the acreage of vernal pool habitat lost since historic times (Holland 1978).

Since dwarf downingia is adapted to the smaller, more "flashy" types of vernal pools, as well as to the margins of larger or deeper pools, estimates of vernal pool habitat lost may reflect loss of potentially suitable dwarf downingia habitat as well. Effects of historic livestock grazing combined with drought cycles and habitat alterations relating to development of non-native annual grassland are not quantifiable.

Table DWDO-3
Dwarf downingia Population Estimates Recorded For Sacramento County

CNDDB Occurrence #	# of Pools Observed	Range of Population Estimates
32	unknown	1994: 100 plants
53	Large vernal marsh	1991: 1000 plants
54	1	1991: 200 plants
55	6 vernal pools and 2 scraped areas	1991: 300
56	2 vernal pools	1990: varied from 100's to 1000's
57	Created depression	1991:50 plants
58	Vernal pool	1993: 50 plants
59	Vernal pool	1993: 150 plants

Between-year variation in population numbers has been documented for several of the dwarf downingia occurrences outside of Sacramento County, although none have been studied in detail. One occurrence is reported as supporting 300 plants in 1988, and 10,000 in 1989 (CNDDB occurrence #29). Another occurrence (CNDDB occurrence #60) was reported as supporting more than 1,000 plants in 1989 and 237 plants in 1990. CNDDB occurrence #62 was found to support 200-400 plants in 1989 and 36 plants in 1990 (CDFG 2010).

Studies involving other vernal pool plant rarities, including Orcuttiae grasses and Hoover's spurge (*Chamaesyce hooveri*) have demonstrated marked fluctuation in numbers of individuals within populations between years (Griggs 1983; Holland 1987; Alexander and Schlising 1997). This extreme population variability is attributable to interactions of seed dormancy, early seedling survivorship, and average seed set per plant, as principally determined by seasonal and between-year limitations in available moisture (Griggs and Jain 1983; Holland 1987). It is not known however, to what degree dwarf downingia exhibits a similar between-year pattern.

Observations made over a decade or so may provide a reasonable indication of the short-term vigor of a given dwarf downingia population. It is important to consider however, that in order to assess the trend of the species, long-term monitoring of both habitat and populations conducted over multiple cycles of wet and dry years is needed. Another critical aspect of population demography is the presence and nature of the soil seed bank, which is unknown for dwarf downingia.

1.4 Threats to the Species

Potential direct threats to dwarf downingia include: loss of vernal pool habitat to agricultural or urban/industrial land-use conversions; construction and maintenance of firebreaks, roads, and utility corridors; inappropriate livestock grazing regimes (later spring/summer rotations, sheep versus cattle); grassland fires; recreational vehicles; equestrian and pedestrian traffic, and refuse dumping.

Potential Indirect threats to dwarf downingia include hydrological alteration of sub-watersheds by surrounding developments and land uses, shifts in competitive interactions (hydrology-mediated or invasive weeds), windblown refuse accumulation, point and non-point source water pollution, air pollution, and global climate change.

1.5 Data Gaps and Conservation Implications

Despite its distinctive appearance and relative rarity, dwarf downingia has received little research attention from botanists or ecologists. Aside from general observations of field workers provided in the CNDDB, detailed studies have not been conducted regarding the biology, ecology, pollinators, breeding system, population genetics, habitat relationships, population levels, trends or threats associated with this species. Pertinent data gaps, implications for conservation, and operating assumptions include:

1.5.1 Unknown Number of Undiscovered Populations

Additional unsurveyed and partially surveyed potentially suitable habitat exists within the Plan Area and elsewhere within the range of the species. In the Plan Area, discovery of new populations may occur on the large dry-land ranchlands, public quasi-public lands and vernal pool-grassland preserves already established in the eastern portion of the County.

1.5.2 Unknown Relationship between Landform/Soil Chemistry and Bio-Geographic Distribution

Throughout its range, dwarf downingia is associated with a variety of geological formations and associated soil types. In Sacramento County, this species is occurs on the Lower Unit Riverbank Formation (five occurrences) and on the Laguna Formation (two occurrences) (CDFG 2010). The exact nature of relationship to landform is however, unknown. It is unknown if soil pH or other edaphic factors influence dwarf downingia distribution and population vigor. It is possible that the presence of functioning vernal pools, regardless of landform, soil series and soil pH indicates suitable habitat.

1.5.3 Unknown Pollination Ecology

Dwarf downingia possesses the smallest flowers of any of the species in the genus, and is thought to be a self-pollinator; however, without knowing specific breeding abilities and pollinator relationships, it is difficult to ascertain habitat needs for potentially co-evolved insect pollinators.

1.5.4 What Constitutes Population Vigor, and How to Measure?

Population vigor will need to be monitored during the life of the SSHCP, yet population dynamics, including year-to-year variability in abundance, have not been studied for dwarf downingia. The existence of a dormant soil seed bank, a critical contributor to population stability in some other vernal pool species, is unknown for dwarf downingia as well. Other rare vernal pool species have been shown to be highly variable in abundance from year-to-year (Holland 1987; Griggs pers. comm. 2003), and causative factors contributing to year-to-year population fluctuations may be difficult to identify (Alexander and Schlising 1997).

Trends may occur that are not discernable and trends that are discerned may be unexplainable. These factors will complicate attempts to change management for benefit of the species if measured vigor shows decline.

1.5.5 Specific Hydrological Requirements of Dwarf downingia

Numerical data do not exist regarding specific parameters of the annual hydrological cycle of vernal pools supporting dwarf downingia populations (e.g., timing of rainfall, depth of ponding, duration of ponding and soil dry down rate).

The general lack of numerical hydrological data limits the ability to precisely monitor and/or assess hydrological suitability of dwarf downingia-vernal pool habitat within established preserves. Similarly, assessment of potentially suitable dwarf downingia habitat for preserve establishment or for detection of the species at this time must rely on generalities. Once preserves for existing dwarf downingia populations are established, assessed and monitored over time, a more quantifiable definition of suitable dwarf downingia -vernal pool hydrology may be developed.

1.5.6 Baseline Hydrological Trend of Pools and Existing Indirect Effects

Extant dwarf downingia populations may have already experienced some degree of hydrological modification resulting from development-related alterations to sub-watersheds (CDFG 2010). Without complete protection of entire vernal pool watersheds, or precise hydrological monitoring and accurate modeling on a pool complex-scale, long-term indirect effects resulting from existing alterations to sub-watershed hydrology are unknown.

Baseline dwarf downingia conditions for the SSHCP may not be pristine, so if trends in vigor or habitat quality become apparent during the 50-year period or at some time beyond, it may be difficult to attribute trend to any specific management activity.

1.5.7 Definition of Appropriate Hydrology Buffer

There is no standard for appropriate scale of effective hydrologic buffers for vernal pool-annual grassland ecosystems, since the nature of vernal pool complexes and their geo-hydrological relations may vary substantially by geography (Holland and Dains 1990).

Proposed preserve designs may not afford complete protection to the hydrological systems that support dwarf downingia and other species assemblages dependant on them.

1.5.8 Definition of Appropriate Scale Dwarf Downingia-Vernal Pool-Annual Grassland Preserve

There is no standard for appropriate scale of effective dwarf downingia-vernal pool preserves. It is a paradigm of conservation biology that “bigger is better” for a variety of well-documented reasons. Conservation challenges associated with the relatively small-scale vernal pool preserve that includes dwarf downingia at Phoenix Field and Phoenix Park are well documented and reflect consequences of increase edge effect associated with smaller preserves (Clark et al. 1998).

1.5.9 Determination of Appropriate Livestock Grazing Regime

Livestock grazing will occur in at least some of the dwarf downingia-vernal pool preserves, primarily for purposes of upland annual grassland vegetation management. Specific grazing regimes have not been formulated for annual grassland pasture systems with dwarf downingia-occupied pools, although grazing and monitoring in similar systems have been addressed (Barry 1998; TNC 2000; Griggs 2000; Robins and Vollmar 2002). It is important to note that dwarf downingia does persist though, in historically and contemporary operating livestock ranches. At a minimum, compatibility with some level of grazing is evidenced by persistence of the species in these systems. Since dwarf downingia occupied small to medium size vernal pools, management of Italian wild rye and Mediterranean barley around the margins of vernal pools, and Medusa-Head Grass in uplands should be of particular management concern.

Presently, Witham et al. are formulating site-specific livestock grazing regimes for annual grassland-vernal pool systems in an area of Sacramento County (Witham pers. comm.). Livestock grazing regimes in dwarf downingia -vernal pool preserves covered under the SSHCP will tier towards the results of this work, as well as to the specific needs of dwarf downingia. Specific livestock grazing regimes cannot be formulated until preserve size, configuration, and soil and vegetation conditions and vegetation management goals are determined.

1.5.10 Interactions with Non-Native Weeds and Weed Management Activities

Non-native weeds, or weedy native species reported as occurring in vernal pools include European mannagrass, swamp pricklegrass, Bermuda grass, common spikerush, field bindweed, lippia, paradox canary grass, hairy hawkbit, cocklebur and cattails. None of these are reported to co-inhabit dwarf downingia-occupied vernal pools in Sacramento County. Any of these and others now unknown may appear or change in abundance in dwarf downingia-occupied pools over time. Italian wild rye and Mediterranean barley, two common non-native inhabitants of shallow vernal pools and vernal pool margins, might be of management concern to dwarf downingia, owing to the latter's preference for small to medium size vernal pools.

Potential competitive interactions with these species may affect the vigor of dwarf downingia populations. In addition, any eradication or control methods implemented for these species may in turn potentially affect dwarf downingia populations.

1.5.11 Potential Association and Compatibility with Other Rare Vernal Pool Species

It is desirable to design preserves for multi-species conservation. Suitability of dwarf downingia habitat for supporting other rare plant species has not been specifically addressed, although in Sacramento County natural populations of legenere and Sanford's arrowhead (*Sagittaria sanfordi*) are documented as sharing habitat with it. Many of these pool complexes also may provide habitat for rare invertebrates, amphibians, mammals, and bird species as well.

Management for multiple species maximizes the effectiveness of habitat conservation and requires coordinated monitoring and actions. Management for the benefit of one species may conflict with management needs of other rare species. For instance, livestock grazing anytime between November 1st and April 15th may be compatible with or even benefit some dwarf downingia-associated pool complexes, but may be detrimental to ground-dwelling amphibians depending on those complexes (e.g., California tiger salamander).

1.5.12 Genetic Considerations (Spatial and Temporal Variation, Seed Bank, Drift, Bottlenecks)

Population genetics for dwarf downingia are completely unknown. For an overview of genetic considerations of vernal pool plant species see Elam (1998).

Current limitations in our understanding of dwarf downingia population genetics have little immediate conservation implication, given the extreme rarity of dwarf downingia.

If experimental inoculation of pools is proposed as part of the SSHCP, appropriate measures will be developed to ensure that seed collection, seed treatment and pool inoculation methods are consistent with what we know and do not know about dwarf downingia ecology and population genetics.

1.5.13 Critical Population Size

Critical population size is a statistical estimate of the minimum number of individuals required for a population to maintain itself over generations, through time. This population parameter has been determined for assorted wildlife and some perennial plant species. The most simplistic estimations take into account recruitment rates of individuals into the population via reproduction and immigration, and removal rates of individuals from that same population via death and emigration.

Since dwarf downingia is an annual species, its population sizes are known to be highly variable from year to year, and the soil seed bank constitutes an important demographic component of the population, definition and assessment of a critical population size is impracticable and lacks ecological meaning.

Knowledge of critical population size provides an ecologically meaningful and quantifiable benchmark for adaptive management purposes (e.g., if monitored populations drop to within 30 percent of critical population size, site-specific analysis, appropriate management changes and additional monitoring will occur). This is not possible for annual species, so other measurable benchmarks are needed.

1.5.14 Seed Longevity and Dynamics of Stored Soil Seed Bank

As previously mentioned, the existence and potential role of a dormant soil seed bank in population dynamics is completely unknown for dwarf downingia. There have been no studies addressing the presence of a soil seed bank, seed dormancy or longevity.

From the perspective of conservation, knowledge of site-specific soil seed bank characteristics would allow more accurate assessment of population size and stability (vigor). This is particularly true of populations that typically support the fewest standing individuals through time.

1.5.15 Unknown Aspects of Experimental Inoculation

Since there are so few natural populations of dwarf downingia in Sacramento County, species viability may be significantly enhanced by inoculating unoccupied, apparently suitable pools and increasing the number of naturally self-sustaining populations. These additional populations would increase the likelihood of natural dispersal events into preserved but unoccupied dwarf downingia habitat, create meta-population structure at extant occurrences where single pools may support the species, and ensure existence should any natural populations become compromised.

Uncertainties regarding the political ramifications and ecological effectiveness of experimental inoculation lead the conservation community and Agencies to not consider experimental inoculation as an appropriate conservation goal. Given the extreme rarity of this species though, this option may need reconsideration at some point in time.

1.5.16 Air Pollution (Dust/Ozone/Nitric Oxide, Sulphur Dioxide)

Portions of the Central Valley of California frequently exceed State and Federal safety levels for a variety of air pollutants, including particulate matter, ozone, and others. Some of these pollutants are known to negatively affect plant physiology and health, although none have been investigated as they relate to vernal pool vegetation. Assuming that extant dwarf downingia occurrences are maintaining their vigor at existing ambient pollution levels, air pollution will probably not present a major threat to the viability of dwarf downingia, if existing air quality can be maintained. If however, California's human population increases as projected and air pollution control measures are not developed and implemented concomitantly and effectively, these pollutants may negatively affect dwarf downingia and other native plant species.

1.5.17 Effects of Global Climate Change

The scientific community commonly accepts as valid the phenomenon of increasingly rapid global climate change. Specific climatic models for California predict an average increase in temperature over the coming decades, with concomitant unpredictability in annual rainfall patterns. There is uncertainty regarding the exact nature and extent of these changes, as well as the consequences these changes pose to conservation biology.

It is likely that given the expected global climate trends, a vigor response of some kind could be expected for dwarf downingia populations within the implementation period of this HCP, or at some time beyond.

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2 BOGG'S LAKE HEDGE-HYSSOP (BLHH)

Prepared by Dittes and Guardino Consulting (John Dittes and Josephine Guardino)

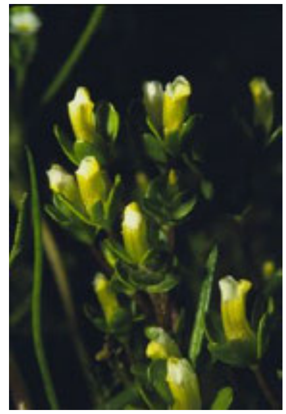
Bogg's Lake hedge-hyssop (BLHH)

(Gratiola heteropepala)

Status USFWS: None

Status CDFG: Endangered

Status CNPS: List 1B.2



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2.1 Legal Status

Bogg's Lake hedge-hyssop (*Gratiola heterosepala*) was listed by the California Department of Fish and Game (CDFG), as State Endangered under the California Endangered Species Act (CESA) in 1978. The California Native Plant Society (CNPS) includes Bogg's Lake hedge-hyssop as a CNPS List 1B.2 species which means it is a plant species that is fairly threatened in California with moderate degree or immediacy of threat (CNPS 2010). CNPS has also assigned an R-E-D Code of 1-2-2, meaning it is rare but found in sufficient numbers and distributed widely enough that the potential for extinction is low at this time, it is endangered in a portion of its range, and it is rare outside of California (CNPS 2010).

2.2 Life History and Ecology

2.2.1 Species Description and Life History

Bogg's Lake hedge-hyssop is a small-stature annual in the figwort family (Scrophulariaceae). This diminutive species has an erect, un-branched stem that can reach from two to 10 cm in height. Small one to two centimeter-long leaves are arranged oppositely on the stem; the lower ones are linear-lanceolate and the upper ones are shorter, proportionally wider and more blunt (obtuse) at the tip. The inflorescence is comprised of one to several six to eight millimeter-long flowers arranged in a terminal raceme. Individual pale-yellow and white, tubular flowers are born on 10 to 20 millimeter-long stalks (pedicels). The pedicels and upper stem are glandular puberulent. The calyx is comprised of five round-tipped sepals, three of which are united about 1/3 the distance from their base, and two that are more–or-less separate. Of the three united sepals, the central one is wider and longer. Numerous small seeds are produced in pear-shaped (pyriform) capsules that usually equal the mature calyx in length (four to six millimeter).

The more common and potentially co-occurring bractless hedge-hyssop (*Gratiola ebracteata*) is distinguished from its rare relative on the basis of having more elongate and sharply pointed sepals that are mostly separate to their bases, and white, versus mostly yellow flowers (Mason and Bacigalupi 1954; Hickman 1993). A third species, clammy hedge-hyssop (*Gratiola neglecta*), is distinguished from *G. bracteata,* and *G. heterosepala* on the basis of having two small bracts subtending the flowers, and flowers that are at least two to three times as long as the calyx.

Bogg's Lake hedge-hyssop, and the genus *Gratiola* in general, has received little attention from biologists or ecologists. Other than basic taxonomic and biogeographic treatments, and a single study of pollinator ecology (Kaye et al. 1990), Bogg's Lake hedge-hyssop remains mostly unstudied. Ecological information, mostly from observations of field workers, exists mostly as a result of land management and agency-mandated resource management activities (Corbin 2000; Corbin et al. 1994; Schoolcraft 2000; Plantenkamp 1998; Jones and Stokes 1994).

2.2.1.1 Ecological Life Cycle

Bogg's Lake hedge-hyssop shares the annual growth habit with the vast majority of other endemic vernal pool plants. This adaptive trait confers to the populations avoidance of the regular and extreme seasonal drought that characterizes vernal pool habitat and the Mediterranean Climate (Griggs and Jain 1983; Holland 1987; Stone et al. 1988; Zedler 1990).

2.2.1.2 Seed Germination

The specific timing of germination of Bogg's Lake hedge-hyssop seeds relative to the timing of the vernal pool inundation cycle has not been described in detail. Observations indicate that Bogg's Lake hedge-hyssop seeds germinate and begin juvenile growth under water (Kaye et al. 1990; Corbin et al. 1994). Seed longevity, germination requirements and germination optima for Bogg's Lake hedge-hyssop have not been investigated.

2.2.1.3 Vegetative Growth

One of the challenges to many vernal pool plant species is optimization of physiological processes in both the early season aquatic and later season terrestrial phases of the vernal pool cycle. For Bogg's Lake hedge-hyssop, the hollow (fistulous) stem is the principal structural adaptation to growth in the aquatic habitat. The air-filled stems hold the plant vertical in the water column, thus facilitating light exposure and gas exchange. This in effect lengthens the growing season by maximizing growth while vernal pools are still inundated. It is interesting to note that, although the species inhabits the basins and slopes of deeper/larger vernal pools, it lacks distinctly different juvenile aquatic morphology, an adaptation that is shared by many other deep pool annual species with which it occurs (e.g., *Orcuttia* spp., *Downingia* spp., *Navarretia* spp., *Eryngium* spp., *Callitriche* spp.).

2.2.1.4 Reproduction

Bogg's Lake hedge-hyssop flowers and sets seeds during the dry-down phase of the vernal pool hydrologic cycle, typically while shallow water up to two inches (five centimeters) deep remains in the pool basin (Corbin et al. 1994). Flowering occurs in the Central Valley from April to June (CNPS 2010), and at higher elevations as late as August (Corbin et al. 1994; CNPS 2010; CDFG 2010). Bogg's Lake hedge-hyssop is completely self-compatible as indicated by pollinator exclusion experiments (Kaye et al. 1990). Fruits mature quickly, usually within one to two weeks after the flowers appear (Corbin et al. 1994). The mature capsules produce numerous minute seeds that are released as the 4-valved capsule opens, and as the parent plant disintegrates. Fecundity and variation in seed production have not been investigated in Bogg's Lake hedge-hyssop .

2.2.1.5 Dispersal

In many other vernal pool species, seed dispersal is naturally limited, although this has not been stated specifically for *Gratiola*. Limited seed dispersal in vernal pool species is thought to represent an adaptation to spatially unpredictable and limited vernal pool habitat (Griggs 1974, 1980, 1990). Bogg's Lake hedge-hyssop does not appear to have dispersal-limiting traits (e.g., fruit adherent to parent plant, fruit not opening).

Evidence of natural Bogg's Lake hedge-hyssop dispersal and colonization exists in occupancy of man-made topo-hydrologic features located within or near occupied vernal pool landscapes (artificially created vernal pools, stock pond and reservoir margins, ditches, and other excavated or scraped depressions (CDFG 2010). Further evidence of long-range dispersal exists in the relatively widespread range of this species in northern California. Natural dispersal of Bogg's Lake hedge-hyssop seeds likely occurs via flowing water, transport on feet and feathers of waterfowl, and in mud on hooves and legs of livestock. As with all other vernal pool species, natural dispersal of seeds was likely a more frequent event when there were many more vernal pools, more pool interconnectivity, exceedingly larger waterfowl migrations and unfenced roaming native ungulates (Griggs 1980).

2.2.1.6 Seed Dormancy

Seed dormancy is indicated by observation of a three-year period where Bogg's Lake hedge-hyssop plants were absent, followed by reappearance during the favorable growing season of the fourth year (Corbin et al. 1994). Seed longevity and seed abundance in the soil has not been investigated. The presence of a persistent soil seed bank provides insurance against localized extirpation resulting from the unpredictable occurrence and duration of appropriate growing conditions. If total seed crop failure occurs in a given year or set of years (failure to germinate, loss to late season flooding or fire, excessive grazing by livestock or grasshopper herbivory), additional stored seeds are available for another year's effort.

2.2.1.7 Population Genetics

Population genetics of Bogg's Lake hedge-hyssop have not been investigated, so intra- and inter-population patterns of genetic variability are unknown. Elam (1996) provides a good overview of the myriad considerations in assessing the population genetics of vernal pool plants in the absence of empirical data for a given taxon. Given the limited number of occurrences in the Plan Area and the scattered geographical distribution, all intra-pool Bogg's Lake hedge-hyssop populations should be considered unique, and for the purposes of conservation, important genetic entities.

2.2.2 Habitat Requirements and Ecology

2.2.2.1 Biogeography and Landform Relations

Bogg's Lake hedge-hyssop is strictly associated with the vernal pool-type hydrologic cycle. Over its geographic range, this species is found in a number of distinct physiographic/edaphic settings. In Sacramento County, Bogg's Lake hedge-hyssop is associated with vernal pools located on ancient weathered alluvial terraces of the Laguna Geologic formation, with soils of the Redding, Red Bluff and related Series. Soils of the Redding Series tend to be strongly acidic (indication of age and weathering) and are generally gravelly with cobble. These soils also typically possess a shallow, water-impermeable iron-silica hardpan that favors the development of vernal pools (SCS 1993). In Tehama County, Bogg's Lake hedge-hyssop occurs in vernal pools associated with cemented hardpan of the Tuscan, Toomes and related series, as well as in more shallow volcanic soils (CDFG 2010). The montane occurrences of Lassen, Shasta and Modoc Counties are also associated with volcanic soils, but in addition to volcanic mudflow and basalt substrates, wetlands formed on large hydric clay flats also support the species. Similarly, in Lake County, and Solano County, Bogg's Lake hedge-hyssop is associated with large seasonal Playa Lake-type pools formed on clay substrates.

2.2.2.2 Hydrology Relations

Bogg's Lake hedge-hyssop is a strict endemic of the vernal pool hydrologic cycle. This species is reported to grow in well-developed vernal pools, and playa lakes, as well as along the seasonally fluctuating margins of more permanent water bodies (small lakes, reservoirs, stock ponds, seasonally saturated clay flats in meadows). It is significant to note that most of the other rare species with which Bogg's Lake hedge-hyssop grows are also associated with well-developed large or deep vernal pools that exhibit more extreme, longer duration inundation such as slender

Orcutt grass (*Orcuttia tenuis*), San Joaquin Valley Orcutt grass (*O. ineaequalis*), Sacramento Orcutt grass (*O. viscida*), Greene's tuctoria (*Tuctoria greenei*), hairy Orcutt grass (*Orcuttia pilosa*), legenere (*Legenere limosa*), and Hoover's spurge (*Chamaesyce hooveri)* (CDFG 2010). Specific pool area, pool depth, or other measures of pool hydrology are not reported for any of the Bogg's Lake hedge-hyssop occurrences. It has been observed that the species germinates and grows underwater, and quickly flowers and sets seed as the pool dries, while two to five inches of water remain in the pool basin.

2.2.2.3 Biological Community Relations

Floristic associations provide further indication of preference for more extreme vernal pool hydrological cycles. Like the Orcuttiae grasses, Bogg's Lake hedge-hyssop often grows in comparatively barren areas within deeper portions of vernal pools, sometimes in barren openings with commom spikerush (*Eleocharis macrostachya*). In addition to the fore-mentioned rarities, other associated species indicative of well-developed vernal pool hydrology, including hairy pepperwort (*Marsilea vestida*), coyote thistle (*Eryngium castrense, E. vaseyi*)*,* Alisma-leaved coyote thistle (*E. alismifolium),* bee-thistle (*E. arictulatum*), Mathia's thistle (*E. mathiasae),* bractless hedge-hyssop, downingias (*Downingia bicornuta, D. bacigalupi, D. cuspidata, D. ornatissima*), quillwort (*Isoetes howellii, I. orcuttii and I. nuttallii*), flowering quillwort (*Lilaea scilloides*), smooth goldfields (*Lasthenia glaberrima*), California elatine (*Elatine californica*), and winged water starwort (*Callitriche marginata*),

Other vernal pool endemics reported as occurring with Bogg's Lake hedge-hyssop include common inhabitants of shallower or smaller to medium-size vernal pools with shorter duration ponding, or the slopes and edges of larger or deeper pools. These species include Fremont's goldfields (*Lasthenia fremontii*), white-headed navarretia (*Navarretia leucocephala*), stalked popcorn-flower (*Plagiobothrys stipitatus*), bracted popcorn-flower (*P. bracteatus*), dwarf wooly marbles (*Psilocarphus brevissimus*), dwarf downingia (*Downingia pusilla*), annual hairgrass (*Deschampsia danthonioides*), Douglas' meadowfoam (*Limnanthes douglasii*), tricolored monkey-flower (*Mimulus tricolor*).

2.2.2.4 Non-Native Weed Relations

Hydrological stresses associated with vernal pools exclude the majority of non-native weedy species that characterize the present-day valley annual grassland, agricultural fields, and ruderal habitats. Italian Rye and Mediterranean Barley, two non-native facultative wetland species typically dominate disturbed wetlands and can be invasive in smaller, more ephemeral vernal pool types. Some suggest that built-up thatch from Italian wild rye (*Lolium multiflorum*), Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), Medusa-head grass (*Taeniatherum caput-medusae*), and other non-native upland species may indirectly affect vernal pool species as well by lessening the amount of water entering the system through surface and subsurface flow (Robins and Vollmar 2001).

Since Bogg's Lake hedge-hyssop occupies medium to larger or deeper vernal pools, it may not be particularly susceptible to the effects of excessive growth of Italian wild rye and Mediterranean barley and thatch buildup, as with the more deeply-adapted legenere and Orcuttiae grasses.

No weedy hydrophytic species are presently reported as growing with Bogg's Lake hedge-hyssop. Although none of the following are specifically reported to co-inhabit vernal pools with Bogg's Lake hedge-hyssop, other non-native weedy hydrophytes may present future problems, including mannagrass (*Glyceria declinata*), lippia (*Phyla nodiflora*), swamp pricklegrass (*Crypsis schoenoides*), field bindweed (*Convolvulus arvensis*), common unicorn plant (*Probiscidea louisianica*), Bermuda grass (*Cynodon dactylon*) and paradox canary grass (*Phalaris paradoxa*). Cocklebur (*Xanthium strumarium*), a native species, can also dominate vernal pools (Schlising pers. comm.; Unger pers. comm.).

2.2.2.5 Livestock Grazing Relations

In general, appropriately timed dry-pasture livestock grazing regimes are thought to be compatible with the persistence of vernal pool vegetation. Robins and Vollmer (2002) provide a review of information pertaining to livestock grazing in vernal pool ecosystems. Observations made on (U.S. Bureau of Land Management (BLM) and U.S. Forest Service (USFS) grazing allotments indicate that Bogg's Lake hedge-hyssop populations are somewhat resistant to grazing and trampling pressures, with abundant and vigorous flowering and fruiting plants present despite hoof-pocked surfaces. Others have indicated livestock grazing as a threat (CDFG 2010).

Many extant populations of Bogg's Lake hedge-hyssop inhabit long-operating cattle ranches and USFS and BLM grazing allotments. Persistence in un-irrigated pasture systems indicates tolerance for at least some level of grazing. In most cases, timing of livestock grazing is likely more important than stocking rates in affecting persistence of Bogg's Lake hedge-hyssop , as it is for the Orcuttiae grasses (Stone et al. 1988). During the period when pools are inundated and upland forage is still green and attractive, cattle tend to not congregate in pools and trampling and grazing pressures to vernal pool plant species in their seedling or juvenile aquatic phase are minimized. As the upland forage cures and the vernal pools are in their flowering and seed-producing terrestrial phase, moist pools become more attractive to livestock and grazing and trampling pressures are increased. Excessive trampling and grazing during this period may negatively affect Bogg's Lake hedge-hyssop, and other vernal pool species. Grazing in the summer and fall months, after seeds have set and plants have died likely has little negative effect on Bogg's Lake hedge-hyssop (Mason and Bacigalupi 1954; CDFG 1987) especially since the plant usually disintegrates rapidly once pools have dried (Corbin et al. 1994).

It should be noted however, as with many other vernal pool annuals, small stature and high plant densities ensure that in all but extreme cases, a portion of every year's cohort escapes destruction, matures and sets seed.

2.2.2.6 Disturbance Response

Observations of field workers provide some evidence of the potential response of Bogg's Lake hedge-hyssop populations to particular disturbance regimes. One occurrence has been extirpated as a result of disking and harrowing. It is interesting to note that several rare and common vernal pool species, including Bogg's Lake hedge-hyssop and Orcuttiae grasses are recorded to persist despite periodic disking of the vernal pool substrates over decades (Hoover 1941; Crampton 1959; Stone et al. 1988; CDFG 2010; Ahart pers. comm.; Kelsey pers. comm.; Dittes pers. obs.). It is very important to note that in these cases, disking is not so deep as to significantly affect the subtending impermeable layer or the vernal pool hydrological cycle. In addition, the disking is performed in the late summer or fall months in preparation for dry land winter grain crops, so vernal pool plants have set seed and dried. If this disking occurs earlier in the growing season, before seeds are mature, over consecutive years, population extirpation is probable through exhaustion of soil seed bank.

2.2.2.7 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for Bogg's Lake hedge-hyssop are identified in Table BLHH-1 and have been derived from input from local species experts.

Table BLHH-1
Essential Habitat Elements for Bogg's Lake Hedge Hyssop

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, and vernal pool.	Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools, providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and non-native upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the

Table BLHH-1
Essential Habitat Elements for Bogg's Lake Hedge Hyssop

Essential Activities	Land Cover Types	Habitat Elements
		development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

2.3 Species Distribution and Population Trends

2.3.1 Species Distribution

Bogg's Lake hedge-hyssop was first collected from Bogg's Lake in Lake County, California in 1954. Since that time, 90 total occurrences have been recorded (CDFG 2010), ranging from Fresno County in the south to northern Modoc County in northeast California. Bogg's Lake hedge-hyssop occurrences are distributed among five of the Geographic Sub-regions of the California Floristic Province, as described by Hickman (1993); the San Joaquin Valley, Sacramento Valley, Inner Coast Range, Cascade Range Foothill, High Cascade Range, and the non-Warner Mountain and Warner Mountain Sub-regions of the Modoc Plateau Region. Bogg's Lake hedge-hyssop is among the most widespread of the rare vernal pool species addressed in the SSHCP and exhibits the widest range in elevations (25 to 7,900 feet elevation) (CNPS 2010).

Tehama and Modoc Counties together support 40 percent of the 90 presently known Bogg's Lake hedge-hyssop occurrences, with 17 and 19 occurrences for each county, respectively. Shasta County supports 14 occurrences (16 percent of total), while Sacramento County supports 11 occurrences (12 percent of total) and Solano County supports six occurrences (seven percent of total). San Joaquin, Fresno, Lake, Placer, Lassen, Madera, Siskiyou, Merced, and Fresno Counties each support five or fewer occurrences (CDFG 2010).

This comparatively wide geographic and elevation distribution of Bogg's Lake hedge-hyssop may partially reflect comparatively broad habitat requirements relative to some of the other vernal pool rarities (e.g., Sacramento Orcutt Grass). It may also reflect a different propensity for seed dispersal by waterfowl, or perhaps even a different "biogeographic legacy" (e.g., timeline of evolution and geographic distribution of ancestral taxon).

2.3.2 Central Valley Distribution

In the Central Valley, Bogg's Lake hedge-hyssop occurs among five roughly defined population centers. The southernmost of these, comprising four CNNDB occurrences, is located along the eastern edge of the Great Central Valley near the Fresno and Madera County lines. The next population center to the northwest, comprised of a single occurrence, is located approximately 45 miles away in eastern Merced County. A third population center is located 75 miles to the north and is comprised of 18 occurrences. These occurrences extend approximately 45 miles north-to-south along the eastern edge of the Great Central Valley from northern San Joaquin County north through Sacramento County, to western Placer County. A fourth population center, comprised of six occurrences, is located approximately 30 miles to the west near the Sacramento-San Joaquin River Delta in Solano County. The northernmost Great Central Valley population center, comprised of four occurrences, is located in southern Tehama County, approximately 75 miles north of the northernmost Placer County occurrence. Another Tehama County population center, comprised of 13 additional occurrences, is located approximately 20 miles further northeast at higher elevations on the volcanic mudflow formations of the Cascade Range Foothills, east of the Great Central Valley.

2.3.3 Range within the Plan Area

Currently, there are ten CNDDB occurrences of Bogg's Lake hedge-hyssop within the Plan Area (Figure BLHH-1), all of which are located within the Urban Development Area (UDA). Within the UDA, the northeastern-most occurrence (CNDDB occurrence #48) is located northwest of the intersection of White Rock and Prairie City Roads. This occurrence is located on private land and is comprised of an unrecorded number of occupied pools. The next occurrence to the southwest is located approximately seven mi away (CNDDB occurrence #57) at the proposed Sunrise-Douglas Subdivision development. With 12 occupied pools, this is the largest Bogg's Lake hedge-hyssop occurrence in Sacramento County (CDFG 2010).

The next occurrence to the west (CNDDB occurrence #84) is located approximately two miles from the Sunrise Douglas site, just north of Morrison Creek and west of Eagles Nest Road near the southern edge of Mather Field. This occurrence is comprised of an unrecorded number of occupied vernal pools.

Another occurrence (CNDDB occurrence #30), associated with the 138-acre Sheldon Mitigation Site, is located approximately 2.5 miles south of the Sunrise-Douglas occurrence, just north of the Cosumnes River Floodplain. The number of occupied pools at this site is not recorded. CNDDB occurrence #81, comprised of a single occupied pool, is located on private land near Laguna Creek east of Excelsior Road, approximately 4.5 miles west by southwest of CNDDB occurrence #30.

The three westernmost occurrences (CNDDB occurrence #33, #34, and #35) are distributed along a north-south oriented axis with Elk Grove-Florin Road on the west, and Gerber Road and Elk Grove Boulevard on the north and south, respectively. The southernmost of these three occurrences (CNDDB occurrence #33) is located on private land, and is comprised of one occupied vernal pool. CNDDB occurrence #34, located on private land approximately 1.8 miles to the north, is comprised of an unrecorded number pools. The northernmost of these three occurrences (CNDDB occurrence #35) is located approximately one mile north of the central occurrence, and is also comprised of an unrecorded number of occupied pools.

Two additional occurrences are associated with the Kiefer Landfill development (CNDDB occurrence #18 and #82). Occurrence #18 is composed of seven occupied vernal pools, and occurrence #82 is reported to support one occupied vernal pool (Jones and Stokes 1998; CDFG 2010).

In Sacramento County, eight of the nine (89 percent) extant Bogg's Lake hedge-hyssop occurrences are associated with the Laguna Formation. Associated soils include those of the Redding and Red Bluff/Redding Series. This geological landform is comprised of remnant old-terrace alluvial deposits of ancestral river channels and pediment gravels, which were deposited during the early Pleistocene, between 600,000 and 1,500,000 years ago. Laguna Formation and associated soils are strongly associated with the distribution of vernal pools. Table BLHH-2 shows the soil series, geological formation and landform associations for each known occurrence in Sacramento County. It is significant to note that owing to the diminutive size of the species, its ability to inter-mingle with the more common species bractless hedge-hyssop, and the area of unsurveyed or partially surveyed area of Laguna Formation, other occurrences are likely to be present in Sacramento County. In addition, well-developed vernal pools on landforms other than Laguna could provide suitable habitat. For the purposes of the SSHCP, the range of Bogg's Lake hedge-hyssop is considered to be all vernal habitats as well as other seasonal wetlands and impoundments.

Table BLHH-2
CNDDB Occurrence Numbers, Distribution, Associated Soil Series and Landform Formations for Bogg's Lake hedge-hyssop in Sacramento County

CNDDB Occurrence #	Quadrangle	Soil Series	Geological Formation and Landform
3 (possibly extirpated)	Rio Linda	San Joaquin Fine Sandy Loam, 3-8% Slopes	Lower Unit, Riverbank Formation
18	Buffalo Creek	Redding gravelly loam, 0-8% slopes, Claypan and hardpan +/- 20 inches	Laguna Formation, remnant, high-terrace deposits of Pleistocene river channels.
30	Sloughhouse	Redding gravelly loam, 0-8% slopes, Claypan and hardpan +/- 20 inches	Laguna Formation, remnant, high-terrace deposits of Pleistocene river channels.
33	Elk Grove	Redding gravelly loam, 0-8% slopes, Claypan and hardpan +/- 20 inches	Laguna Formation, remnant, high-terrace deposits of Pleistocene river channels.
34	Elk Grove	Redding gravelly loam, 0-8% slopes, Claypan and hardpan +/- 20 inches	North Merced Gravel (Arroyo Seco gravel)
35	Elk Grove	Redding gravelly loam, 0-8% slopes, Claypan and hardpan +/- 20 inches	Laguna Formation, remnant, high-terrace deposits of Pleistocene river channels.
48	Buffalo Creek	Redding gravelly loam, 0-8% slopes, Claypan and hardpan +/- 20 inches	Laguna Formation, remnant, high-terrace deposits of Pleistocene river channels.

Table BLHH-2
CNDDB Occurrence Numbers, Distribution, Associated Soil Series and Landform Formations for Bogg's Lake hedge-hyssop in Sacramento County

CNDDB Occurrence #	Quadrangle	Soil Series	Geological Formation and Landform
57	Buffalo Creek	Red Bluff-Redding Complex, 0-5% Slopes	Laguna Formation, remnant, high-terrace deposits of Pleistocene river channels.
81 (extirpated)	Elk Grove	Redding gravelly loam, 0-8% slopes, Claypan and hardpan +/- 20 inches	Laguna Formation, remnant, high-terrace deposits of Pleistocene river channels.
82	Buffalo Creek	Redding gravelly loam, 0-8% slopes, Claypan and hardpan +/- 20 inches	Laguna Formation, remnant, high-terrace deposits of Pleistocene river channels.
84	Carmichael	Red Bluff-Redding Complex, 0-5% Slopes	Laguna Formation, remnant, high-terrace deposits of Pleistocene river channels.

2.3.4 Population Levels and Trends

Of the 90 documented CNDDB occurrences, all but two are presumed extant. One occurrence in Sacramento County is listed as "possibly extirpated" after the vernal pools were plowed, harrowed, and leveled for a housing development in 1977 (CNNDB occurrence #3) (CDFG 2010). The extirpated occurrence is located in the City of Elk Grove where the site had been disked and partially leveled and is slated for development (CDFG 2010).

Downward population trends have been reported for five populations (two in Sacramento County and one each in Placer, Lake, and Tehama Counties); while three occurrences from Shasta County are classified as "fluctuating" and one Shasta County occurrence is classified as "increasing." The population trends for the remaining occurrences are listed as "unknown."

It should be noted that Bogg's Lake hedge-hyssop is a diminutive and a relatively ephemeral species that easily escapes the notice of botanists, particularly since the taxonomic features used to circumscribe it are subtle, and it often grows intermingled with the more common and superficially similar species. Given these considerations and the amount of unsurveyed or partially surveyed potentially suitable habitat, additional occurrences will likely be discovered.

It is impossible to determine the number of historically occurring Bogg's Lake hedge-hyssop populations lost or the acreage of suitable habitat lost to historic agricultural land-use conversions, since so much had happened before these species first received attention (Stone et al. 1988). Investigators have made estimates as to the acreage of vernal pool habitat lost since historic times (Holland 1978; Jones and Stokes 1990), however owing to habitat specificity (restriction to), only a subset of the vernal pool habitat lost within the natural range of the species likely provided suitable habitat for Bogg's Lake hedge-hyssop.

There has been no comprehensive effort to monitor all populations of Bogg's Lake hedge-hyssop although various monitoring projects have been conducted by the BLM and USFS. However, the population estimates for some of the occurrences in Sacramento County occurrences have been made (Table BLHH-3).

Table BLHH-3
Bogg's Lake Hedge-hyssop Population Estimates for Sacramento County (CNDDB)

CNDDB Occurrence #	Occurrence # of pools observed	Range of population estimates
3	Reported from "several vernal pools:	Possibly extirpated
18	7	10,000 + plants
30	1	1990: 0 plants 1993: 1,000 + plants
33	1	1991: 20 plants
34	1	1991: 200 plants
35	3	?
48	Ponds	?
57	12	Several thousand to several hundred thousand
81	1	1998: 1 plant
82	1	?
84	1	2000: 1,000's of plants

Observations of Bogg's Lake hedge-hyssop indicate that abundance of individuals in a population can vary greatly from year-to year, depending at least in part on precipitation of the season. Abundance estimates made at several occurrences range from a complete lack of plants to thousands in subsequent years (CDFG 2010). Population variability in some vernal pools species is attributable to interactions of seed dormancy, early seedling survivorship, and average seed set per plant, as principally determined by seasonal and between-year limitations in available moisture (Griggs and Jain 1983; Holland 1987). Fluctuations of similar magnitude are also recorded for Hoover's spurge, hairy Orcutt grass, and Greene's tuctoria at the Vina Plains Preserve in Tehama County (Alexander and Schlising 1997).

Observations made over a decade or so may provide a reasonable indication of the short-term vigor of a given Bogg's Lake hedge-hyssop population. It is important to consider however, that in order to assess the trend of the species, long-term monitoring of both habitat and populations conducted over multiple cycles of wet and dry years is needed. Another aspect of population demography is the quantity and age of stored seed in the soil profile. Undoubtedly, the number of stored seeds in the soil profile has bearing on how many plants can be produced in a given favorable year.

2.4 Threats to the Species

Potential direct threats to Bogg's Lake hedge-hyssop include loss of vernal pool habitat to agricultural or urban/industrial land-use conversions; construction and maintenance of firebreaks, roads, and utility corridors; timber harvest activities (in montane Occurrences); inappropriate livestock grazing regimes (later spring/summer rotations); grassland fires; recreational vehicles; equestrian and pedestrian traffic; and refuse dumping (CDFG 1992, 1998; CDFG 2010; Corbin et al. 1994; Kaye et al. 1990).

Potential Indirect threats to Bogg's Lake hedge-hyssop include hydrological alteration of sub-watersheds by surrounding developments and land uses; shifts in competitive interactions (hydrology-mediated or invasive weeds); windblown refuse accumulation; point and non-point source water pollution; air pollution, and global climate change.

2.5 Data Gaps and Conservation Implications

With exception to an investigation into the breeding system (Kaye et al. 1990), various monitoring projects, and the visual observations of field workers (Corbin et al. 1994; Schoolcraft 2000; CDFG 2010; Witham pers. comm.), Bogg's Lake hedge-hyssop has received limited research attention. Detailed studies have not been conducted regarding the biology, ecology, potential for cross pollination, population genetics, habitat relationships, population dynamics, trends or threats. Pertinent data gaps, implications for conservation, and operating assumptions include the following.

2.5.1 Unknown Number of Undiscovered Populations

Additional unsurveyed and partially surveyed potentially suitable habitat exists within the Plan Area and elsewhere within the range of the species. In the Plan Area, discovery of new populations of Bogg's Lake hedge-hyssop may occur on the large dry-land ranchlands, public/quasi-public lands and vernal pool-grassland preserves already established in Sacramento County.

2.5.2 Unknown Relationship Between Landform/Soil Chemistry and Bio-Geographic Distribution

In Sacramento County, Bogg's Lake hedge-hyssop has a geographic association with old alluvial terraces possessing acidic soils, primarily of the Redding and Red Bluff Families (Laguna Geological Formation). The exact nature of this relationship is, however, unknown. It is unknown if soil pH or other edaphic factors influence the species distribution and population vigor. It is possible that functioning vernal pools with well-developed hydrology, regardless of landform, soil series and soil pH may provide suitable habitat for this species. This is supported by the occurrence of this species in vernal pools and wetlands with vernal pool-type hydrology on other landforms, with different soil types, at varying locations. In the Plan Area, vernal pools are most frequent and best developed on the Laguna Formation.

2.5.3 Unknown Pollination Ecology

In a study conducted in Oregon, Bogg's Lake hedge-hyssop has been shown to be completely self-compatible, and insects were never observed visiting its flowers (Kaye et al. 1990). It is not known though whether or not out-crossing ability exists, and if so, whether or not insect pollinators are associated with the species anywhere in its range.

2.5.4 What Constitutes Population Vigor, and How to Measure?

Population vigor will need to be monitored during the life of the SSHCP, yet population dynamics, including year-to-year variability in abundance, has not been described in detail for any of the occurrences in Sacramento County. In other areas, Bogg's Lake hedge-hyssop population estimates have been made over varying periods of time. Populations estimates range from 1,000,000 plants at CNDDB occurrence #36, to a single individual at CNDDB occurrence #64. Observations made over time also indicate that Bogg's Lake hedge-hyssop populations can vary by several orders of magnitude between years, with low numbers present during years with sub-optimal hydrology (CDFG 2010; Corbin et al. 1994). Other rare vernal pool species have been shown to be variable in population abundance from year-to-year (Holland 1987; Griggs pers. comm.), and causative factors contributing to year-to-year population fluctuations in rare species may be difficult to identify (Alexander and Schlising 1997).

Population vigor will be difficult to assess based on number of individuals present over short intervals of time. Trends occurring over longer periods may occur that are not discernable, and trends that are discerned may be unexplainable. These factors will complicate attempts to change management for benefit of the species if measured vigor shows decline.

2.5.5 Specific Hydrological Requirements of Bogg's Lake hedge-hyssop

Numerical data do not exist regarding specific parameters of the annual hydrological cycle of vernal pools supporting Bogg's Lake hedge-hyssop populations in the Plan Area (e.g., timing of rainfall, depth of ponding, duration of ponding and soil dry down rate).

The general lack of numerical hydrological data limits the ability to precisely monitor or assess hydrological suitability of Bogg's Lake hedge-hyssop -vernal pool habitat within established preserves. Similarly, assessment of potentially suitable Bogg's Lake hedge-hyssop habitat for preserve establishment or for detection of the species at this time must rely on generalities. Once preserves for existing Bogg's Lake hedge-hyssop populations are established, assessed and monitored over time, a more quantifiable definition of suitable Bogg's Lake hedge-hyssop - vernal pool hydrology will emerge based on learned information.

2.5.6 Baseline Hydrological Trend of Pools and Existing Indirect Effects

Extant Bogg's Lake hedge-hyssop populations in the Plan Area may have already experienced some degree of hydrological modification resulting from development-related alterations to sub-watersheds (CDFG 2010). Without complete protection of entire vernal pool watersheds, or precise hydrological monitoring and accurate modeling on a pool complex-scale, long-term indirect effects resulting from existing alterations to sub-watershed hydrology are unknown.

Baseline Bogg's Lake hedge-hyssop habitat conditions for the SSHCP may not be pristine, so if trends in vigor or habitat quality become apparent during the 50-year period or at some time beyond, it may be difficult to attribute trend to any specific management activity.

2.5.7 Definition of Appropriate Hydrology Buffer

There is no standard for appropriate scale of effective hydrologic buffers for vernal pool-annual grassland ecosystems, since the nature of vernal pool complexes and their geo-hydrological relations may vary substantially by geography (Holland and Dains 1990).

Proposed preserve designs may not afford complete protection to the hydrological systems that support Bogg's Lake hedge-hyssop and other species assemblages dependant on them.

2.5.8 Definition of Appropriate Scale Bogg's Lake hedge-hyssop -Vernal Pool-Annual Grassland Preserve

There is no standard for appropriate scale of effective Bogg's Lake hedge-hyssop -vernal pool preserves. It is a paradigm of conservation biology that "bigger is better" for a variety of well-documented reasons. Conservation challenges associated with the relatively small-scale vernal pool preserve that includes rare plant populations at Phoenix Field and Phoenix Park are well documented and reflect consequences of increase edge effect associated with smaller preserves (Clark et al. 1998).

2.5.9 Determination of an Appropriate Livestock Grazing Regime

Livestock grazing will occur in at least some of the Bogg's Lake hedge-hyssop -vernal pool preserves, primarily for purposes of upland annual grassland vegetation management. Specific grazing regimes have not been formulated for annual grassland pasture systems with Bogg's Lake hedge-hyssop -occupied pools, although grazing and monitoring in similar systems have been addressed (Barry 1998; TNC 2000; Griggs 2000; Robins and Vollmar 2002). It is important to note that Bogg's Lake hedge-hyssop does persist though, in historically and contemporary operating livestock ranches and USFS and BLM grazing allotments. At a minimum, compatibility with some level of grazing is evidenced by persistence of the species in these systems. Since Bogg's Lake hedge-hyssop occupies medium to large-size vernal pools, management of Italian wild rye and Mediterranean barley around the margins of vernal pools, and Medusa-head grass in uplands should be monitored and managed but not primarily for the needs of Bogg's Lake hedge-hyssop specifically.

Presently, Witham et al. are formulating site-specific livestock grazing regimes for annual grassland-vernal pool systems in an area of Sacramento County. Livestock grazing regimes in Bogg's Lake hedge-hyssop -vernal pool preserves covered under this HCP will tier towards the results of this work, as well as to the specific needs of Bogg's Lake hedge-hyssop . Specific livestock grazing regimes cannot be formulated until preserve size, configuration, and soil and vegetation conditions and vegetation management goals are determined.

2.5.10 Interactions with Non-Native Weeds and Weed Management Activities

Non-native weeds, or weedy native species reported as occurring in vernal pools include western mannagrass, swamp pricklegrass, Bermuda grass, common spikerush, filed bindweed, lippia, paradox canary-grass, hairy hawkbit, Cocklebur and cattails. None of these are reported to co-inhabit Bogg's Lake hedge-hyssop -occupied vernal pools in Sacramento County. Any of these and others now unknown may appear and/or change in abundance in Bogg's Lake hedge-hyssop -occupied pools over time. Italian wild rye and Mediterranean barley, two common non-native inhabitants of shallow vernal pools and vernal pool margins, might be of management concern to Bogg's Lake hedge-hyssop if they are allowed to completely dominate the vernal pool margins and adjacent uplands._Potential competitive interactions with these species may affect the vigor of Bogg's Lake hedge-hyssop populations. In addition, any eradication or control methods implemented for these species may in turn potentially affect Bogg's Lake hedge-hyssop populations.

2.5.11 Potential Association and Compatibility with Other Rare Vernal Pool Species

It is desirable to combine to design preserves for multi-species conservation. Bogg's Lake hedge-hyssop has been reported as sharing vernal pools with other rare plant species, including Sacramento Orcutt grass, hairy Orcutt grass, slender Orcutt grass, Greene's tuctoria, San Joaquin Valley Orcutt grass, Bogg's Lake hedge-hyssop , Hoover's spurge, legenere, succulent owl's-clover. Many of these pool complexes supporting rare species also provide habitat for rare invertebrates, amphibians, mammals, and bird species as well.

Management for multiple species maximizes the effectiveness of habitat conservation and requires coordinated monitoring and actions. Management for the benefit of one species may conflict with management needs of other rare species. For instance, livestock grazing anytime between July 1 and April 1 may be compatible with or even benefit some Bogg's Lake hedge-hyssop -associated pool complexes, but may be detrimental to ground-dwelling amphibians depending on those complexes (e.g., California tiger salamander).

2.5.12 Genetic Variation (Spatial and Temporal [Seed Bank], Genetic Drift, Genetic Bottlenecks)

Population genetics for Bogg's Lake hedge-hyssop are completely unknown. For an overview of genetic considerations of vernal pool plant species, see Elam 1998)._Current limitations in our understanding of Bogg's Lake hedge-hyssop population genetics have little immediate conservation implication, given the relatively few number of Bogg's Lake hedge-hyssop occurrences in the Plan Area.

If experimental inoculation of pools is proposed as part of the SSHCP, appropriate measures will be developed to ensure that seed collection, seed treatment and pool inoculation methods are consistent with what we know and do not know about Bogg's Lake hedge-hyssop ecology and population genetics.

2.5.13 Critical Population Size

Critical population size is a statistical estimate that defines the minimum number of individuals required for a population to maintain itself over generations, through time. This population parameter has been determined for assorted wildlife and some perennial plant species. The most simplistic estimations take into account recruitment rates of individuals into the population via reproduction and immigration, and removal rates of individuals from that same population via death and emigration.

Since Bogg's Lake hedge-hyssop is an annual species, its population sizes may be highly variable from year to year, and the soil seed bank constitutes an unknown demographic component of the population, definition and assessment of a critical population size is impracticable and lacks ecological meaning for the purposes of the SSHCP.

Knowledge of critical population size provides an ecologically meaningful and quantifiable benchmark for adaptive management purposes (e.g., if monitored populations drop to within 30 percent of critical population size, site-specific analysis, appropriate management changes and additional monitoring will occur). This is not possible for annual species, so other measurable benchmarks are needed.

2.5.14 Seed Longevity and Dynamics of Stored Soil Seed Bank

As previously mentioned, the existence and potential role of a dormant soil seed bank in population dynamics is indicated by the observation of a three-year period during which plants were absent, followed by abundant plants the following favorable hydrologic season. Beyond this observation though, there have been no empirical studies addressing the presence of a soil seed bank, seed dormancy or longevity for Bogg's Lake hedge-hyssop.

From the perspective of conservation, knowledge of site specific soil seed bank characteristics would allow more accurate assessment of population size and stability (vigor). This is particularly true of populations that typically support the fewest standing individuals through time.

2.5.15 Unknown Aspects of Experimental Inoculation

Since there are so few natural populations of Bogg's Lake hedge-hyssop in Sacramento County, species viability may be significantly enhanced by inoculating unoccupied, apparently suitable pools and increasing the number of naturally self-sustaining populations. These additional populations would increase the likelihood of natural dispersal events into preserved but unoccupied Bogg's Lake hedge-hyssop habitat, create meta-population structure at extant occurrences where single pools may support the species, and help ensure existence should any natural populations become compromised. Dispersal into, and colonization of artificially created or enhanced vernal pools, stock-ponds, reservoirs and even rutted tire tracks in occupied vernal pool landscapes has been documented (CDFG 2010; Sanger pers. comm. 2003). Bogg's Lake hedge-hyssop is a fully self-compatible species, which is a pre-adaptation for colonization.

Uncertainties regarding the political ramifications and ecological effectiveness of experimental inoculation lead the conservation community and Agencies to not consider experimental inoculation as an appropriate conservation goal. Given the rarity of this species in the Plan Area though, this option may need reconsideration at some point in time.

2.5.16 Air Pollution (Dust/Ozone/Nitric Oxide, Sulphur Dioxide)

Portions of the Central Valley of California frequently exceed State and Federal safety levels for a variety of air pollutants, including particulate matter, ozone, and others. Some of these pollutants are known to negatively affect plant physiology and health, although none have been investigated as they relate to vernal pool vegetation. Assuming that extant Bogg's Lake hedge-hyssop occurrences are maintaining their vigor at existing ambient pollution levels, air pollution will probably not present a major threat to the viability of Bogg's Lake hedge-hyssop, if existing air quality can be maintained. If however, California's human population increases as projected and air pollution control measures are not developed and implemented concomitantly and effectively, these pollutants may negatively affect Bogg's Lake hedge-hyssop and other native plant species in the future.

2.5.17 Effects of Global Climate Change

The scientific community commonly accepts as valid the phenomenon of increasingly rapid global climate change. Specific climatic models for California predict an average increase in temperature over the coming decades, with concomitant unpredictability in annual rainfall patterns. There is uncertainty regarding the exact nature and extent of these changes, as well as the consequences these changes pose to conservation biology.

It is likely that given the expected global climate trends, a vigor response of some kind could be expected for Bogg's Lake hedge-hyssop populations within the implementation period of this HCP, or at some time beyond.

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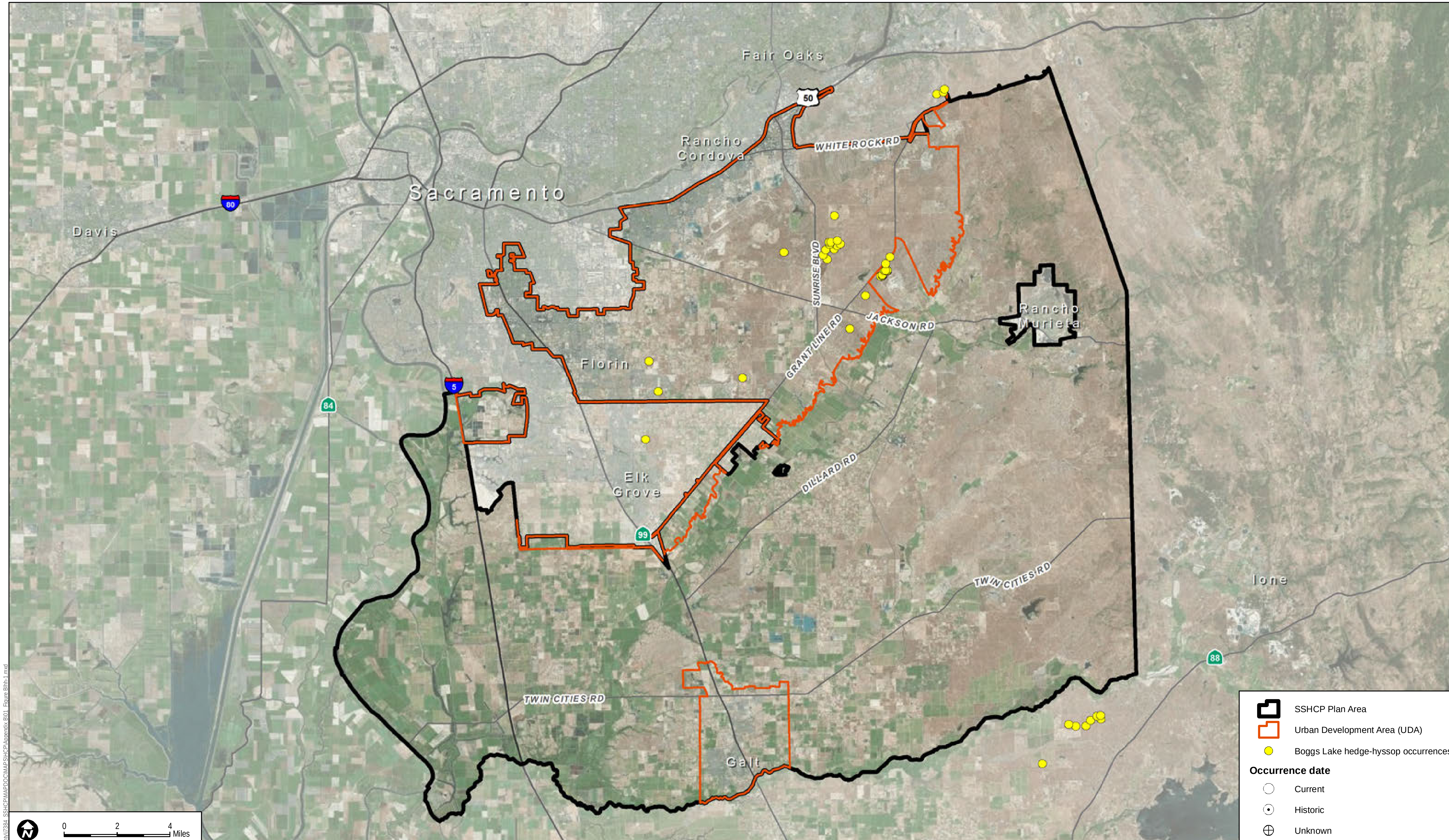

SOURCE: Bing Maps, County of Sacramento 2012, CDFG 2012, Sugnet & Associates 1993, Jones & Stokes 2990

FIGURE BLHH-1

Boggs Lake Hedge-Hyssop Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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3 AHART'S DWARF RUSH (ADR)

Prepared by Dittes and Guardino Consulting (John Dittes and Josephine Guardino)

Ahart's dwarf rush (ADR)
(Juncus leiospermus ahartii)
Status USFWS: None

Status CDFG: None

Status CNPS: 1B.2

photo courtesy BCAG

3.1 Legal Status

Ahart's dwarf rush is considered to be rare, threatened or endangered throughout its range, thus qualifying its designation as a list 1B.2 species by the California Native Plant Society (CNPS 2010). It has been assigned an R-E-D Code of 3-2-3, meaning it is distributed in one to several highly restricted occurrences, endangered in a portion of its range, and entirely restricted to California.

Being a CNPS List 1B plant species, Ahart's dwarf rush meets the California Department of Fish and Game's (CDFG) definition of a special plant though it has no formal protection status by the CDFG or United States Fish and Wildlife Service (USFWS).

3.2 Life History and Ecology

3.2.1 Species Description and Life History

Dwarf rush (*Juncus leiospermus* F.J. Herm.), is represented by two varieties, var. *leiospermus* (Red Bluff dwarf rush), and var. *ahartii* (Ahart's dwarf rush), both of which are rare and endemic to California. The species is an annual in the rush family (Juncaceae) that is restricted to wetlands possessing vernal pool-type hydrology.

This inconspicuous species exhibits a tufted growth form, with a basal cluster of thread-like leaves exceeded by one to several erect, 1.9 to 11.6 centimeter-long, stiff, thread-like stems. One to seven flowers are born together in a compact cluster at the tip of each stem. The flower clusters are subtended by small (0.7 to 2.4 millimeters) bract scales. Flowers are small (1.5 to 4.6 millimeters) and comprised of 6 to 10 dark brown, pointed scales, three stamens, and a single ovary with a long (1.5 to 3 millimeters), three-branched style. The mature fruit capsule is similar to the flower scales in color and is equal, or slightly exceeding them in length. Ahart's dwarf rush (*J.leiospermus* var. *ahartii*) is distinguished from the rare Red Bluff dwarf rush (*J.leiospermus* var. *leiospermus*) on the basis of the former having only one to two flowers per cluster, overall smaller size and fewer parts (Ertter 1986).

Other small annual rushes also occur in vernal pool habitat and may co-occur with Ahart's dwarf rush. Dwarf rush is distinguished from the closely related Yosemite rush (*J. triformis*) by the latter having slightly narrower stems (less than 0.4 millimeter), capsules shorter than flower scales, and flower scales that are unequal in length. Dwarf rush is most easily distinguished from toad rush (*J. bufonius* vars.) on the basis of having a simple versus a branched stem and terminal versus axillary flowers. Dwarf rush is readily distinguished from leafy-bracted dwarf rush (*J. capitatus*) by the former having a shorter inflorescence bract (0.7 to 2.4 millimeters versus five to 15 millimeters). Dwarf rush is distinguished from inch-high rush (*J. uncialis*) and vernal pool dwarf rush (*J. hemiendytus* vars.) by its comparatively long (1.5 to 3 millimeters) long style.

Ahart's dwarf rush, and annual vernal pool rushes in general, have received little attention from biologists or ecologists. Other than observations of field botanists and basic taxonomic and biogeographic treatments (Ertter 1986), the biology and ecology of Ahart's dwarf rush remains unstudied.

Since all vernal pool plant species share similar environmental selective pressures, they likely also share similar adaptive traits. For this reason, studies addressing the life history and ecology of other more common vernal pool plant species may provide some insight into the life history and ecology of Ahart's dwarf rush.

Ahart's dwarf rush shares the annual growth habit with the vast majority of other endemic vernal pool plants. This adaptive trait confers to population's avoidance of the regular and extreme seasonal drought that characterizes vernal pool habitat and the Mediterranean climate (Griggs and Jain 1983; Holland 1987; Stone et al. 1988; Zedler 1990).

The specific timing of the germination of Ahart's dwarf rush seeds relative to the timing of the vernal pool inundation cycle has not been studied or described. In general, a given vernal pool species may germinate either during the wetting phase or the inundation-phase of the vernal pool cycle (Keeley and Zedler 1998). Based on the preference of Ahart's dwarf rush for the outer margins of larger vernal pools, the margins of shallow vernal pools, and shallow swales (CDFG 2010; Dittes and Guardino pers. obs.) and its relatively early flowering date (late March), it might be expected that it germinates relatively early in the hydrological season during the wetting or early inundated-phase, in saturated, as opposed to inundated soil. Germination requirements, optima and the potential presence of seed dormancy for Ahart's dwarf rush have not been investigated.

One of the challenges posed to "deeply adapted" vernal pool plants is the need to photosynthesize and grow while submersed, and then transition into a terrestrial growth phase. Many vernal pool species exhibit an aquatic juvenile growth form that is different from the adult form. These morphological adaptations, not exhibited by Ahart's dwarf rush, facilitate light exposure and gas exchange under aquatic conditions, thus lengthening the growing season by maximizing growth while vernal pools are still inundated. The lack of this specialized dimorphism is further indicative of preference to the less-extreme inundation regimes of those encountered in the spectrum of vernal wetland types.

Dwarf rush flowers and sets seeds during the terrestrial phase of the vernal pool hydrologic cycle, typically in March and April (CNPS 2010). The very long style, and large stamens generally indicate an outcrossing breeding strategy (Hickman 1993), although breeding system and pollination strategies have not been investigated for this species. It is likely that these and other outcrossing annual *Juncus* are mainly wind-pollinated, although the potential for flower-visiting insects has not been studied.

Mature fruit capsules dehisce and release mature seeds by late spring to early summer (Dittes pers. obs.). Unlike some other vernal pool species (e.g., Orcuttiae grasses, pincushion navarretia), Ahart's dwarf rush does not appear to exhibit anti-dispersal adaptations, although the species often appears in small discrete aggregations amid larger areas of available habitat (Dittes pers. obs.). Natural dispersal of seeds, however limited, likely occurs via flowing water, transport on feet and feathers of waterfowl, and in mud on hooves and legs of livestock. As with all other vernal pool species, natural dispersal of seeds was likely a more frequent event when there were many more vernal pools, more pool interconnectivity, exceedingly larger waterfowl migrations and unfenced roaming ungulates (Griggs 1980).

The existence of a dormant soil seed bank is unknown for Ahart's dwarf rush. The presence of a persistent soil seed bank provides insurance against localized extirpation resulting from the unpredictable occurrence and duration of appropriate growing conditions. If total seed crop failure occurs in a given year or set of years (failure to germinate, loss to late season flooding or fire, excessive grazing by livestock or grasshopper herbivory), additional stored seeds are available for another year's effort.

The population biology and genetics of Ahart's dwarf rush have not been investigated, so intra- and inter-population patterns of genetic variability are unknown. Elam (1996) provides a good overview of the myriad considerations in assessing the population genetics of vernal pool plants in the absence of empirical data for a given taxon. Given the highly limited number of occurrences and the scattered geographical distribution, all Ahart's dwarf rush populations should be considered unique, and for the purposes of conservation, important genetic entities.

3.2.2 Habitat Requirements and Ecology

It is generally held that many of the endemic vernal pool plant species are relatively recent evolutionary derivations of more common and widespread upland progenitors (Stebbins 1976; Stone 1990; Raven and Axlerod 1978; Thorne 1984), likely including Ahart's dwarf rush. These neoendemic vernal pool species are thought to have evolved from terrestrial habitat into seasonally aquatic vernal pool habitat made available as the Mediterranean Climate developed and the inland Tertiary-age Sea dried.

In Eastern Sacramento County, the two Ahart's dwarf rush occurrences are associated with the Redding Gravelly Loam Series of the Arroyo Seco Formation. This soil series has a very gravelly hardpan approximately 28 inches below the surface and is strongly cemented with silica. These soils are typically acidic and conducive to the development of vernal pool hydrology).

Ahart's dwarf rush is strictly adapted to the vernal pool hydrologic cycle. It is of importance to conservation however, that in contrast to most of the more "deeply-adapted" vernal pool endemics, Ahart's dwarf rush occupies the more "flashy" hydrology of vernal pool margins, shallow vernal pools, and swales (Ahart pers. comm.; Dittes and Guardino pers. obs.; CDFG 2010). The closely related and comparatively more widespread Red Bluff dwarf rush is also known from vernally moist edges of groundwater seep areas as well. Quantified vernal pool dimensions are not given for any of the CNDDB occurrences.

Floristic associations provide further indication of preference for the more "flashy" portion of the spectrum of vernal pool hydrological cycles. In Butte County, Ahart's dwarf rush is most often observed with other "shallow pool" or "edge" species, including other annual rushes (toad rush; *Juncus bufonius*, leaf-bracted rush; *J. capitatus*, inch-high rush; *J. capitatus*), annual hairgrass (*Deschampsia danthonoides*), Sacramento Valley pogogyne (*Pogogyne zizyphoroides*), marigold navarretia (*Navarretia tagetina*), smooth cat's-ear (*Hypochaeris glabra*), hyssop loosestrife (*Lythrum hyssopifolium*), long-beaked hawkbit (*Leontodon taraxicoides*), cowbag clover (*Trifolium depauperatum*) and Fremont's goldfields (*Lasthenia fremontii*) (Dittes and Guardino pers. obs.; Ahart pers. comm.).

Although Ahart's dwarf rush is also recorded as occurring with the more "deeply-adapted" vernal pool endemics, including coyote thistle (*Eryngium castrense*), bractless hedge-hyssop (*Gratiola ebracteata*), tricolor monkey-flower (*Mimulus tricolor*), American pillwort (*Pilularia americana*), double-horned downingia (*Downingia bicornuta*), ornate downingia (*Downingia ornatissima*), white-headed navarretia (*Navarretia leucocephala*) and water pygmyweed (*Crassula aquatica*) (CDFG 2010), it usually is growing at the higher-drier edge of hydro-topographic position preferred by the latter species (Dittes and Guardino pers. obs.; Ahart pers. comm.). Interestingly, Ahart's dwarf rush is also known to do well on disturbed gopher mounds along the margins of the wetlands as well (Ahart pers. comm.; Dittes and Guardino pers. obs.; CDFG 2010).

Hydrological stresses associated with vernal pools exclude the majority of non-native weedy species that characterize the present-day valley annual grassland, agricultural areas, and ruderal habitats. Italian wild rye (*Lolium multiflorum*) and Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), two non-native facultative wetland species, typically dominate vernal pool portions of disturbed wetlands in the Central Valley and can be invasive around vernal pool margins and in smaller, more ephemeral vernal pool types. Similarly, long-beaked hawkbit (*Leontodon taraxicoides*), another non-native annual, can dominate the edges of vernal pool and the basins of smaller pools and swales. Some suggest that built-up thatch from Italian wild rye, Mediterranean barley, Medusa-head grass (*Taeniatherum caput-medusae*), and other non-native upland species may indirectly affect vernal pool species as well by lessening the amount of water entering the system through surface and subsurface flow (Robins and Vollmar 2002).

Since Ahart's dwarf rush occupies the margins of pools and smaller pools and swales, it may be more susceptible to the effects of excessive growth of Italian wild rye, Mediterranean barley, long-beaked hawkbit, and thatch buildup, than many of the other "more deeply-adapted" vernal pool rarities. As a case in point, Ahart mentions that some populations of Ahart's dwarf rush and other vernal pool species in his area have diminished over the years with concomitant increase in cover of European annual grasses (Ahart 2003 and pers. comm.).

Specific interactions between livestock grazing and Ahart's dwarf rush have not been investigated empirically. Some regimes of livestock grazing have been shown to benefit the floristic composition of vernal pools and associated upland annual grassland. Vernal pools included within livestock exclosures have demonstrated a "simplification" of floral composition with a shift towards dominance by Italian wild rye and Mediterranean barley (Robins and Vollmar 2002; Dittes pers. obs.). Uplands that are not grazed can shift in dominance towards Medusa-head grass and yellow-star thistle (*Centaurea solstitialis*). Appropriate livestock grazing regimes can result in reduction of cover by weedy grasses and thatch and opening of habitat at vernal pool margins by hoof-pocking. This in turn increases micro-habitat heterogeneity and provides germination and colonization opportunities for other native vernal pool species.

Field observations indicate that annual rushes, and many other associated vernal pool annuals do well on gopher mounds and between deep hoof print depressions in wetter areas, and within the puddled hoof prints around drier margins (Dittes pers. obs.). It has also been observed though, that in some cases at the Vina Plains Preserve in Tehama County, excessive trampling of shallow vernal pools can result in their obliteration as distinct topographical features, particularly on heavy clay soils (Schlising pers. comm.). Robins and Vollmer (2002) provide a recent review of information pertaining to livestock grazing in vernal pool-annual grassland ecosystems.

Timing of grazing appears more important than stocking rates in affecting persistence of some vernal pool rarities (Stone *et. al*. 1988; Robins and Vollmer 2002). During the period when pools are inundated and upland forage is still green and attractive (late fall to early spring), cattle tend to not congregate in pools, and trampling and grazing pressures to vernal pool plant species in their seedling or juvenile aquatic phase are minimized. Once the upland forage cures and the vernal pools are in the flowering and seed-producing terrestrial phase (mid-spring to early summer), moist pools become more attractive to livestock, and trampling pressures are increased. Grazing in the summer and fall months, after seeds have set and plants have died likely has little negative effect on most vernal pool annuals, and may enhance the habitat by further reducing thatch and exposing soil for the following growing season (Ahart pers. comm.).

Ahart's dwarf rush is small enough to escape grazing pressures by livestock (except perhaps sheep). The most vulnerable stage of Ahart's dwarf rush is probably after pool margins have dried and the plant is in flower, before seed matures. It likely will not attract grazers, but if trampled at this point in the life cycle, seed production may be limited. However, with many vernal pool species of such small stature, at least some individuals escape livestock trampling pressures during most years except under all, but the most severe grazing regimes.

Although none are specifically reported to co-inhabit vernal pools with Ahart's dwarf rush, several non-native weedy hydrophytes may present future problems. Mannagrass (*Glyceria occidentalis*), an aggressive weed of irrigated agriculture and degraded vernal pools, has already been reported as a potential problem at vernal pools in the region. Additional species to consider include rosy lippia (*Phyla nodiflora* var. *rosea*), field bindweed (*Convolvulus arvensis*), common unicorn plant (*Probiscidea louisianica*), swamp pricklegrass (*Crypsis schoenoides*), crabgrass (*Cynodon dactylon*) and paradox canary-grass (*Phalaris paradoxa*). Cocklebur (*Xanthium strumarium*), another native species, can also dominate vernal pools (Schlising pers. comm.; Unger pers. comm.).

3.2.3 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for Ahart's dwarf rush are identified in Table ADR-1 and have been derived from input from local species experts.

Table ADR-1
Essential Habitat Elements for Ahart's Dwarf Rush

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, vernal pool, and vernal swale.	Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools, providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and non-native upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

3.3 Species Distribution and Population Trends

3.3.1 Range Wide Distribution

Presently, Ahart's dwarf rush is recorded from 10 CNDDB occurrences scattered throughout the Great Central Valley, from Calaveras County in the south to Tehama County in the north (CDFG 2010). These occurrences are all situated at sites ranging from 100 to 320 feet in elevation, and with the exception of the occurrence in Calaveras County (San Joaquin Valley Subregion) and the occurrence in Tehama County (North Coast Ranges Subregion), all lie within the Sacramento Valley Subregion of the Great Valley Region of the California Floristic Province (Hickman 1993).

3.3.2 Central Valley Distribution

The northernmost occurrence of Ahart's dwarf rush is located in Tehama County. Four occurrences are found in Butte County, one in the vicinity of the Oroville Municipal Airport, south of Chico and three on the Peter Ahart Ranch, near Honcut (CDFG 2010). The single occurrence in Yuba County is located south of Honcut Creek near the Butte County line. Two occurrences are located in central Sacramento County, and the southernmost occurrence is located in the northwest portion of Calaveras County (CDFG 2010).

3.3.3 Range within the Plan Area

Currently, there are two documented CNDDB occurrences of Ahart's dwarf rush in Sacramento County and the two not-yet-recorded occurrences, each of which is found within both the Plan Area and UDA (CDFG 2010; Mather Field date unknown; Wetland Research Associates 2004).

Figure ADR-1 shows these occurrences. One of the occurrences (CNDDB occurrence #7) is located southeast of Rancho Cordova on private land southeast of the intersection of Kiefer Boulevard and Sunrise Boulevard. The other occurrence (CNDDB occurrence #8) is located approximately 1.75 miles to the northwest on Mather Field. The two occurrences not yet recorded are located on Mather Field north of Kiefer Boulevard.

It is important to note that owing to its small stature, preference for vernal pool margins and swales, early flowering season, and the area of remaining unsurveyed or partially surveyed habitat, moderate to high potential exists for discovery of additional populations of Ahart's dwarf rush within the Plan Area.

Table ADR-2 shows the soil series, geological formation and landform associations for the two Ahart's dwarf rush occurrences in Sacramento County that are recorded in the CNDDB. Generally, this species is associated with old terrace remnant alluvial deposits of ancestral river channels and pediment gravels, which were deposited during the early Pleistocene between 600,000 and 1,500,000 years ago. Though the distribution of the taxon is extremely disjunct, the range of the taxon in the Plan Area is considered to be all vernal pool habitats.

Table ADR-2
Extant CNDDB Occurrence Numbers, Distribution, Associated Soil Series And Landform Formations For Ahart's dwarf rush In Sacramento County

CNDDB Occurrence #	Quadrangle	Soil Series	Geological Formation and Landform
7	Buffalo Creek	Redding gravelly loam	Arroyo Seco Formation Remnant high terraces
8	Carmichael	Redding gravelly loam	Arroyo Seco Formation Remnant high terraces

3.3.4 Population Levels and Trends

Ahart's dwarf rush is known from a total of 10 CNDDB occurrences, all in California, including four in Butte County, two in Sacramento County, and one in each of Calaveras, Placer, Tehama and Yuba Counties (CDFG 2010).

Of the 10 documented occurrences presumed extant, one in Sacramento County (CNDDB occurrence #7) is listed as "Possibly Extirpated" (CDFG 2010). The other Sacramento County occurrence, presumed extant (CNDDB occurrence #8), was observed to support approximately 300 plants in 2001 (CDFG 2010). The Tehama County occurrence is reported as supporting 750 plants as of 2004. The Calaveras County population was observed to support approximately 100 plants among three vernal pools in 1987, the last time this population was recorded (CDFG

2010). The Placer County occurrence, reported as supporting 45 plants in 1990, is on land proposed for development. The Yuba County occurrence was reported as supporting several hundred plants among three colonies in 1998 (CDFG 2010). The northernmost occurrence (CNDDB occurrence #4) was observed to support several hundred plants in the spring of 2003 (Dittes and Guardino pers. obs.). The occurrences on the Peter Ahart Ranch are presumed extant, but it and other vernal pool species in the area likely have diminished over the last few decades concomitant with an overall increase in range productivity and increasing abundance of weedy annual European grasses (Ahart pers. comm. 2003). Table ADR-3 shows the population estimates of the CNDDB occurrences.

Table ADR-3
Population Estimates for CNDDB Occurrences

CNDDB #	# of Pools Observed	Range of Population Estimates
7	Unknown	1999: 4 plants
8	Unknown	2000: 300 plants

It is impossible to determine the number of historically occurring Ahart's dwarf rush populations or the acreage of suitable habitat lost to historic agricultural and urban land-use conversions, since so much had happened before these species first received attention. Investigators have made estimates as to the acreage of vernal pool habitat lost since historic times (Holland 1978); however, owing to habitat specificity, only a subset of the vernal pool habitat lost within the natural range of the species may have provided suitable habitat for Ahart's dwarf rush. Effects of historic livestock grazing combined with drought and habitat alterations relating to development of non-native annual grassland are unknown as well.

There has been no comprehensive effort to monitor any of the known populations of Ahart's dwarf rush. Numbers of individuals have not been recorded for the populations since their discovery and the overall population dynamics for this plant are unknown.

Studies involving other vernal pool plant rarities, including Orcuttiae grasses and Hoover's Spurge have demonstrated marked fluctuation in numbers of individuals within populations between years (Griggs and Jain 1983; Holland 1987; Alexander and Schlising 1997). This extreme population variability is attributable to interactions of seed dormancy, early seedling survivorship, and average seed set per plant, as principally determined by seasonal and between-year limitations in available moisture (Griggs and Jain 1983; Holland 1987). It is not known however, if Ahart's dwarf rush exhibits a similar between-year pattern.

Observations made over a decade or so may provide a reasonable indication of the short-term vigor of a given Ahart's dwarf rush population. It is important to consider however, that in order to assess the trend of the species, long-term monitoring of both habitat and populations conducted over multiple cycles of wet and dry years is needed. Another critical aspect of population demography is the presence and nature of the soil seed bank, which is unknown for Ahart's dwarf rush.

3.4 Threats to the Species

Potential threats to Ahart's dwarf rush include loss of vernal pool habitat to agricultural or urban/industrial land-use conversions, hydrological alteration of sub-watersheds and associated vernal pool habitat, shifts in competitive interactions (hydrological mediated or invasive weedy species), inappropriate livestock grazing regimes (none, mid-spring rotations, sheep vs. cattle), recreational vehicle use, equestrian and pedestrian traffic, refuse dumping, windblown refuse accumulation, air pollution and global climate change.

Proposed development is a threat to one of the Sacramento County Occurrences (CNDDB occurrence # 7). This population is now listed as "Possibly Extirpated" (CDFG 2010). Proposed development of an aggregate mine was stated as a threat to the only other Sacramento County Occurrence (CNDDB occurrence #8) in 2000. This occurrence is now within the boundaries of the proposed Mather Field Vernal Pool Preserve. Off-road vehicle traffic, road construction, cattle grazing, surrounding development and a proposed subdivision are stated as threats for the single Placer County occurrence (CNDDB occurrence #3). Power line corridor maintenance activities are stated as a threat to the single Yuba County Occurrence (CNDDB occurrence #9). No threats are stated for the Calaveras County population (CNDDB occurrence #2). The Butte County occurrences in the vicinity of Honcut (CNDDB #1, #5, and #6) have no threats stated in the CNDDB. According to Ahart though (pers. comm. 2003), these populations may be experiencing a decline in vigor associated with increasing range productivity and increasing abundance of annual European grasses.

3.5 Data Gaps and Conservation Implications

Despite its distinctive appearance and extreme rarity, Ahart's dwarf rush has received little research attention from botanists or ecologists. Aside from general observations of field workers provided in the CNDDB and the taxonomic work of Ertter (1986), nothing else exists regarding the biology, ecology, pollinators, breeding system, population genetics, habitat relationships, population levels, trends or threats associated with this taxon. Pertinent data gaps, implications for conservation, and operating assumptions include:

3.5.1 Unknown Number of Undiscovered Populations

Additional unsurveyed and partially surveyed potentially suitable habitat exists within the Plan Area and elsewhere within the range of the species. In the Plan Area, discovery of new populations may occur on the large dry-land ranchlands, public and quasi-public lands and vernal pool-grassland preserves already established in the eastern portion of Sacramento County.

3.5.2 Unknown Relationship between Landform/Soil Chemistry and Bio-Geographic Distribution

Ahart's dwarf rush has a geographic association with old alluvial terraces possessing acidic soils primarily of the Redding Series. The exact nature of this relationship is however, unknown. It is unknown if soil pH or other edaphic factors influence Ahart's dwarf rush distribution and population vigor. It is possible that the presence of functioning vernal pools, regardless of landform, soil series and soil pH can provide suitable habitat.

3.5.3 Unknown Pollination Ecology

The pollination ecology of Ahart's dwarf rush has not been studied. Floral morphology (long style and style branches, exerted anthers) suggests an outcrossing breeding strategy. The inconspicuous scale-like flower parts and lack of nectar suggest wind pollination, as with most other graminoids (grasses, sedges, rushes, and other grass-like plants). Without knowing specific aspects of pollination ecology, it is difficult to ascertain the importance of associated uplands in the design and management of preserves supporting Ahart's dwarf rush.

It is well documented that specific co-evolved bee species are depended on by a guild of vernal pool plant species. Conservation of these vernal pool plant communities depends on inclusion of adequate areas of surrounding functioning upland habitat to maintain populations of the co-evolved ground-dwelling bees. Some suggest that buffers of up to ½-mile around vernal pools might be needed (Robin Thorp, e-mail to D. Burmester 2003).

3.5.4 What Constitutes Population Vigor, and How to Measure?

Population vigor will need to be monitored during the life of the SSHCP, yet population dynamics, including year-to-year variability in abundance, have not been studied for Ahart's dwarf rush. The existence of a dormant soil seed bank, a critical contributor to population stability in some other vernal pool species, is unknown for Ahart's dwarf rush as well. Other rare vernal pool species have been shown to be highly variable in abundance from year-to-year (Holland 1987; Griggs pers. comm. 2003), and causative factors contributing to year-to-year population fluctuations may be difficult to identify (Alexander and Schlising 1997). Trends may occur that are not discernable and trends that are discerned may be unexplainable. These factors will complicate attempts to change management for benefit of the species if measured vigor shows decline.

3.5.5 Specific Hydrological Requirements of Ahart's dwarf rush

Data do not exist regarding specific parameters of the annual hydrological cycle of vernal pools supporting Ahart's dwarf rush populations (e.g., timing of rainfall, depth of ponding, duration of ponding and soil dry down rate).

The general lack of numerical hydrological data limits the ability to precisely monitor and/or assess hydrological suitability of Ahart's dwarf rush-vernal pool habitat within established preserves. Similarly, assessment of potentially suitable Ahart's dwarf rush habitat for preserve establishment or for detection of the species at this time must rely on generalities.

3.5.6 Baseline Hydrological Trend of Pools and Existing Indirect Effects

Extant Ahart's dwarf rush populations may have already experienced some degree of hydrological modification resulting from development-related alterations to sub-watersheds (CDFG 2010). Without complete protection of entire vernal pool watersheds, or precise hydrological monitoring and accurate modeling on a pool complex-scale, long-term indirect effects resulting from existing alterations to sub-watershed hydrology are unknown. Baseline Ahart's dwarf rush conditions for the SSHCP may not be pristine, so if trends in vigor or habitat quality become apparent during the 50-year period or at some time beyond, it may be difficult to attribute trend to any specific management activity.

3.5.7 Definition of Appropriate Hydrology Buffer

There is no standard for appropriate scale of effective hydrologic buffers for vernal pool-annual grassland ecosystems, since the nature of vernal pool complexes and their geo-hydrological relations may vary substantially by geography (Holland and Dains 1990).Proposed preserve designs may not afford complete protection to the hydrological systems that support Ahart's dwarf rush and other species assemblages dependant on them.

3.5.8 Definition of Appropriate Scale Ahart's dwarf rush-Vernal Pool-Annual Grassland Preserve

There is no standard for appropriate scale of effective Ahart's dwarf rush-vernal pool preserves. It is a paradigm of conservation biology that "bigger is better" for a variety of well-documented reasons. Conservation challenges associated with the relatively small-scale vernal pool preserve at Phoenix Field and Phoenix Park are well documented and reflect consequences of increase edge effect associated with smaller preserves (Clark *et. al*. 1998).

3.5.9 Determination of an Appropriate Livestock Grazing Regime

Specific grazing regimes have not been formulated for annual grassland pasture systems with Ahart's dwarf rush-occupied pools, although grazing and monitoring of vernal pool-annual grassland stems have been addressed (Barry 1998; TNC 2000; Griggs 2002; Robins and Vollmar 2002).

Ahart (2003 and pers. comm.) emphasizes the need to graze vernal pool-annual grasslands, particularly those supporting Ahart's dwarf rush, for the purposes of maintaining vernal pool diversity and the "edge" habitat that Ahart's dwarf rush and many of the showy vernal pool annuals require. This upper, drier topographic-hydrologic microhabitat has been termed the "transition zone" between the wetter vernal pool habitat and the surrounding upland annual grassland matrix (Schlising and Sanders 1982).

Since Ahart's dwarf rush occupies small and/or shallow vernal pools, or the edges of larger pools, management of Italian wild rye and Mediterranean barley in and around pools and Medusa-head grass in surrounding uplands should be of particular management concern. Ahart states that for this species, it is better to err on the side of overgrazing (Ahart pers. comm. 2003).

Presently, Witham et al. are formulating site-specific livestock grazing regimes for annual grassland-vernal pool systems in an area of Sacramento County. Livestock grazing regimes in Ahart's dwarf rush-vernal pool preserves covered under the SSHCP will tier towards the results of this work, as well as to the specific needs of Ahart's dwarf rush. Specific livestock grazing regimes cannot be formulated until preserve size, configuration, and soil and vegetation conditions and vegetation management goals are determined.

3.5.10 Interactions with Non-Native Weeds and Weed Management Activities

Non-native weeds, or weedy native species reported as occurring in vernal pools include western mannagrass, swamp pricklegrass, Bermuda grass, common spikerush, bindweed, lippia, paradox canary-grass, long-beaked hawkbit, cocklebur and cattails. None of these are reported to co-inhabit Ahart's dwarf rush-occupied vernal pools in Sacramento County. Any of these and others now unknown may appear or change in abundance in Ahart's dwarf rush-occupied pools over time. Italian Rye and Mediterranean Barley, two common non-native inhabitants of shallow vernal pools and vernal pool margins, might be of management concern to Ahart's dwarf rush, owing to the latter's preference for small to medium size vernal pools. Similarly, Medusa-head grass in uplands should be monitored and controlled._Potential competitive interactions with these species may affect the vigor of Ahart's dwarf rush populations. In addition, any eradication or control methods implemented for these species may in turn potentially affect Ahart's dwarf rush populations.

3.5.11 Potential Association and Compatibility with Other Rare Vernal Pool Species

It is desirable to combine design preserves for multi-species conservation. Suitability of Ahart's dwarf rush habitat for supporting other rare plant species has not been specifically addressed. Many of these pool complexes also may provide habitat for rare invertebrates, amphibians, mammals, and bird species as well. Management for multiple species maximizes the effectiveness of habitat conservation and requires coordinated monitoring and actions. Management for the benefit of one species may conflict with management needs of other rare species. For instance, livestock grazing anytime after May 15 may be compatible with or even benefit some Ahart's dwarf rush-associated pool complexes, but may be detrimental to other later-flowering species depending on those complexes (e.g., slender Orcutt grass).

3.5.12 Genetic Variation (Spatial and Temporal [Seed Bank], Genetic Drift, Genetic Bottlenecks)

Population genetics for Ahart's dwarf rush are completely unknown._Current limitations in our understanding of Ahart's dwarf rush population genetics have little immediate conservation implication, given the extreme rarity of Ahart's dwarf rush.

If experimental inoculation of pools is proposed as part of the SSHCP, appropriate measures will be developed to ensure that seed collection, seed treatment and pool inoculation methods are consistent with what we know and do not know about Ahart's dwarf rush ecology and population genetics.

3.5.13 Critical Population Size

In conservation biology, critical population size is usually defined as a statistical probability over time, or model that describes the minimum number of individuals required for a population to maintain itself through time. This population parameter has been determined for assorted wildlife and some perennial plant species. The most simplistic estimations take into account recruitment rates of individuals into the population via reproduction and immigration, and removal rates of individuals from that same population via death and emigration.

Since Ahart's dwarf rush is an annual species, its population sizes are known to be highly variable from year to year, and the soil seed bank constitutes an important demographic component of the population, definition and assessment of a critical population size is impracticable and lacks ecological meaning.

Knowledge of critical population size provides an ecologically meaningful and quantifiable benchmark for adaptive management purposes (e.g., if monitored populations drop to within 30 percent of critical population size, site-specific analysis, appropriate management changes and additional monitoring will occur). This is not possible for annual species, so other measurable benchmarks are needed.

3.5.14 Seed Longevity and Dynamics of Stored Soil Seed Bank

As previously mentioned, the existence and potential role of a dormant soil seed bank in population dynamics is completely unknown for Ahart's dwarf rush. There have been no studies addressing the presence of a soil seed bank, seed dormancy or longevity. From the perspective of conservation, knowledge of site specific soil seed bank characteristics would allow more accurate assessment of population size and stability (vigor). This is particularly true of populations that typically support the fewest standing individuals through time.

3.5.15 Unknown Aspects of Experimental Inoculation

Since there are so few natural populations of Ahart's dwarf rush in Sacramento County, species viability may be significantly enhanced by inoculating unoccupied, apparently suitable pools and increasing the number of naturally self-sustaining populations. These additional populations would increase the likelihood of natural dispersal events into preserved but unoccupied Ahart's dwarf rush habitat, create meta-population structure at extant occurrences where single pools may support the species, and ensure existence should any natural populations become compromised. Uncertainties regarding the political ramifications and ecological effectiveness of experimental inoculation lead the conservation community and agencies to not consider experimental inoculation as an appropriate conservation goal. Given the extreme rarity of this species though, this option may need reconsideration at some point in time.

3.5.16 Air Pollution (Dust/Ozone/Nitric Oxide, Sulphur Dioxide)

Portions of the Central Valley of California frequently exceed State and Federal safety levels for a variety of air pollutants, including particulate matter. ozone, and others. Some of these pollutants are known to negatively affect plant physiology and health, although none have been investigated as they relate to vernal pool vegetation. Assuming that extant Ahart's dwarf rush occurrences are maintaining their vigor at existing ambient pollution levels, air pollution will probably not present a major threat to the viability of Ahart's dwarf rush, if existing air quality can be maintained. If however, California's human population increases as projected and air pollution control measures are not developed and implemented concomitantly and effectively, these pollutants may negatively affect Ahart's dwarf rush and other native plant species.

3.5.17 Effects of Global Climate Change

The scientific community commonly accepts as valid the phenomenon of increasingly rapid global climate change. Specific climatic models for California predict an average increase in temperature over the coming decades, with concomitant unpredictability in annual rainfall patterns. There is uncertainty regarding the exact nature and extent of these changes, as well as the consequences these changes pose to conservation biology. It is likely that given the expected global climate trends, a vigor response of some kind could be expected for Ahart's dwarf rush populations within the implementation period of this HCP, or at some time beyond.

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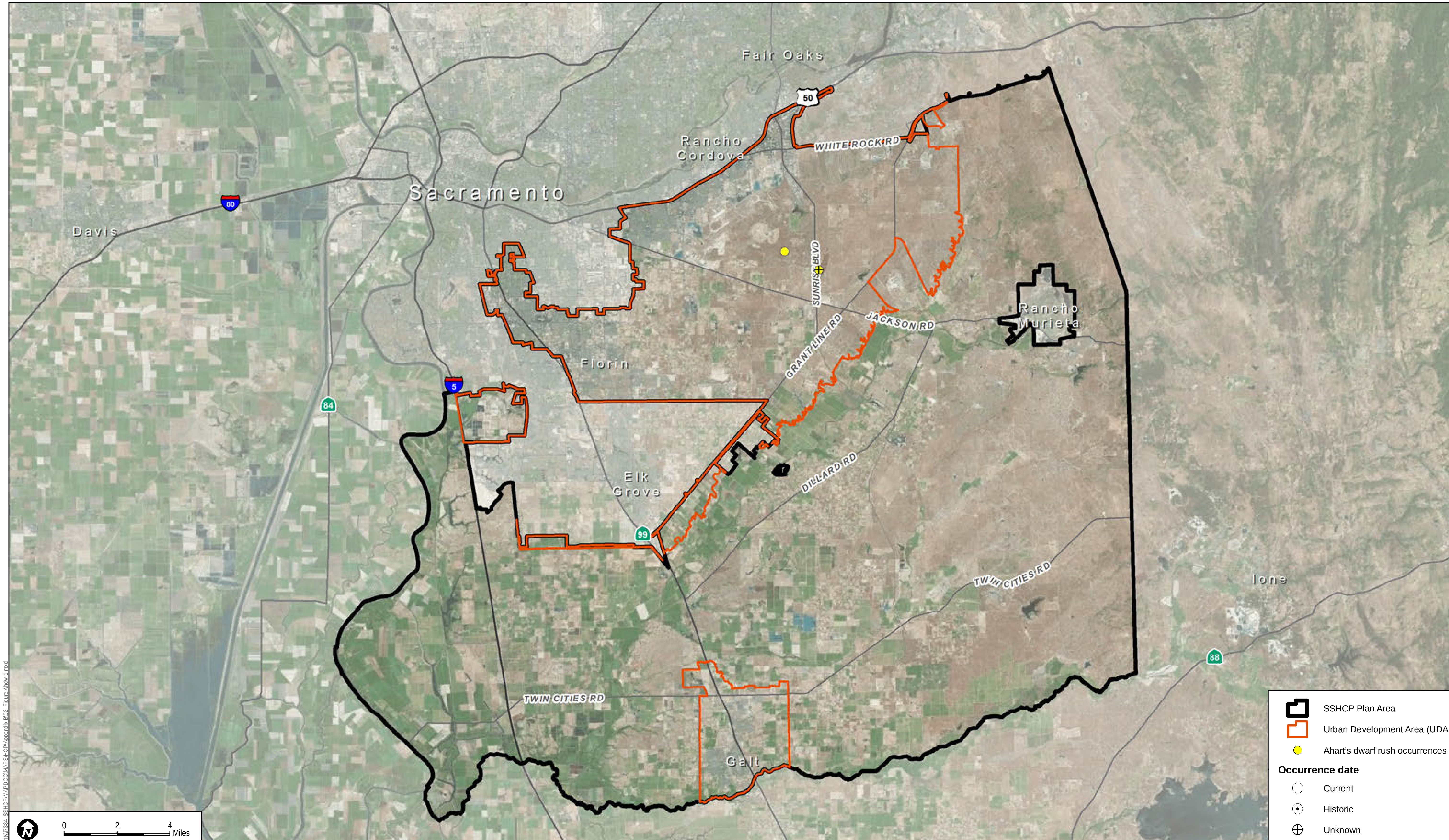

SOURCE: Bing Maps, County of Sacramento 2015, CNDDB 2012

FIGURE ADR-1

Ahart's Dwarf Rush Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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4 LEGENERE (LEG)

Prepared by Dittes and Guardino Consulting (John Dittes and Josephine Guardino)

Legenere (LEG)
(Lgenere limosae)
Status USFWS: None
Status CDFG: None
Status CNPS: 1B.1

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4.1 Legal Status

Legenere (*Legenere limosa*), a vernal pool endemic, is considered to be rare, threatened or endangered throughout its range, thus qualifying its designation as a List 1B Species by the California Native Plant Society (CNPS) (CNPS 2010). It has been assigned an R-E-D Code of 2-3-3, meaning it is distributed in a limited number of occurrences, occasionally more if each occurrence is small, it is endangered throughout its range, and entirely restricted to California.

Being a CNPS List 1B plant species, legenere meets the California Department of Fish and Game (CDFG) definition of a special plant though it has no formal protection status by the CDFG or United States Fish and Wildlife Service (USFWS).

4.2 Life History and Ecology

4.2.1 Species Description and Life History

Legenere is an inconspicuous annual in the Bellflower family (Campanulaceae). This species has slender, sprawling, sometimes branched stems that can grow from 10 to 30 centimeters in length. These stems may also root at the nodes. Small one to three centimeter-long leaves are arranged alternately on the stem; the lower (submersed) ones are linear and early deciduous and the upper ones (emersed) are proportionally shorter, wider and oblong-lanceolate to oblanceolate (Mason 1957), or narrowly triangular (Hickman 1993; Oswald 1994). The inflorescence is a terminal raceme with flowers and fruit born on slender six to 20 millimeter-long stalks (pedicels). These flowers are alternately arranged along an often zig-zag central axis. Each flower stalk is subtended by a six to 12 millimeter-long leaf-like bract. Flowers consist of an inferior ovary, five narrowly triangular green sepals that are 1/2 to 1/3 the length of the ovary, and five greenish-white to yellowish petals (two to four millimeter-long) that are unequally united into a two-lipped, five-lobed corolla with a tubular base. The lower flowers often lack petals entirely. The +3.5 millimeter-long obconic ovary elongates as it matures, eventually becoming a cylindrical fruit that reaches six to 10 millimeter in length and one to two millimeter diameter.

Legenere is a monotypic genus with no close relatives in North America Stone (1990). When in full fruit and without petals present however, legenere might be confused with potentially co-occurring with downingia (*Downingia* spp.). Mature downingias, however, lack the often up-curved, narrow pedicel (stalk) that subtends each cylindrical fruit. Downingias also do not exhibit the often zig-zag central axis of the inflorescence.

The genus *Legenere* has received little empirical study from biologists or ecologists and other than basic taxonomic and biogeographic treatments, legenere remains mostly unstudied. Ecological information resulting from observations of field botanists exists primarily as a result of land management and Agency-related resource surveys (Holland 1983; Platenkamp 1998; CDFG 2010).

4.2.1.1 Ecological Life Cycle

Legenere shares the annual growth habit with the vast majority of other endemic vernal pool plants. This adaptive trait confers to the population's avoidance of the regular and extreme seasonal drought that characterizes vernal pool habitat and the Mediterranean climate (Griggs and Jain 1983; Holland 1987; Stone et al. 1988; Zedler 1990).

4.2.1.2 Seed Germination

The specific timing of germination of legenere seeds relative to the timing of the vernal pool inundation cycle has not been described in detail. Seeds are reported to germinate under water in late February to April (Holland 1983). Seed longevity, dormancy characteristics, germination requirements and germination optima for legenere have not been investigated.

4.2.1.3 Vegetative Growth

One of the challenges to many vernal pool plant species is optimization of physiological processes in both the early season aquatic and later season terrestrial phases of the vernal pool cycle. For legenere, the principal structural adaptation to amphibious growth appears to be production of thin linear aquatic leaves, and thicker, proportionately wider aerial leaves. Although not determined for legenere, it has been shown in other amphibious vernal pool plants that the aquatic leaves lack both waxy cuticle and stomates, in this respect differing from adult aerial leaves (Keeley 1990). These juvenile leaves optimize photosynthesis in the aquatic environment and maximize growth while vernal pools are still inundated, thus lengthening the vernal pool-growing season.

4.2.1.4 Reproduction

Legenere flowers and sets seeds during the dry-down phase of the vernal pool hydrologic cycle, sometimes while shallow water or inundated soil remains in the deepest parts of the pool basin (Dittes pers. obs.). Flowering and fruit maturation occurs from April through June (CNPS 2010; CDFG 2010), and likely varies by vernal pool depth/ponding duration and conditions of the season. Although pollination and breeding experiments have not been carried out for legenere, the reduced white flowers and flowers without corollas suggest a self-pollinating breeding system. Oswald (1994) has observed completely cleistogamous plants (flowers never open) in the Northern Sacramento Valley, which further indicates self-compatibility. Plants typically produce from several to 10 or more fruit, with each fruit containing up to 20 small smooth brown seeds (Holland 1983).

4.2.1.5 Dispersal

Short-distance seed dispersal in legenere appears to be naturally limited by the mature fruit capsule, which only partially opens at its apex. Seeds can remain in the mature capsule after disintegration of the mother plant, potentially being transported by flowing water during the following fall-winter inundation phase (Holland 1983). Seed dispersal is naturally limited in a suite of other vernal pool plant species. This adaptive trait is thought to represent an adaptation to spatially unpredictable and limited vernal pool habitat (Griggs 1974, 1980; Zedler 1990). It should be noted though, that at several occurrences, legenere is recorded to inhabit artificially excavated depressions, drainage ditches and created or enhanced wetlands within occupied vernal pool landscapes (CDFG 2010), thus indicating capacity for short-range, between pool dispersal.

Evidence of long-distance dispersal and colonization exists in the overall geographic distribution of this species in northern California. Natural dispersal of legenere seeds likely occurs via flowing water, transport on feet and feathers of waterfowl, and in mud on hooves and legs of livestock. As with other vernal pool species, natural dispersal of seeds was likely a more frequent event when there were many more vernal pools, more pool interconnectivity, exceedingly larger waterfowl migrations and unfenced roaming native ungulates (Griggs 1980).

4.2.1.6 Seed Dormancy

Seed dormancy and a stored soil seed bank is indicated by observation of multi-year periods with insufficient precipitation where legenere plants were absent, followed by reappearance during following favorable-hydrology growing seasons (Holland 1983; CDFG 2010). Seed longevity and seed abundance in the soil has not been investigated. The presence of a persistent soil seed bank provides insurance against localized extirpation resulting from the unpredictable occurrence and duration of appropriate growing conditions. If total seed crop failure occurs in a given year or set of years (failure to germinate, loss to late season flooding or fire, excessive grazing by livestock or grasshopper herbivory), additional stored seeds are available for another year's effort.

4.2.1.7 Population Genetics

Population genetics of legenere have not been investigated, so intra- and inter-population patterns of genetic variability are unknown. In general, self-pollinating species tend to exhibit low levels of intrapopulation variation and a high degree of between population divergences. Elam (1996) provides a good overview of the myriad considerations in assessing the population genetics of vernal pool plants in the absence of empirical data for a given taxon. Given the limited number of occurrences in the Plan Area and the scattered geographical distribution, all intra-pool legenere populations should be considered unique, and for the purposes of conservation, important genetic entities.

4.2.2 Habitat Requirements and Ecology

4.2.2.1 Biogeography and Landform Relations

Legenere is strictly associated with the vernal pool-type hydrologic cycle. Over its geographic range, this species is found in several physiographic/edaphic settings, including northern basalt, northern claypan, northern hardpan, northern volcanic ashflow, and northern volcanic mudflow vernal pools (Holland 1983). In Sacramento County, legenere is associated with vernal pools located on various geologic surfaces, including the Laguna, Mehrten, Riverbank, Undifferentiated Surficial Alluvial Deposit and South Fork Gravels. For this reason, it is more likely that presence of wetland habitat with suitable vernal pool-type hydrology is a more important factor in determining the geographical distribution of this species than is geologic surface or soils. All well-developed vernal pools, regardless of landform association, should be considered potentially suitable habitat for legenere.

4.2.2.2 Hydrology Relations

Legenere is a strict endemic of the vernal pool hydrologic cycle. This species grows in well-developed vernal pools and playa lakes, as well as along the seasonally fluctuating margins of more permanent water bodies (small lakes, ponds, stock ponds), and basins within seasonal drainages (Holland 1983; CDFG 2010). Legenere has been reported to inhabit vernal wetlands ranging in size from 40 square feet to 100 acres (Holland 1983). Topographical position within pools and associated plant species indicate tolerance of, or preference for, the more extreme (longer-duration) inundation regimes encountered in vernal wetlands. It is interesting to note however, that in the larger/deeper pools encountered by Holland (1983), legenere was reported as not inhabiting basin positions deeper than eight inches ponding depth.

4.2.2.3 Biological Community Relations

Floristic associations provide further indication of preference for more extreme vernal pool hydrological cycles. Legenere most frequently co-occurs in micro-sites with smooth goldfields (*Lasthenia glaberrima*) and common spikerush (*Eleocharis macrostachya*) (CDFG 2010). Both are typically associated with well-developed large or deep pools with longer periods of inundation, as well as with vernal marshes, permanent marsh edges and the seasonally fluctuating margins of stockponds. Most rare plant species found with legenere are also inhabitants of pools with longer duration inundation, including slender Orcutt grass (*Orcuttia tenuis*), Bogg's Lake hedge-hyssop (*Gratiola heterosepala*), and Sanford's arrowhead (*Sagittaria sanfordi*). Other associates indicative of well-developed vernal pool hydrology include three-sepaled buttercup (*Ranunculus bonariensis* var. *trisepalus*), coyote thistle (*Eryngium castrense*, *E. vaseyi*), bractless hedge-hyssop (*Gratiola ebracteata*), downingias (*Downingia bicornuta*, *D. cuspidata, D. ornatissima*), flowering quillwort (*Lilaea scilloides*), and American pillwort (*Pilularia americana*).

Other vernal pool endemics reported as occurring with legenere include common inhabitants of shallower and/or smaller to medium-size vernal pools with shorter duration ponding, or the slopes and edges of larger or deeper pools. These species include Fremont's goldfields (*Lasthenia fremontii*), white-headed navarretia (*Navarretia leucocephala*), stalked popcorn-flower (*Plagiobothrys stipitatus*), bracted popcorn-flower (*P. bracteatus*), wooly marbles (*Psilocarphus brevissimus*), dwarf downingia (*Downingia pusilla*), annual hairgrass (*Deschampsia danthonioides*), and Douglas' meadowfoam (*Limnanthes douglasii*).

4.2.2.4 Non-Native Weed Relations

Hydrological stresses associated with vernal pools exclude the majority of non-native weedy species that characterize the present-day valley annual grassland, agricultural fields, and ruderal habitats. Italian wild rye (*Lolium multiflorum*), and Mediterranean barley (*Hordeum marimum* ssp. *gussoneanum*), two non-native facultative wetland species, typically dominate disturbed wetlands and can be invasive in smaller, more ephemeral vernal pool types and the margins of larger/deeper ones as well. Some suggest that built-up thatch from Italian wild rye, Mediterranean barley, Medusa-head grass (*Taeniatherum caput-medusae*), and other non-native upland species may indirectly affect vernal pool species as well by lessening the amount of water entering the system through surface and subsurface flow (Robins and Vollmar 2002).

Since legenere occupies medium to larger or deeper vernal pools, it may not be particularly susceptible to the effects of excessive growth of Italian wild rye and Mediterranean barley and thatch build-up, as with the more deeply-adapted Orcuttiae grasses and Bogg's Lake hedge-hyssop.

Weedy hydrophytic species presently reported as growing with legenere include mannagrass (*Glyceria occidentalis declinata*) and lippia (*Phyla nodiflora*). Although not-yet reported to co-inhabit vernal pools with legenere, other non-native weedy hydrophytes may present future problems. These species include swamp pricklegrass (*Crypsis schoenoides*), field bindweed (*Convolvulus arvensis*), common unicorn plant (*Probiscidea louisianica*), Bermuda grass (*Cynodon dactylon*), and paradox canary grass (*Phalaris paradoxa*). Cocklebur (*Xanthium strumarium*), a native species, can also become weedy and dominate vernal pools (Schlising pers. comm.; Unger pers. comm.).

4.2.2.5 Livestock Grazing Relations

In general, appropriately timed dry-pasture livestock grazing regimes are thought to be compatible with the persistence of vernal pool vegetation. Robins and Vollmer (2002) provide a review of information pertaining to livestock grazing in vernal pool ecosystems.

Livestock grazing is reported as a threat at a number of populations (CDFG 2010), however many extant populations of legenere inhabit long-operating cattle ranches. Persistence in un-irrigated pasture systems indicates tolerance for at least some level of grazing. In most cases, timing of livestock grazing is likely more important than stocking rates in affecting persistence of legenere, as it is for the Orcuttiae grasses (Stone et al. 1988). During the period when pools are inundated and upland forage is still green and attractive, cattle tend to not congregate in pools, and trampling and grazing pressures to vernal pool plant species in their seedling or juvenile aquatic phase are minimized. As the upland forage cures and the vernal pools are in their flowering and seed-producing terrestrial phase, moist pools become more attractive to livestock and grazing and trampling pressures are increased. Excessive trampling and grazing during this period may negatively affect legenere, and other vernal pool species. Grazing in the summer and fall months, after seeds have set and plants have died likely has little negative effect on legenere.

It should be noted however, of all vernal pool rarities, legenere is the only one with a decumbent or sprawling habit, and it tends to intermingle with a comparatively succulent mass of intertwined smooth goldfields (*Lasthenia glaberrima*) stems. This growth habit, combined with typically low population numbers may make legenere somewhat more susceptible to inappropriately timed livestock grazing. For most other vernal pool annuals, small stature and high plant densities ensure that in all but extreme cases, a portion of every year's cohort escapes destruction, matures, and sets seed.

4.2.2.6 Disturbance Response

With exception to persistence of some populations within operating ranches, little is known about the potential response of legenere to other disturbances. One wetland in Sacramento County, observed to support up to 1,000 to 10,000 plants in 1991 (CNDDB occurrence # 33), has been "…disked annually for firebreak" (CDFG 2010). Another "large vernal pool" in Tehama County, "ripped and filled in Fall of 1994," was observed to support an estimated 1,000 legenere plants in 1995 (CDFG 2010).

Populations of several other rare vernal pool species, including Orcuttiae grasses and dwarf downingia, as well as more common species, may persist despite periodic disking of their resident pools over decades (Hoover 1941; Crampton 1959; Stone et al. 1988; Ahart pers. comm.; Kelsey pers. comm.; Dittes pers. obs.; CDFG 2010). It is exceedingly important to note that in these cases, disking is not so deep as to significantly affect the subtending impermeable layer or the vernal pool hydrological cycle. In addition, the disking is performed in the late summer or fall months in preparation for dry land winter grain crops, so vernal pool plants have set seed and dried. If this disking occurs earlier in the growing season, before seeds are mature, over consecutive years population extirpation is probable through exhaustion of the soil seed bank.

4.2.2.7 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for legenere are identified in Table LEG-1 and have been derived from input from local species experts.

Table LEG-1
Essential Habitat Elements for Legenere

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, vernal pool, and vernal swale.	Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools, providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and non-native upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

4.3 Species Distribution and Population Trends

4.3.1 Species Distribution

Legenere was first collected in 1890 from Solano County, California. Since that time, 61 occurrences have been recorded in the California Natural Diversity Data Base (CNDDB) (CDFG 2010), ranging from Santa Clara County in the south to southern Shasta County at the northern edge of the Great Central Valley. Legenere occurrences are distributed among four of the Geographic Sub-regions of the California Floristic Province, as described by Hickman (1993), including the San Joaquin Valley, Sacramento Valley, Inner Coast Range and Cascade Range Foothills. Elevations of legenere occurrences range from one to 880 meters (three to 2,887 feet) (CNPS 2010).

Sacramento County has the largest number of legenere occurrences with 23 of the 61 occurrences (38 percent) represented. Solano County has the second largest number with 12 occurrences (~20 percent), followed by Tehama County with five occurrences reported (~eight percent). The remaining 21 occurrences are found in Lake, Placer, Yuba, , Sonoma, Alameda, Napa, Santa Clara, Shasta, San Mateo, San Joaquin and Stanislaus Counties which each have three or fewer occurrences (CDFG 2010).

Legenere's comparatively wide geographic and elevation distribution may partially reflect comparatively broad habitat requirements, or preference for a more commonly occurring vernal pool hydro-period. It may also reflect a higher propensity for seed dispersal by waterfowl, or even a different "biogeographic legacy" (e.g., timeline of evolution and geographic distribution of ancestral taxon).

4.3.1.1 Central Valley Distribution

The Central Valley supports 52 (85 percent) of the 61 recorded legenere occurrences. The two southernmost occurrences, one of which is extirpated, are located in the Central Valley in northern San Joaquin County, approximately three miles southeast of the City of Galt. The next occurrence to the north is in southern Sacramento County, located approximately 7.5 miles away, just south of the Cosumnes River. An additional 22 occurrences are recorded from Sacramento County, these being widely distributed from near Interstate 5 near the western edge of the county, to the vicinity of Arkansas Creek along the eastern county line, to just northeast of Rio Linda, near the county's northern boundary (CDFG 2010).

Another population center, comprised of 12 clustered occurrences is located approximately 15 miles to the west in Solano County. A gap of approximately 12 miles exists between the northernmost Sacramento County occurrence and the two closely situated occurrences in Placer County. Another two occurrences are located approximately 19 miles further north of the Placer

County occurrences in southwest Yuba County. A distance of approximately 70 miles separates the southernmost of the two Tehama County occurrences from the Yuba County occurrences to the south. In Tehama County, the southern most of the two occurrences is located between Corning and Black Butte Lake in southern Tehama County, and the other is located approximately 15 miles to the northeast, west of the Sacramento River near Gerber. The northernmost Central Valley legenere population is comprised of a single occurrence southeast of Redding at the Stillwater Plains (CDFG 2010). Although suitable habitat exists in Butte County, legenere has not yet been encountered there.

4.3.1.2 Range within the Plan Area

Of the 23 CNDDB legenere occurrences presently known in Sacramento County, 21 are located within the Plan Area (Figure LEG-1). The two outlying occurrences, one of which is extirpated, are located near the northern Sacramento County line, in the vicinity of Rio Linda (CNDDB occurrences #32 and #33). Of the 21 extant occurrences in the Plan Area, 15 are located within the UDA, and six are outside (CDFG 2010). One additional legenere occurrence not yet recorded in the CNDDB is located within the UDA (within the Sunrise-Douglas Mitigation Bank).

Within the UDA, the western-most CNDDB occurrence, located within the 2,465-acre Beach Lake Mitigation Site on the south side of Laguna Creek, is comprised of an unspecified number of vernal pools (CNDDB occurrence #41). Another occurrence is located approximately 3.5 miles to the east on private land, northeast of the intersection of State Highway 99 and Sheldon Road. This occurrence (CNDDB occurrence #31) is comprised of an unspecified number of occupied vernal pools as well (CNDDB 2010). A distance of less than two miles separates occurrence #31 from its nearest neighbor (CNDDB occurrence #27), located northwest of the intersection of Waterman and Bond Roads. Occurrence #27, comprised of five occupied natural pools and five occupied created pools, is located on private land (CDFG 2010). Another occurrence, supporting three colonies, is located on private land, approximately 0.75 miles to the east, northeast of the intersection of Waterman Road and Bond Road (CNDDB occurrence #30). Two occurrences, situated within 0.75 mile of each other, are located on the 320-acre Gene Andel Park, approximately five miles northeast of CNDDB occurrence #30. One of these (CNDDB occurrence #28) is comprised of four occupied vernal pools; the other (CNDDB occurrence #29), located approximately 1.3 miles to the north, is comprised of two colonies associated with vernally wet depressions along a seasonal drainage (CDFG 2010).

Four CNDDB occurrences are located three to four miles to the north of occurrence #29, in association with Mather Air Force Base (AFB); all are near the southern boundary, north of Kiefer Blvd. The westernmost of these occurrences (CNDDB occurrence #44), is comprised of four occupied vernal pools. The next occurrence to the southeast, located approximately one-mile distant within the 700-acre Mather Regional Park, is comprised of two occupied vernal pools (CNDDB occurrence #45). The two easternmost of the four Mather AFB occurrences, each support one occupied vernal pool (CNDDB occurrences #46 and #47) (CDFG 2010).

An additional occurrence, not yet registered in the CNDDB, is located east of Mather Field, northeast of the intersection of Sunrise Boulevard and Kiefer Boulevard (Figure LEG-1). This occurrence, comprised of 12 occupied vernal pools, is included within the 400-acre Sunrise-Douglas Mitigation Bank (Sugnet and Associates 1998). Another occurrence, not yet registered in the CNDDB, is located within the UDA to the east (Cordova Hills Survey *date unknown*) and another occurrence is located outside the UDA in the southeastern portion of the Plan Area at Howard Ranch (TNC *date unknown*).

In Sacramento County, nine of the 23 legenere occurrences (39 percent) are associated with River Bank Formation. This Formation consists of alluvial deposits associated with the Sacramento, American and Cosumnes Rivers. Eight other legenere occurrences (40 percent) are associated with Redding and Red Bluff/Redding soils of the Laguna Formation. This geological landform is comprised of remnant old-terrace alluvial deposits of ancestral river channels and pediment gravels, which were deposited during the early Pleistocene, between 600,000 and 1,500,000 years ago. Laguna Formation and associated soils are strongly associated with the distribution of vernal pools. It is significant to note that owing to the diminutive size of the species, its ability to inter-mingle with more common species, and the area of unsurveyed or partially surveyed area of Riverbank and Laguna Formation, other occurrences are likely to be present in Sacramento County. In addition, well-developed vernal pools on landforms other than Riverbank and Laguna could provide suitable habitat. Though the distribution of the species is extremely disjunct, the range of the species in the Plan Area is considered to be all vernal habitats, seasonal wetlands, and seasonal impoundments.

4.3.1.3 Population Levels and Trends

Of the 61 documented CNDDB occurrences, six are now reported as “extirpated” (10 percent), including one occurrence in each of Sacramento County (CNNDB occurrence #32), Placer County (Occurrence CNDDB #14), and Sonoma County (occurrence #8). An occurrence on the San Joaquin and Stanislaus County line (CNDDB occurrence #4) is reported as extirpated, as well as two occurrences in Solano County (occurrence CNDDB #2 and #3). A single occurrence in Lake County (occurrence CNDDB #9) is reported as “possibly extirpated” (CDFG 2010).

Population trends are listed as unknown from all occurrences statewide, with the exception of one occurrence in Placer County (decreasing) and one occurrence in Lake County listed as possibly extirpated (CDFG 2010). Population trends for all extant legenere occurrences in Sacramento County are reported as unknown. In all but three cases, only one estimate for population numbers is recorded (Table 3). Botanists making second visits to the other three sites did not observe any legenere plants during 1993 (CNNDB occurrence #5) and 1997 (CNNDB occurrences #46 and #47) (CDFG 2010).

It should be noted that legenere is an inconspicuous and relatively ephemeral species that easily escapes the notice of botanists; it lacks showy flowers, and it most frequently grows clambering and mixed with the stems of more common and superficially similar species. Given these considerations and the amount of unsurveyed or partially surveyed suitable habitat in the Plan Area, additional occurrences may have escaped notice during past surveys, and more populations likely remain to be discovered.

It is impossible to determine the number of historically occurring legenere populations lost or the acreage of suitable habitat lost to historic agricultural land-use conversions, since so much had happened before these species first received attention. Investigators have made estimates as to the acreage of vernal pool habitat lost since historic times (Holland 1978; Jones and Stokes 1990), however owing to habitat specificity (restriction to), only a subset of the vernal pool habitat lost within the natural range of the species likely provided suitable habitat for legenere.

There has been no comprehensive effort to monitor all populations of legenere. In summary, the following population estimates for the Sacramento County occurrences have been recorded (CDFG 2010).

Table LEG-3
Legenere Population Estimates for Sacramento County

CNDDB Occurrence #	Occurrence # of pools observed	Range of population estimates
5	Streambed	1976: Locally common 1983: none
12	Large vernal pool (> 1 Acre)	1983: 1000+
13	Vernal pool (~ 1000 sq ft.)	1983: 100
21	Vernal pool Marsh	1991: >4100
22	Large vernal marsh	1991: 15
27	5 vernal pools and 5 created depressions	1991: 1000's
28	4 vernal pools	1988: <100
29	Ephemeral drainage	1988: <100
30	Seasonal wetland vernal pool	1991: 300+
31	Vernal pools	1993: 2500+
32	Artificial seasonal pond	1991: 150 1997: Site extirpated by subdivision
33	Seasonal wetland	1991: 1000-10,000 1997: none (too late for surveys?)
40	Vernal pool	1995: 50
41	Vernal pools	1995: 300

Table LEG-3
Legenere Population Estimates for Sacramento County

CNDDB Occurrence #	Occurrence # of pools observed	Range of population estimates
42	Vernal pools	1995: Unknown
44	4 vernal pools	1997: Several hundred
45	2 vernal pools	1997: Several hundred
46	1 deep vernal pool	1993: 1000 1997: none
47	1 vernal pool and swale	1993: 500 1997: none
50	Stock pond	2000: ?
60	Vernal pools	2002: thousands
62	Vernal pool	2002: ~1,000
63	Vernal pool	2003: 300-500

Source: CDFG 2010.

Observations, monitoring and research conducted on other rare vernal pool species indicate that abundance of individuals within populations may vary greatly between species, between populations within species, and within populations through years (Griggs and Jain 1983; Holland 1987; Alexander and Schlising 1997; CDFG 2010). For Orcuttiae grasses and other species, this extreme population variability is attributable to interactions of seed dormancy, early seedling survivorship, and average seed set per plant, as principally determined by seasonal and between-year limitations in available moisture (Griggs and Jain 1983; Holland 1987). Fluctuations of similar magnitude are also recorded for hairy Orcutt grass (*Orcuttia pilosa*), Hoover's spurge (*Chamaesyce hooveri*), and Greene's tuctoria (*Tuctoria greenei*) at the Vina Plains Preserve in Tehama County (Alexander and Schlising 1997).

Observations made over a decade or so may provide a reasonable indication of the short-term vigor of a given legenere population. It is important to consider however, that in order to assess the trend of the species, long-term monitoring of both habitat and populations conducted over multiple cycles of wet and dry years is needed. Another aspect of population demography is the quantity and age of stored seed in the soil profile. Undoubtedly, the number of stored seeds in the soil profile has bearing on how many plants can be produced in a given favorable year.

4.4 Threats to the Species

Potential direct threats to legenere include loss of vernal pool habitat to agricultural or urban/industrial land-use conversions; construction and maintenance of firebreaks, roads, and utility corridors; inappropriate livestock grazing regimes (later spring/summer rotations); feral pigs, recreational target shooting, grassland fires; recreational vehicles; equestrian and pedestrian traffic; and refuse dumping (CDFG 2010).

Potential Indirect threats to legenere include hydrological alteration of sub-watersheds by surrounding developments and land uses; shifts in competitive interactions (hydrology-mediated or invasive weeds); windblown refuse accumulation; point and non-point source water pollution; air pollution, and global climate change.

4.5 Data Gaps and Conservation Implications

With exception to observations of field workers (Holland 1983; Platenkamp 1998; Preston pers. comm.; CDFG 2010), legenere has received limited research attention. Detailed studies have not been conducted regarding the biology, ecology, potential for cross pollination, population genetics, habitat relationships, population dynamics, trends or threats associated with the species. Pertinent data gaps, implications for conservation, and operating assumptions include the following.

4.5.1 Unknown Number of Undiscovered Populations

Additional unsurveyed and partially surveyed potentially suitable habitat exists within the Plan Area and elsewhere within the range of the species. In the Plan Area, discovery of new populations of legenere may occur on the large dry-land ranchlands, public quasi-public lands and vernal pool-grassland preserves already established in the eastern portion of the County.

4.5.2 Unknown Relationship between Landform/Soil Chemistry and Bio-Geographic Distribution

In Sacramento County, legenere is associated primarily with the Riverbank and Laguna Formations, although it also occurs on Mehrten, Undifferentiated Surfucial Alluvial Deposits, and South Fork Gravels as well. Elsewhere within its range, legenere is associated with northern basalt flow, northern claypan, northern hardpan, northern volcanic ashflow, and northern volcanic mudflow vernal pool settings. Soil properties, including chemistry, likely vary substantially among these edaphic settings.

The exact nature of the relationship of Landform to species distribution is unknown. It is probable that functioning vernal pools with well-developed hydrology, regardless of landform, soil series and soil pH (except extremes) may provide suitable habitat for this species. In the Plan Area, vernal pools are most frequent and best developed on the Laguna Formation.

4.5.3 Unknown Pollination Ecology

In general, plants with reduced flowers tend to be self-pollinators. In addition to plants producing flowers with no petals at all (Holland 1983; Mason 1957), Oswald (1994) mentions cleistogamous flowers present in northern California legenere populations. Pollination and breeding studies have not been conducted, so the potential for outcrossing and potential pollinator relationships are unknown.

4.5.4 What Constitutes Population Vigor, and How to Measure?

Population vigor will need to be monitored during the life of the SSHCP, yet population dynamics, including year-to-year variability in abundance, has not been described in detail for any of the occurrences in Sacramento County, or elsewhere. The majority of CNDDB occurrences do not have population estimates recorded for single year observations. Where given, estimates range from 15 plants to 10,000 individuals, although most vernal pools are reported to support fewer than 1,000 individuals. At several sites, observations made over multiple years indicate that legenere populations can vary between years, with low numbers present during years with sub-optimal hydrology (CDFG 2010). Other rare vernal pool species have been shown to be variable in population abundance from year-to-year (Holland 1987; Griggs pers. comm. 2003), and causative factors contributing to year-to-year population fluctuations in rare species may be difficult to identify (Alexander and Schlising 1997).

Population vigor will be difficult to assess for this cryptic species, based on number of individuals present over short intervals of time. Trends occurring over longer periods may occur that are not discernable, and trends that are discerned may be unexplainable. These factors will complicate attempts to change management for benefit of the species if measured vigor shows decline.

4.5.5 Specific Hydrological Requirements of Legenere

Numerical data do not exist regarding specific parameters of the annual hydrological cycle of vernal pools supporting legenere populations in the Plan Area (e.g., timing of rainfall, depth of ponding, duration of ponding and soil dry down rate).

The general lack of numerical hydrological data limits the ability to precisely monitor or assess hydrological suitability of legenere -vernal pool habitat within established preserves. Similarly, assessment of potentially suitable legenere habitat for preserve establishment or for detection of the species at this time must rely on generalities. Once preserves for existing legenere populations are established, assessed and monitored over time, a more quantifiable definition of suitable legenere-vernal pool hydrology will emerge based on the new information.

4.5.6 Baseline Hydrological Trend of Pools and Existing Indirect Effects

Extant legenere populations in the Plan Area may have already experienced some degree of hydrological modification resulting from development-related alterations to sub-watersheds (CDFG 2010). Without complete protection of entire vernal pool watersheds, or precise hydrological monitoring and accurate modeling on a pool complex-scale, long-term indirect effects resulting from existing alterations to sub-watershed hydrology are unknown.

Baseline legenere habitat conditions for the SSHCP may not be pristine, so if trends in vigor or habitat quality become apparent during the 50-year period or at some time beyond, it may be difficult to attribute trend to any specific management activity.

4.5.7 Definition of Appropriate Hydrology Buffer

There is no standard for appropriate scale of effective hydrologic buffers for vernal pool-annual grassland ecosystems, since the nature of vernal pool complexes and their geo-hydrological relations are complex and may vary substantially by geography (Holland and Dains 1990).

Proposed preserve designs may not afford complete protection to the hydrological systems that support legenere and other species assemblages dependant on them.

4.5.8 Definition of Appropriate Scale Legenere-Vernal Pool-Annual Grassland Preserve

There is no standard for appropriate scale of effective legenere-vernal pool preserves. It is a paradigm of conservation biology that “bigger is better” for a variety of well-documented reasons. Conservation challenges associated with the relatively small-scale vernal pool preserve that includes rare plant populations at Phoenix Field and Phoenix Park are well documented and reflect consequences of increase edge effect associated with smaller preserves (Clark et al. 1998).

4.5.9 Determination of an Appropriate Livestock Grazing Regime

Livestock grazing will occur in at least some of the legenere-vernal pool preserves, primarily for purposes of upland annual grassland vegetation management. Specific grazing regimes have not been formulated for annual grassland pasture systems with legenere-occupied pools, although grazing and monitoring in similar systems have been addressed (Barry 1998; TNC 2000; Griggs 2002; Robins and Vollmar 2002). It is important to note that legenere does persist though, in historically and contemporary operating livestock ranches and United States Forest Service (USFS) and Bureau of Land Management (BLM) grazing allotments. At a minimum, compatibility with some level of grazing is evidenced by persistence of the species in these systems. Since legenere occupies medium to large-size vernal pools, management of Italian wild rye and Mediterranean barley around the margins of vernal pools, and Medusa-head grass in uplands should be monitored and managed, but not primarily for the needs of legenere specifically.

Presently, Witham and others are formulating site-specific livestock grazing regimes for annual grassland-vernal pool systems in an area of Sacramento County (Witham pers. comm.). Livestock grazing regimes in legenere-vernal pool preserves covered under the SSHCP will tier towards the results of this work, as well as to the specific needs of legenere. Specific livestock grazing regimes cannot be formulated until preserve size, configuration, and soil and vegetation conditions and vegetation management goals are determined.

4.5.10 Interactions with Non-Native Weeds and Weed Management Activities

Non-native weeds, or weedy native species reported as occurring in vernal pools include western mannagrass and lippia. Others that may become problematic in the future include swamp pricklegrass, Bermuda grass, common spikerush, field bindweed, paradox canary grass, hairy hawkbit, cocklebur, and cattails. None of these species are reported to co-inhabit legenere-occupied vernal pools in Sacramento County. Any of these and others now unknown may appear and/or change in abundance in legenere -occupied pools over time. Italian wild rye and Mediterranean barley, two common non-native inhabitants of shallow vernal pools and vernal pool margins, might be of management concern to legenere if they are allowed to completely dominate the vernal pool margins and adjacent uplands. Potential competitive interactions with these species may affect the vigor of legenere populations. In addition, any eradication or control methods implemented for these species may in turn potentially affect legenere populations.

4.5.11 Potential Association and Compatibility with Other Rare Vernal Pool Species

It is desirable to combine to design preserves for multi-species conservation. Within Sacramento County, legenere has been reported as sharing vernal pools and wetlands with other rare plant species, including slender Orcutt grass, Bogg’s Lake hedge-hyssop, and Sanford’s arrowhead. Many of these pool complexes supporting rare species also provide habitat for rare invertebrates, amphibians, mammals, and bird species as well.

Management for multiple species maximizes the effectiveness of habitat conservation and requires coordinated monitoring and actions. Management for the benefit of one species may conflict with management needs of other rare species. For instance, livestock grazing anytime between July 1st and April 1st may be compatible with or even benefit some legenere-associated pool complexes, but may be detrimental to ground-dwelling amphibians depending on those complexes (e.g., California tiger salamander).

4.5.12 Genetic Considerations (Spatial and Temporal Variation, Seed Bank, Drift, Bottlenecks)

Population genetics for legenere are completely unknown. For an overview of genetic considerations of vernal pool plant species, see Elam (1998). Current limitations in our understanding of legenere population genetics have little immediate conservation implication, given the relatively few number of legenere occurrences in the Plan Area.

If experimental inoculation of pools is proposed as part of the SSHCP, appropriate measures will be developed to ensure that seed collection, seed treatment and pool inoculation methods are consistent with what we know and do not know about legenere ecology and population genetics.

4.5.13 Critical Population Size

Critical population size is a statistical estimate of the minimum number of individuals required for a population to maintain itself over generations, through time. This population parameter has been determined for assorted wildlife and some perennial plant species. The most simplistic estimations take into account recruitment rates of individuals into the population via reproduction and immigration, and removal rates of individuals from that same population via death and emigration.

Since legenere is an annual species, its population sizes may be highly variable from year to year, and the soil seed bank constitutes an unknown demographic component of the population, definition and assessment of a critical population size is impracticable and lacks ecological meaning for the purposes of the SSHCP.

Knowledge of critical population size provides an ecologically meaningful and quantifiable benchmark for adaptive management purposes (e.g., if monitored populations drop to within 30 percent of critical population size, site-specific analysis, appropriate management changes and additional monitoring will occur). This is not possible for annual species, so other measurable benchmarks are needed.

4.5.14 Seed Longevity and Dynamics of Stored Soil Seed Bank

As previously mentioned, the existence and potential role of a dormant soil seed bank in population dynamics is indicated by the observation of multiple-year periods during which plants were absent, followed by reappearance during a following favorable hydrologic season. Beyond observations though, there have been no empirical studies addressing the presence of a soil seed bank, seed dormancy or longevity for legenere. From the perspective of conservation, knowledge of site-specific soil seed bank characteristics would allow more accurate assessment of population size and stability (vigor). This is particularly true of populations that typically support the fewest standing individuals through time.

4.5.15 Unknown Aspects of Experimental Inoculation

Since there are few populations of legenere in Sacramento County, species viability may be significantly enhanced by inoculating unoccupied, apparently suitable pools and increasing the number of naturally self-sustaining populations. These additional populations would increase the likelihood of natural dispersal events into preserved but unoccupied legenere habitat, create meta-population structure at extant occurrences where single pools may support the species, and help ensure existence should any natural populations become compromised. Dispersal into, and colonization of artificially created or enhanced seasonal wetlands and vernal pools, irrigation ditches, trenches next to railroad tracks and a artificial ponds has been documented (CDFG 2010). Legenere appears to be a self-compatible species, which is a pre-adaptation for colonization.

Uncertainties regarding the political ramifications and ecological effectiveness of experimental inoculation lead the conservation community and agencies to not consider experimental inoculation as an appropriate conservation goal. Given the rarity of this species in the Plan Area though, this option may need reconsideration at some point in time.

4.5.16 Air Pollution (Dust/Ozone/Nitric Oxide, Sulphur Dioxide)

Portions of the Central Valley of California frequently exceed State and Federal safety levels for a variety of air pollutants, including particulate matter, ozone, and others. Some of these pollutants are known to negatively affect plant physiology and health, although none have been investigated as they relate to vernal pool vegetation. Assuming that extant legenere occurrences are maintaining their vigor at existing ambient pollution levels, air pollution will probably not present a major threat to the viability of legenere, if existing air quality can be maintained. If however, California's human population increases as projected and air pollution control measures are not developed and implemented concomitantly and effectively, these pollutants may negatively affect legenere and other native plant species in the future.

4.5.17 Effects of Global Climate Change

The scientific community commonly accepts as valid the phenomenon of increasingly rapid global climate change. Specific climatic models for California predict an average increase in temperature over the coming decades, with concomitant unpredictability in annual rainfall patterns. There is uncertainty regarding the exact nature and extent of these changes, as well as the consequences these changes pose to conservation biology.

It is likely that given the expected global climate trends, a vigor response of some kind could be expected for legenere populations within the implementation period of this HCP, or at some time beyond.

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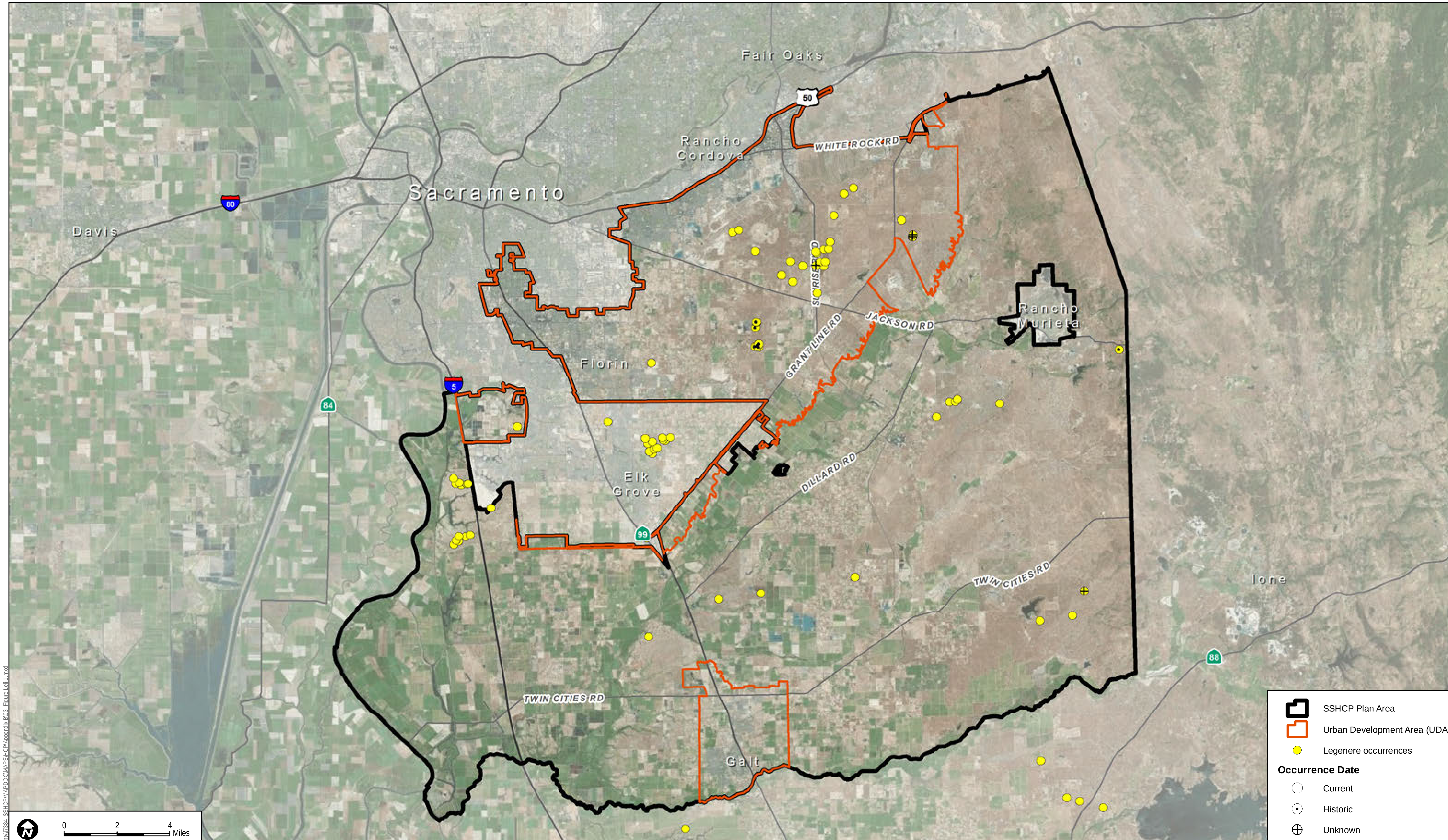

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SSHCP South Sacramento Habitat Conservation Plan

SOURCE: Bing Maps, County of Sacramento 2015, CDFG 2012

FIGURE LEG-1

Legenere Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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5 PINCUSHION NAVARRETIA (PINA)

Prepared by Dittes and Guardino Consulting (John Dittes and Josephine Guardino)

Pincushion Navarretia (PINA)

(Navarretia myersii)

Status USFWS: None

Status CDFG: None

Status CNPS: 1B.1

5.1 Legal Status

Pincushion navarretia *(Navarretia myersii)* is considered to be rare, threatened or endangered throughout its range, thus qualifying its designation as a list 1B.1 species by the California Native Plant Society (CNPS 2010). It has been assigned an R-E-D Code of 3-3-3, meaning it is distributed in one to several highly restricted occurrences, endangered throughout its range, and entirely restricted to California.

Being a CNPS List 1B.1 plant species, pincushion navarretia meets the California Department of Fish and Game's (CDFG) definition of a special plant though it has no formal protection status by the CDFG or United States Fish and Wildlife Service (USFWS).

5.2 Life History and Ecology

5.2.1 Species Description and Life History

Pincushion navarretia, a strict vernal pool endemic, is an annual in the phlox family (Polemoniaceae). This distinctive species grows very low with aggregations attaining a mat-like appearance. The typically low-growing stems can reach up to two centimeters in height. Long thread-like leaves reaching from four to eight centimeters in length radiate from the base of the inflorescence. The inflorescence is comprised of five to 60, long (1.2 to 2.1 centimeters), tubular, sessile (stalkless) white flowers (Day 1993). These sessile flowers, long flower tubes and low-growing stems are features that most readily distinguish pincushion navarretia from the co-occurring and much more common white-headed navarretia (*N. leucocephala* ssp. *leucocephala*).

Interestingly, pincushion navarretia specimens collected from the northern edge of its range (Sacramento and Amador Counties) possess slightly shorter flower tubes, and in Sacramento County, more lobing of the inflorescence bracts, than do specimens collected from the type locality in Merced County. Plants from these northern localities are considered to be morphologic and geographic intermediates between typical *N. myersii* ssp. *myersii* and the closely related and even more rare Small pincushion navarretia (*N. myersii* ssp. *deminuta* P.S Allen and Day)*,* which only occurs in the Coast Ranges to the northeast (Day 1995).

Pincushion navarretia, and the genus in general, has received little attention from biologists or ecologists. Pincushion navarretia was included in an investigation of evolution of adaptive morphological and life history traits of vernal pool species, with the genus *Navarretia* used as a model (Spencer and Reiseberg 1998). Pincushion navarretia was determined to be one of the more highly adapted of the vernal pool specialists in the group. Other than this single study and basic taxonomic and biogeographic treatments, pincushion navarretia remains mostly unstudied.

Since all vernal pool plant species share similar environmental selective pressures, they likely also share similar adaptive traits. For this reason, studies addressing the life history and ecology of other more common vernal pool plant species may provide some insight into the life history and ecology of pincushion navarretia.

Pincushion navarretia shares the annual growth habit with the vast majority of other endemic vernal pool plants. This adaptive trait confers to populations avoidance of the regular and extreme seasonal drought that characterizes vernal pool habitat and the Mediterranean Climate (Griggs and Jain 1983; Holland 1987; Stone et al. 1988; Zedler 1990).

The specific timing of the germination of pincushion navarretia seeds relative to the timing of the vernal pool inundation cycle has not been studied or described. In general, a given vernal pool species may germinate either during the wetting phase or the inundation-phase of the vernal pool cycle (Keeley and Zedler 1998). Seeds of the more common and related white-headed navarettia germinate under water in pool basins or on saturated soil at pool margins in the late fall and winter months, after the soil profile is saturated and vernal pools have filled (Crampton 1959; Dittes pers. obs.).

Germination requirements and optima for pincushion navarretia have not been investigated. It has been shown however, that seeds readily germinate in the laboratory by cold-stratifying imbibed seeds at two to four degrees Celsius in the dark for two weeks and then subjecting them to a cycle of 16 hours of light at 21 degrees Celsius and eight hours of dark at 15 degrees Celsius (Spencer and Rieseberg 1998). Unlike Orcuttiae grasses, symbiosis with an aquatic fungus does not appear necessary to break seed dormancy in the lab. Seed dormancy and required environmental cues for in-situ germination may exist, but are presently unknown.

One of the challenges posed to vernal pool plants is the need to photosynthesize and grow while submersed, and then transition into a terrestrial growth phase. pincushion navarretia and some other vernal pool species exhibit a juvenile isoetid growth form defined by production of cylindrical, air-filled, erect/floating leaves while submersed. These leaves facilitate light exposure and gas exchange, thus lengthening the growing season by maximizing growth while vernal pools are still inundated. This juvenile morphology contrasts with that of "adult" plants, or those producing growth during the dry-down or terrestrial phase of the vernal pool cycle. In their study of adaptive traits of vernal pool navarretias, Spencer and Rieseberg (1998) found that pincushion navarretia was the only one possessing an "unambiguous" isoetid growth form. The others were found to exhibit an inducible isoetid growth form, likely indicating a less strict requirement for, or lower tolerance of more severe vernal pool inundation regimes.

Pincushion navarretia flowers and sets seeds during the terrestrial phase of the vernal pool hydrologic cycle, typically in May (CNPS 2010), although populations in eastern Merced County were fully flowering by April 15th (Dittes and Guardino 2001). The large flowers, long flower tubes, and exerted stamens and stigmas indicate an outcrossing breeding strategy, as do a high proportion of pollen grains per flower, a large pollen-ovule ratio, and a comparatively wide corolla limb (Spencer and Rieseberg 1998).

Considering the unusually long white flowers, a specific co-evolved insect pollinator of pincushion navarretia may exist, although this has not been investigated. The existence of pollinator guilds involving co-evolved native solitary bees has been reported as occurring with a variety of vernal pool plant species (Thorp 1990, 1996). Although pollinators of Navarretia have not been investigated specifically, native solitary bees have been frequently observed visiting the closely related White-Headed Navarretia (Dittes pers. obs.). Fecundity and variation in seed production have not been investigated in pincushion navarretia.

As with many other vernal pool species, seed dispersal is naturally limited, in the case of pincushion navarretia, by an indehiscent fruit capsule that is forced open only after the fiberous seed coats absorb water and expand (Spencer and Rieseberg 1998). Limited seed dispersal in vernal pool species is thought to represent an adaptation to spatially unpredictable and limited vernal pool habitat (Griggs 1974, 1980). Natural dispersal of seeds, however limited, likely occurs via flowing water, transport on feet and feathers of waterfowl, and in mud on hooves and legs of livestock. As with all other vernal pool species, natural dispersal of seeds was likely a more frequent event when there were many more vernal pools, more pool interconnectivity, exceedingly larger waterfowl migrations and unfenced roaming ungulates (Griggs 1980).

The existence of a dormant soil seed bank is unknown for pincushion navarretia. The presence of a persistent soil seed bank provides insurance against localized extirpation resulting from the unpredictable occurrence and duration of appropriate growing conditions. If total seed crop failure occurs in a given year or set of years (failure to germinate, loss to late season flooding or fire, excessive grazing by livestock or grasshopper herbivory), additional stored seeds are available for another year's effort.

The population biology and genetics of pincushion navarretia have not been investigated, so intra- and inter-population patterns of genetic variability are unknown. Elam (1996) provides a good overview of the myriad considerations in assessing the population genetics of vernal pool plants in the absence of empirical data for a given taxon. Given the highly limited number of occurrences and the scattered geographical distribution, all intra-pool pincushion navarretia populations should be considered unique, and for the purposes of conservation, important genetic entities.

5.2.2 Habitat Requirements and Ecology

It is generally held that many of the endemic vernal pool plant species are relatively recent evolutionary derivations of more common and widespread upland progenitors (Stebbins 1976; Stone 1990; Raven and Axlerod 1978; Thorne 1984), including pincushion navarretia (Spencer and Rieseberg 1998). These neoendemic vernal pool species are thought to have evolved from terrestrial habitat into seasonally aquatic vernal pool habitat made available as the Mediterranean Climate developed and the inland Tertiary-age Sea dried.

Most of the pincushion navarretia occurrences in eastern Merced County are associated with the ancient, weathered alluvial terraces comprising the Valley Springs and Ione Geologic Formations (Dittes and Guardino 2001). A small number of occurrences are also found in vernal pools on the North Merced Gravels Formation. In Sacramento County, pincushion navarretia is associated primarily with the Ione and Laguna Formations

Pincushion navarretia is a strict vernal pool endemic. It is of importance to conservation however, that in contrast to the "deeply-adapted" vernal pool grasses of the Orcuttiae Tribe, pincushion navarretia occupies more commonly occurring, smaller and/or shallower vernal pools with comparatively more "flashy" hydrology. In a survey involving 19 occupied vernal pools in eastern Merced County, pincushion navarretia was documented as occurring in small to medium size vernal pools that range from 16 to 283 square meters (0.004 to 0.07 acres) in area and from 12.7 to 25.4 centimeters (five to 10 inches) in depth (Dittes and Guardino 2001). At the Phoenix Field Ecological Reserve in Sacramento County (CNDDB occurrence #3) pincushion navarretia is reported to inhabit the margins of "the more shallow, dry pools" in the complex (CDFG 2010). Vernal pool dimensions (or reference to size) are not given for any of the other CNDDB occurrences.

Floristic associations provide further indication of preference for less extreme (more typical) vernal pool hydrological cycles than the Orcuttiae grasses. In contrast to the latter, pincushion navarretia grows in the same hydro-topographical position as more commonly occurring vernal pool associates, while Common Spikerush (*Eleocharis macrostachya*, an indicator of longer duration inundation) is lacking. Pincushion navarretia grows mixed together with Fremont's goldfields (*Lasthenia fremontii*), wooly marbles (*Psilocarphus* spp.), annual hairgrass (*Deschampsia danthonoides*), stipitate popcorn-flower (*Plagiobothrys stipitatus*), double-horned downingia (*Downingia bicornuta*), bluestars (*Brodiaea minor*), toad rush (*Juncus bufomius*), capitate rush (*Juncus capitatus*), quillwort (*Isoetes howellii*), coyote thistle (*Eryngium* spp.), Sacramento Valley pogogyne (*Pogogyne zizyphoroides*), long-beaked stork's-bill (*Erodium botrys*), and succulent owl's clover (*Castilleja campestris* ssp. *succulenta*). Most of these species are commonly occurring vernal pool species that inhabit small to medium size vernal pools and swales, and the slopes and margins of larger or deeper pools that support Orcuttiae grasses and common spikerush.

Hydrological stresses associated with vernal pools exclude the majority of non-native weedy species that characterize the present-day valley annual grassland, agricultural fields, and ruderal habitats. Italian wild rye and Mediterranean barley, two non-native facultative wetland species, typically dominate disturbed wetlands and can be invasive in smaller, more ephemeral vernal pool types. Some suggest that built-up thatch from Italian wild rye, Mediterranean barley, Medusa-head grass, and other non-native upland species may indirectly affect vernal pool species as well by lessening the amount of water entering the system through surface and subsurface flow (Robins and Vollmar 2001).

Since pincushion navarretia occupies the smaller to medium size, "more typical" vernal pool types and the margins of larger and/or deeper pools, it may be more susceptible to the effects of excessive growth of Italian wild rye and Mediterranean barley and thatch buildup than the Orcuttiae grasses, or the more deeply-adapted legenere (*Legenere limosa*).

Although none are specifically reported to co-inhabit vernal pools with pincushion navarretia, several non-native weedy hydrophytes may present future problems. Mannagrass (*Glyceria declinata*), an aggressive weed of irrigated agriculture and degraded vernal pools, has already been reported as a potential problem at vernal pools in the region. Additional species to consider include rosy lippia (*Phyla nodiflora* var. *rosea*), field bindweed (*Convolvulus arvensis*), common unicorn plant (*Probiscidea louisianica*), swamp pricklegrass (*Crypsis schoenoides*), crabgrass (*Cynodon dactylon*) and paradox canary grass (*Phalaris paradoxa*). Cocklebur (*Xanthium strumarium*), another native species, can also dominate vernal pools (Schlising pers. comm.; Unger pers. comm.).

Specific interactions between livestock grazing and pincushion navarretia are largely unknown. In general, appropriately timed dry-pasture livestock grazing regimes are thought to be compatible with the development and persistence of vernal pool vegetation. Robins and Vollmer (2001) provide a review of information pertaining to livestock grazing in vernal pool ecosystems.

All populations of pincushion navarretia located in eastern Merced County inhabit long-operating cattle ranches, so persistence indicates tolerance for at least some level of grazing. Observations made along fence-lines in the region indicate however, that sheep grazing may be responsible at least in part, for absence of pincushion navarretia and the co-occurring rare succulent owl's-clover in some areas (Dittes and Guardino 2001). Sheep exert a somewhat different selective pressure in vernal pools owing to very close cropping of vegetation and a tendancy to "nest" in pool basins during the terrestrial phase (Kelsey pers. comm.).

Timing of livestock grazing is likely more important than stocking rates in affecting persistence of pincushion navarretia. By limiting grazing to the period when pools are inundated and upland forage is still green and attractive, cattle tend to not congregate in pools and trampling and grazing pressures to vernal pool plant species in their seedling or juvenile aquatic phase are minimized. Once the upland forage cures and the vernal pools are in their flowering and seed-producing terrestrial phase, moist pools become more attractive to livestock and grazing and trampling pressures are increased. Grazing in the summer and fall months, after seeds have set and plants have died likely has little effect on pincushion navarretia.

Although responses to disturbance have not been described for pincushion navarretia, other pertinent examples exist. As an illustration of the role of timing in response of vernal pool species to potential disturbances, Hoover (1941) and Crampton (1959) have reported Orcuttieae grass populations being completely disked in dry-farmed grain fields in the late fall, without apparent detriment to the Orcuttieae populations the following growing season. It has been noted that the same disking performed during the late spring or summer growing periods may completely deplete the soil seed bank if performed over successive years (Stone et al. 1988). Similarly, a small vernal pool located in the middle of a winter-wheat field in eastern Merced County persists and continues to support the rare dwarf downingia (*Downingia pusilla*), despite annual disking and planting over decades (Kelsey pers. comm.; Dittes pers. obs.). It is very important to note that in these cases the disking is not disrupting the water-retaining capacity and hydrological cycle of the respective vernal pools. This is not always the case with disking.

5.2.3 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for pincushion navarretia are identified in Table PINA-1 and have been derived from input from local species experts.

Table PINA-1
Essential Habitat Elements of Pincushion Navarretia

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, vernal pool, and vernal swale.	Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools, providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and non-native upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

5.3 Species Distribution and Population Trends

5.3.1 Range Wide Distribution

Presently, pincushion navarretia is recorded from 14 CNDDB occurrences distributed along a narrow swath of the Great Central Valley, from Placer County in the north to Merced County in the south (CDFG 2010). These occurrences are all situated at sites ranging from 65 to 1,082 feet in elevation (CNPS 2010), and all lie within either the Sacramento Valley or San Joaquin Valley Subregions of the Great Valley Region of the California Floristic Province (Hickman 1993).

5.3.2 Central Valley Distribution

The northernmost occurrence of pincushion navarretia is located near the City of Lincoln in Placer County. Six CNDDB occurrences are located in eastern Sacramento County, three in Amador County (one of these is shared with Sacramento County), one in Calaveras County, one in Placer County and four in Merced County (CDFG 2010).

5.3.3 Range within the Plan Area

Currently, of the six documented CNDDB occurrences of pincushion navarretia recorded from Sacramento County, five are included within the Plan Area (CNDDB #7-10 and #16). These five are located outside of the UDA in the southeast corner of the County. Most of these occurrences are on the 13,000-acre Howard Ranch property. The Howard Ranch is managed by The Nature Conservancy (TNC) as part of the Cosumnes River Watershed Project. The remaining

Sacramento County Occurrence (CNDDB occurrence #3) is located outside of the Plan Area, just north of the American River at the Phoenix Field Ecological Reserve.

It is important to note that owing to its small stature, preference for small to medium-sized vernal pools and the area of remaining unsurveyed or partially surveyed habitat, moderate to high potential exists for discovery of additional populations within the Plan Area.

Table PINA-2 shows the soil series, geological formation and landform associations for each known occurrence in Sacramento County. Generally, pincushion navarretia is associated with old terrace remnant alluvial deposits of ancestral river channels and pediment gravels, which were deposited during the early Pleistocene between 600,000 and 1,500,000 years ago (confirm). Though the distribution of the taxon is extremely disjunct, the range of the taxon in the Plan Area is considered to be vernal habitats embedded in valley grasslands or oak savannah.

Table PINA-2
Extant CNDDB Occurrence Numbers, Distribution, Associated Soil Series and Landform Formations For Pincushion Navarretia In Eastern Sacramento County

CNDDB Occurrence #	Quadrangle	Soil Series	Geological Formation and Landform
3	Folsom	Red Bluff-Redding	Laguna Formation
7	Carbondale	Amador-Gillender	Valley Springs Formation
8	Carbondale	Amador-Gillender	Valley Springs Formation
9	Goose Creek	Corning	Laguna Formation
10	Goose Creek	Hadselville-Pentz	Modesto Formation

5.3.4 Population Levels and Trends

Of the 15 documented occurrences presumed extant, one in Amador County (CNDDB occurrence #2) has not been observed since 1941; the Calaveras County population (CNDDB occurrence #13) has not been observed since 1957, and the Placer County population (CNDDB occurrence #12) has not been observed since 1971. The exact locations and status of these occurrences are unknown. The remaining 12 CNDDB occurrences presumed extant are also given a trend assessment of unknown (CDFG 2010).

It is impossible to determine the number of historically occurring pincushion navarretia populations or the acreage of suitable habitat lost to historic agricultural and urban land-use conversions, since so much had happened before these species first received attention. Investigators have made estimates as to the acreage of vernal pool habitat lost since historic times (Holland 1978); however, owing to habitat specificity, only a subset of the vernal pool habitat lost within the natural range of the species may have provided suitable habitat for pincushion navarretia. Effects of historic livestock grazing combined with drought and habitat alterations relating to development of non-native annual grassland are unknown as well.

There has been no comprehensive effort to monitor any of the known populations of pincushion navarretia. Numbers of individuals have not been recorded for any of the populations and year-to-year population dynamics are unknown (wait to hear back from TNC and CDFG).

Table PINA-2
Population Estimates of CNDDB Occurrences

CNDDB #	# of Pools Observed	Range of Population Estimates
3	Unknown	1994: 1000 plants
7	Unknown	2005: 1000's
8	Unknown	Unknown
9	Unknown	Unknown
10	Unknown	Unknown

Studies involving other vernal pool plant rarities, including Orcuttiae grasses and Hoover's Spurge have demonstrated marked fluctuation in numbers of individuals within populations between years (Griggs 1983; Holland 1987; Alexander and Schlising 1997). This extreme population variability is attributable to interactions of seed dormancy, early seedling survivorship, and average seed set per plant, as principally determined by seasonal and between-year limitations in available moisture (Griggs and Jain 1983; Holland 1987). It is not known however, if pincushion navarretia exhibits a similar between-year pattern.

Observations made over a decade or so may provide a reasonable indication of the short-term vigor of a given pincushion navarretia population. It is important to consider however, that in order to assess the trend of the species, long-term monitoring of both habitat and populations conducted over multiple cycles of wet and dry years is needed. Another critical aspect of population demography is the presence and nature of the soil seed bank, which is unknown for pincushion navarretia.

5.4 Threats to the Species

Potential threats to pincushion navarretia include loss of vernal pool habitat to agricultural or urban/industrial land-use conversions, hydrological alteration of sub-watersheds and associated vernal pool habitat, shifts in competitive interactions (hydrological mediated or invasive weeds), inappropriate livestock grazing regimes (later spring/summer rotations, sheep vs. cattle), recreational vehicle use, equestrian and pedestrian traffic, refuse dumping, windblown refuse accumulation, air pollution and global climate change.

Irrigation runoff and invasive plants are listed as a threat at one occurrence (CNDDB occurrence #3) (CDFG 2010). Although no threats are listed for the remaining 12 occurrences, all are located on operating cattle ranches and are subject to potentially inappropriate livestock grazing regimes.

5.5 Data Gaps and Conservation Implications

Despite its distinctive appearance and extreme rarity, pincushion navarretia has received little research attention from botanists or ecologists. Aside from general observations of field workers provided in the CNDDB and the study of vernal pool adaptive traits in the genus *Navarretia* (Spencer and Rieseberg 1998), nothing else exists regarding the biology, ecology, pollinators, breeding system, population genetics, habitat relationships, population levels, trends or threats associated with this taxon. Pertinent data gaps, implications for conservation, and operating assumptions include:

5.5.1 Unknown Number of Undiscovered Populations

Additional unsurveyed and partially surveyed potentially suitable habitat exists within the Plan Area and elsewhere within the range of the species. In the Plan Area, discovery of new populations may occur on the large dry-land ranchlands, public quasi-public lands and vernal pool-grassland preserves already established in the eastern portion of the County.

5.5.2 Unknown Relationship between Landform/Soil Chemistry and Bio-Geographic Distribution

Pincushion navarretia has a geographic association with old alluvial terraces possessing acidic soils primarily of the Ione, and to a lesser extent, Red Bluff Families (Arroyo Seco and Laguna Geological Formations). The exact nature of this relationship is however, unknown. It is unknown if soil pH or other edaphic factors influence pincushion navarretia distribution and population vigor. It is possible that the presence of functioning vernal pools, regardless of landform, soil series and soil pH can provide suitable habitat.

5.5.3 Unknown Pollination Ecology

Pincushion navarretia possesses the longest flowers of any of the species in the genus. Floral morphology generally reflects breeding systems and pollinator relationships. It may be expected that the very long flower tubes select for a particular pollinator, perhaps even a specialized co-evolved species. Bumble-bee flies (family Bombylidae), butterflies, and moths all have feeding apparatus long enough to reach potential nectar rewards located at the base of the floral tube. Since the stigma and anthers are exerted though, it may also be possible that solitary bees, small beetles, or some insect with less specialized mouthparts collects the pollen from the exerted stamens for use and incidentally spreads it to the exerted stigmas of nearby flowers.

5.5.4 What Constitutes Population Vigor, and How to Measure?

Population vigor will need to be monitored during the life of the SSHCP, yet population dynamics, including year-to-year variability in abundance, have not been studied for pincushion navarretia. The existence of a dormant soil seed bank, a critical contributor to population stability in some other vernal pool species, is unknown for pincushion navarretia as well. Other rare vernal pool species have been shown to be highly variable in abundance from year-to-year (Holland 1987; Griggs pers. comm. 2003), and causative factors contributing to year-to-year population fluctuations may be difficult to identify (Alexander and Schlising 1997).

Trends may occur that are not discernable and trends that are discerned may be unexplainable. These factors will complicate attempts to change management for benefit of the species if measured vigor shows decline.

5.5.5 Specific Hydrological Requirements of Pincushion Navarretia

Numerical data do not exist regarding specific parameters of the annual hydrological cycle of vernal pools supporting pincushion navarretia populations (e.g., timing of rainfall, depth of ponding, duration of ponding, and soil dry down rate).

The general lack of numerical hydrological data limits the ability to precisely monitor and/or assess hydrological suitability of pincushion navarretia -vernal pool habitat within established preserves. Similarly, assessment of potentially suitable pincushion navarretia habitat for preserve establishment or for detection of the species at this time must rely on generalities. Once preserves for existing pincushion navarretia populations are established, assessed and monitored over time, a more quantifiable definition of suitable pincushion navarretia -vernal pool hydrology will emerge based on the new information.

5.5.6 Baseline Hydrological Trend of Pools and Existing Indirect Effects

Extant pincushion navarretia populations may have already experienced some degree of hydrological modification resulting from development-related alterations to sub-watersheds (CDFG 2010). Without complete protection of entire vernal pool watersheds, or precise hydrological monitoring and accurate modeling on a pool complex-scale, long-term indirect effects resulting from existing alterations to sub-watershed hydrology are unknown.

Baseline pincushion navarretia conditions for the SSHCP may not be pristine, so if trends in vigor or habitat quality become apparent during the 50-year period or at some time beyond, it may be difficult to attribute trend to any specific management activity.

5.5.7 Definition of Appropriate Hydrology Buffer

There is no standard for appropriate scale of effective hydrologic buffers for vernal pool-annual grassland ecosystems, since the nature of vernal pool complexes and their geo-hydrological relations may vary substantially by geography (Holland and Dains 1990). Proposed preserve designs may not afford complete protection to the hydrological systems that support pincushion navarretia and other species assemblages dependant on them.

5.5.8 Definition of Appropriate Scale pincushion navarretia -Vernal Pool-Annual Grassland Preserve

There is no standard for appropriate scale of effective pincushion navarretia -vernal pool preserves. It is a paradigm of conservation biology that “bigger is better” for a variety of well-documented reasons. Conservation challenges associated with the relatively small-scale vernal pool preserve that includes pincushion navarretia at Phoenix Field and Phoenix Park are well documented and reflect consequences of increase edge effect associated with smaller preserves (Clark et. al. 1998).

5.5.9 Determination of an Appropriate Livestock Grazing Regime

Livestock grazing will occur in at least some of the pincushion navarretia -vernal pool preserves, primarily for purposes of upland annual grassland vegetation management. Specific grazing regimes have not been formulated for annual grassland pasture systems with pincushion navarretia-occupied pools, although grazing and monitoring in similar systems have been addressed (Barry 1998; TNC 2000; Griggs 2002; Robins and Vollmar 2002). It is important to note that pincushion navarretia does persist though, in historically and contemporary operating livestock ranches. At a minimum, compatibility with some level of grazing is evidenced by persistence of the species in these systems. Since pincushion navarretia occupied small to medium size vernal pools, management of Italian Rye and Mediterranean Barley around the margins of vernal pools, and Medusa-head grass in uplands should be of particular management concern.

Presently, Witham et al. are formulating site-specific livestock grazing regimes for annual grassland-vernal pool systems in an area of Sacramento County. Livestock grazing regimes in pincushion navarretia -vernal pool preserves covered under the SSHCP will tier towards the results of this work, as well as to the specific needs of pincushion navarretia. Specific livestock grazing regimes cannot be formulated until preserve size, configuration, and soil and vegetation conditions and vegetation management goals are determined.

5.5.10 Interactions with Non-Native Weeds and Weed Management Activities

Non-native weeds, or weedy native species reported as occurring in vernal pools include western mannagrass, swamp pricklegrass, Bermuda grass, common spikerush, field bindweed, lippia, paradox canary grass, hairy hawkbit, cocklebur and cattails. None of these are reported to coinhabit pincushion navarretia -occupied vernal pools in Sacramento County. Any of these and others now unknown may appear or change in abundance in pincushion navarretia -occupied pools over time. Italian wild rye and Mediterranean barley, two common non-native inhabitants of shallow vernal pools and vernal pool margins, might be of management concern to pincushion navarretia, owing to the latter's preference for small to medium size vernal pools.

Potential competitive interactions with these species may affect the vigor of pincushion navarretia populations. In addition, any eradication or control methods implemented for these species may in turn potentially affect pincushion navarretia populations.

5.5.11 Potential Association and Compatibility with Other Rare Vernal Pool Species

It is desirable to combine design preserves for multi-species conservation. Suitability of pincushion navarretia habitat for supporting other rare plant species has not been specifically addressed, although natural populations of the rare Sacramento Orcutt grass (Orcuttia viscida), legenere (*Legenere limosa*), and succulent owl's-clover (*Castilleja campestris* ssp. *succulenta*) are documented as sharing vernal pools with it. Many of these pool complexes also may provide habitat for rare invertebrates, amphibians, mammals, and bird species as well._Management for multiple species maximizes the effectiveness of habitat conservation and requires coordinated monitoring and actions. Management for the benefit of one species may conflict with management needs of other rare species. For instance, livestock grazing anytime between November 1st and April 15th may be compatible with or even benefit some pincushion navarretia -associated pool complexes, but may be detrimental to ground-dwelling amphibians depending on those complexes (e.g., California tiger salamander).

5.5.12 Genetic Variation (Spatial and Temporal [Seed Bank], Genetic Drift, Genetic Bottlenecks)

Population genetics for pincushion navarretia are completely unknown. Current limitations in our understanding of pincushion navarretia population genetics have little immediate conservation implication, given the extreme rarity of pincushion navarretia.

If experimental inoculation of pools is proposed as part of the SSHCP, appropriate measures will be developed to ensure that seed collection, seed treatment and pool inoculation methods are consistent with what we know and do not know about pincushion navarretia ecology and population genetics.

5.5.13 Critical Population Size

In conservation biology, critical population size is usually defined as a statistical probability over time, or model that describes the minimum number of individuals required for a population to maintain itself through time. This population parameter has been determined for assorted wildlife and some perennial plant species. The most simplistic estimations take into account recruitment rates of individuals into the population via reproduction and immigration, and removal rates of individuals from that same population via death and emigration.

Since pincushion navarretia is an annual species, its population sizes are known to be highly variable from year to year, and the soil seed bank constitutes an important demographic component of the population, definition and assessment of a critical population size is impracticable and lacks ecological meaning.

Knowledge of critical population size provides an ecologically meaningful and quantifiable benchmark for adaptive management purposes (e.g., if monitored populations drop to within 30 percent of critical population size, site-specific analysis, appropriate management changes and additional monitoring will occur). This is not possible for annual species, so other measurable benchmarks are needed.

5.5.14 Seed Longevity and Dynamics of Stored Soil Seed Bank

As previously mentioned, the existence and potential role of a dormant soil seed bank in population dynamics is completely unknown for pincushion navarretia. There have been no studies addressing the presence of a soil seed bank, seed dormancy or longevity. From the perspective of conservation, knowledge of site specific soil seed bank characteristics would allow more accurate assessment of population size and stability (vigor). This is particularly true of populations that typically support the fewest standing individuals through time.

5.5.15 Unknown Aspects of Experimental Inoculation

Since there are so few natural populations of pincushion navarretia in Sacramento County, species viability may be significantly enhanced by inoculating unoccupied, apparently suitable pools and increasing the number of naturally self-sustaining populations. These additional populations would increase the likelihood of natural dispersal events into preserved but unoccupied pincushion navarretia habitat, create meta-population structure at extant occurrences where single pools may support the species, and ensure existence should any natural populations become compromised. Uncertainties regarding the political ramifications and ecological effectiveness of experimental inoculation lead the conservation community and agencies to not consider experimental inoculation as an appropriate conservation goal. Given the extreme rarity of this species though, this option may need reconsideration at some point in time.

5.5.16 Air Pollution (Dust/Ozone/Nitric Oxide, Sulphur Dioxide)

Portions of the Central Valley of California frequently exceed State and Federal safety levels for a variety of air pollutants, including particulate matter. ozone, and others. Some of these pollutants are known to negatively affect plant physiology and health, although none have been investigated as they relate to vernal pool vegetation. Assuming that extant pincushion navarretia occurrences are maintaining their vigor at existing ambient pollution levels, air pollution will probably not present a major threat to the viability of pincushion navarretia, if existing air quality can be maintained. If however, California's human population increases as projected and air pollution control measures are not developed and implemented concomitantly and effectively, these pollutants may negatively affect pincushion navarretia and other native plant species.

5.5.17 Effects of Global Climate Change

The scientific community commonly accepts as valid the phenomenon of increasingly rapid global climate change. Specific climatic models for California predict an average increase in temperature over the coming decades, with concomitant unpredictability in annual rainfall patterns. There is uncertainty regarding the exact nature and extent of these changes, as well as the consequences these changes pose to conservation biology. It is likely that given the expected global climate trends, a vigor response of some kind could be expected for pincushion navarretia populations within the implementation period of this HCP, or at some time beyond.

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6 SLENDER ORCUTT GRASS (SLOG)

Prepared by Dittes and Guardino Consulting (John Dittes and Josephine Guardino)

Slender Orcutt Grass (SLOG)

(Orcuttia tenuis)

Status USFWS: Endangered

Status CDFG: Endangered

Status CNPS: List 1B.

Joe Molter, BLM

6.1 Legal Status

Slender Orcutt grass (*Orcuttia tenuis*) was first listed as state Endangered by the California Department of Fish and Game (CDFG) under the California Endangered Species Act in 1988 (Stone et al. 1988), and on March 26, 1997 the species received Listing as Endangered under the Federal Endangered Species Act by the United States Fish and Wildlife Service (USFWS) (USFWS 1997). The California Native Plant Society (CNPS) includes slender Orcutt grass as a CNPS List 1B.1 species and has assigned an R-E-D Code of 2-3-3, meaning it is distributed in a limited number of occurrences, occasionally more if each occurrence is small, it is endangered throughout its range, and found only in California (CNPS 2010).

6.2 Life History and Ecology

6.2.1 Species Description and Life History

Slender Orcutt grass is a member of the distinctive *Orcuttieae* Tribe of the grass family (Poaceae), a group of nine vernal pool species endemic to California and northern Baja California. The Orcutt grasses have been long recognized by botanists as highly evolved, ecologically unusual and naturally restricted (Hoover 1941; Crampton 1959; Reeder 1965, 1980, 1982).

As with other members of the tribe, slender Orcutt grass is a relatively small-stature annual species. Its five to 15 centimeter-long, sparsely hairy-sticky stems are weakly tufted and mostly erect. Like the stems and inflorescences, the 1-2 mm wide, one to five centimeters-long leaves are sparsely hairy and covered with a sticky, highly aromatic exudate. Small scale-bracted flowers (florets) are arranged in erect, two-ranked, flattened spikelets that are usually separated from each other along the exserted terminal five to 10 centimeter-long spikes (Hickman 1993). Often, the flowering stems branch from the upper nodes, with each branch terminating in a single spike-like inflorescence (Stone et al. 1988).

Slender Orcutt grass is most readily distinguished from its closest relative hairy Orcutt grass (*O. pilosa*) on the basis of the stem branching mostly from the upper nodes, the spikelets being evenly spaced rather than congested along the inflorescence axis, and being only sparsely hairy (Reeder 1982; Hickman 1993). Other than the arrangement of spikelets, slender Orcutt grass is similar to hairy Orcutt grass with respect to floral characteristics. Both have similar-sized irregularly toothed glumes and equally five-toothed lemmas, also of similar size. Although morphologically similar, specific status of slender Orcutt grass is further substantiated by a chromosome number of 2n=26, versus 2n=30 for hairy Orcutt grass (Reeder 1982).

All Orcutt grasses are very highly evolved and uniquely adapted members of the endemic vernal pool flora. Their anatomy and physiology (Keeley 1981, 1990, 1998), morphology, and life history traits (Crampton 1959; Griggs 1974, 1976, 1980, 1981) are highly adapted to the stressful, more extreme portions of the vernal pool niche. Some adaptive traits (physiology, anatomy, morphological-distinct life history stages) confer ability of individuals to survive the varied stresses of a single hydrological season, while others (e.g., annual habit, precise germination cues, stored soil seed bank, indeterminate flowering, dispersal-limiting traits) confer population stability through time in the context of year-to-year hydrological uncertainties that characterize the Mediterranean climate (Griggs 1980; Stone et al. 1988).

Evolution of the annual growth habit is a key adaptation of slender Orcutt grass to vernal pool habitat, as is the case with almost all other vernal pool plants (Griggs and Jain 1983; Holland 1987). The annual growth habit allows populations to persist through the regular and extreme summer drought that is characteristic of California’s vernal pool landscape (Stone et al. 1988).

Slender Orcutt grass seeds germinate during the fall or winter months, generally 2-4 weeks after standing water has been present in the vernal pool (Griggs 1980). Germination can continue after cessation of winter rains and as the shallow water at the pool margins begins to warm and recede (Griggs 1974; Holland 1987; Stone et al. 1988). A requirement of cold stratification followed by increasingly warm fluctuating diurnal temperatures and the presence of a symbiotic aquatic fungus (*Alternaria* sp., *Curvilaria* sp.) that has been determined necessary for Orcutt grass seed germination (Griggs 1980, 1981; Keeley 1988). Sensitivity to these environmental cues ensures germination only during years with hydrological conditions favorable for plants to complete their entire life cycle (Griggs 1980, 1981; Stone et al. 1988).

Slender Orcutt grass is thought to be one of the least specifically adapted of the genus with regard to hydrology and habitat breadth (Stone et al. 1988). It has been observed to be more likely than other Orcutt grasses to germinate during years of marginal precipitation, although seedling mortality can be high during such years (Griggs 1981).

Members of the genus *Orcuttia* develop long (approximately ten centimeters), thin (one to two millimeters-wide) juvenile leaves that float on the water surface when seeds germinate under shallow water or when seeds become submersed shortly after germination (Hoover 1941; Griggs 1974, 1980, 1981; Reeder 1982). By facilitating light exposure and atmospheric gas exchange for photosynthesis while submersed, these amphibious juvenile leaves maximize vegetative growth before vernal pool dry-down (Griggs 1981; Stone et al. 1988; Keeley 1990).

Orcutt grass plants are able to produce most of their aboveground vegetative growth, as well as flowers and seed as the vernal pools dry down in late spring and early to mid-summer (Crampton 1959). Vegetative and phenological demographics appear to be largely determined by pool dry-down rate (Griggs 1974, 1980; Stone et al. 1988). Thus, mature fruiting plants in drying soil above the waterline and submersed seedlings further toward the center can occur simultaneously in a single pool.

Indeterminate growth of new stems and spikelets provides for prolonged productivity as seasonally available water allows (Griggs 1974, 1980). This habit may result in smaller plants with fewer flowers and seeds maturing earlier in the season at the pool margins, and later maturing, larger, more fecund plants towards the pool center. This morphological and phenological plasticity confers an adaptive advantage in the context of extreme seasonal fluctuations and the unpredictable year-to-year variability of the Mediterranean Climate (Griggs 1980; Griggs and Jain 1983; Stone et al. 1988).

Since Orcutt grasses mature in a terrestrial setting during the hotter, more xeric late spring and summer months, possession of the C_4 photosynthetic pathway and Krantz Anatomy (Griggs 1980; Keeley 1990, 1998) are important adaptive traits. This photosynthetic pathway allows plants to exchange atmospheric gasses with increased efficiency and concomitant reduction in water loss to evaporative transpiration. This permits the extended period of vegetative growth and reproduction of Orcutt grasses into the hot arid summer months after most other vernal pool associates have completely desiccated (Griggs 1980; Stone et al. 1988).

All Orcutt grasses possess an aromatic sticky glandular exudate on the stems, leaves and inflorescences. This trait is thought to be advantageous both as an anti-desiccation (Hoover 1941; Crampton 1959) and anti-herbivory adaptation (Griggs 1974, 1980). Grasshoppers can exert significant herbivory pressures late in the season although it has not been noted for slender Orcutt grass specifically.

Slender Orcutt grass plants flower and set seed as the margins and basin of the vernal pools dry from May through October (CNPS 2010). Detailed pollination and breeding experiments have not been conducted on this species. Like most other grasses, Orcutt grasses are thought to be primarily wind-pollinated out-breeders as indicated by protogynous floral maturation, strongly exserted anthers and measured patterns of genetic variation (Griggs 1980; Griggs and Jain 1983; Stone et al. 1988). In one instance, native solitary bees of the family Halictidae were observed collecting pollen from one of its relatives, slender Orcutt grass (Griggs 1974).

Seed production of Orcutt grass plants is known to vary greatly between individuals along moisture gradients within single pools, among populations between pools, and within pools between years (Griggs 1980; Griggs and Jain 1983). Fully mature slender Orcutt grass individuals can produce from 11 to over 164 seeds per plant, with an average of 58 seeds estimated. Seed set in Orcutt grasses appears uncertain and dependent on precise synchrony of appropriate environmental conditions and phenological development (Stone et al. 1988).

After the growing season, the mature slender Orcutt grass seeds are held tightly within maternal floral structures (lemma and pelea) on the inflorescence until the mechanical action of wind, heavy rain and winter inundation shatter the inflorescences and release the mature florets. This lack of dispersal is thought to be an adaptation to the sparsely scattered distribution of suitable large vernal pools (Griggs 1974, 1980). It is an advantage for a large proportion of the seed crop to remain within the available large-pool habitat, rather than chance loss to unsuitable uplands. Even though dispersal is naturally limited, Orcutt grass colonization of pools was probably a more frequently occurring event in the historic past when there were likely more populations, many more pools, more pool interconnectivity, exceedingly larger waterfowl migrations, and unfenced roaming ungulates (Griggs 1980). Of the Genus *Orcuttia*, slender Orcutt grass exhibits the greatest propensity for colonizing newly available habitat, most likely the result of seed transport by livestock (Stone et al. 1988).

Not all *Orcuttia* seeds germinate every year, resulting in the buildup of a dormant soil seed bank (Griggs 1974, 1980, 1981). The soil seed bank is a critical adaptive barrier against local extinction events that could otherwise result from the unpredictable occurrence and duration of favorable growing conditions (Stone et al. 1988). In a study of five slender Orcutt grass populations, 14 seeds were found dormant in the soil for every 1 growing plant present (Griggs 1980; Griggs and Jain 1983). Between-population and between-year variation in soil seed bank density and the duration of seed viability in the soil is unknown. The soil seed bank also may contribute to overall genetic diversity of populations, as seeds stored over multiple years produced under varying growth conditions may harbor adaptive allelic combinations that are infrequently expressed or selected.

Studies of seed weight and allozyme electrophoresis indicate that Orcutt grasses possess low levels of gene flow between populations, and high levels of gene flow within (Griggs 1980, 1984; Griggs and Jain 1983). This is to be expected given the highly insular distribution and seasonally dynamic nature of vernal pool habitat (Stone et al, 1988). These studies also revealed very high levels of genetic diversity within the seed families of individual plants, with almost 50 percent of each species' genetic variation represented in samples from one plant. In addition, approximately 80 to 90 percent of the total genetic diversity of each species was represented in each population (Griggs 1980, 1984; Griggs and Jain 1983). It should be noted that this study was limited to assaying seven enzyme systems from two populations of slender Orcutt grass.

6.2.2 Habitat Requirements and Ecology

Like all grasses in the genus *Orcuttia*, slender Orcutt grass is strictly adapted to the vernal pool hydrological cycle. The tribe is thought to be a relatively ancient evolutionary group (Griggs 1981; Reeder 1982), descendant from a perennial ancestor related to the Chlorideae Tribe (Keeley 1998). The ancestral entity is thought to have inhabited the marshy margins of the Tertiary-age sea formerly covering the Great Central Valley (Axelrod 1973; Raven and Axelrod 1978). The evolving Orcuttieae lineage adapted to the increasing seasonal stresses as the Mediterranean climate developed and the inland water body receded.

Interestingly and of potential significance to conservation, slender Orcutt grass appears to be the least specific of the genus *Orcuttia* with regard to niche breadth and habitat specificity. This is indicated by occupation of a wider range of vernal pool sizes and vernal wetland types, occurrence over a greater geographical area and landform types, a larger number of occurrences, and a marked tendency to colonize newly available habitats (where seed sources are available), including constructed stock-ponds and hydrology-enhanced vernal pools (Stone et al. 1988).

Over its geographic range, slender Orcutt grass is associated with a number of distinct physiographic/edaphic settings (Stone et al. 1988). In eastern Sacramento County (southernmost populations) and on the Stillwater and Millville Plains of Shasta County, slender Orcutt grass is associated with vernal pools located on ancient weathered alluvial terraces with soils of the Redding and related Series (Stone et al. 1988). Soils of the Redding series tend to be strongly acidic (indication of age and weathering) and are generally gravelly with cobble. These soils also typically possess a shallow, water-impermeable iron-silica hardpan that favors the development of vernal pools (SCS 1993). In Tehama County, slender Orcutt grass occurs in vernal pools associated with cemented hardpan of the Tuscan, Toomes and related Series, as well as in more shallow volcanic soils and in volcanic bedrock depressions (Stone et al. 1988; CDFG 2010). The montane Occurrences of Lassen and Shasta Counties are also associated with volcanic soils, but in addition to mudflow and bedrock substrates, wetlands formed on large clay flats also support the species.

Orcutt grasses are strongly adapted to the more extreme hydrological cycles encountered in the spectrum of vernal pool types, e.g., they are typically associated with larger or deeper vernal pools that tend to possess more extreme regimes of inundation (Crampton 1959; Griggs 1974). Of the members of the genus *Orcuttia*, slender Orcutt grass tends to occupy the widest range of vernal pool sizes and types (Stone et al. 1988). Vernal pools occupied by slender Orcutt grass documented prior to 1988 range in size from 840 square meters to 45 hectares at Boggs Lake, and among the 39 pools measured, the median pool size was found to be 6,500 square meters (Stone et al. 1988). Upslope watershed area (Area of Drainage) associated with occupied pools was reported by Stone et al. (1988) to range from 0.4 to 1,145 acres among the known occurrences. It should be noted that a number of occurrences have been discovered since 1988.

Vernal pool hydrology has not been precisely defined for any of the Orcutt grasses. In general, ponding must be of sufficient duration and under the appropriate seasonal temperature regime to release the seeds from dormancy through decomposition of maternal floral structures in the presence of a symbiotic aquatic fungus (Griggs 1980; Griggs and Jain 1983; Keeley 1988). The depth or duration of pool inundation are not only critical for germination, but are likely strong determinants excluding other less specialized, but obligate vernal pool species from the barren micro-sites located in the deeper parts of pools that are inhabited by Orcutt grass species.

Ponding cannot be so excessive though, as to foster the recruitment and proliferation of native perennial marsh species, in particular common spikerush (*Eleocharis macrostachya*) (Crampton 1959; Stone et al. 1988; CDFG 2010) and cattail (*Typha* spp.). Common spikerush, a potentially aggressive rhizomatous species, is usually only found in the deepest portions of the more well developed natural vernal pools. In such cases where it co-occurs with slender Orcutt grass, the latter grows mostly in barren areas lacking the spikerush, or at topographical positions just above the spikerush zone (Stone et al. 1988). Prolonged duration of ponding resulting from placement of berms, construction of road surfaces, or other alterations in the vicinity of natural pools has been cited as potential impacts at a number of slender Orcutt grass occurrences (CDFG 2010).

In the Sacramento Valley, slender Orcutt grass occurs in pools with other vernal pool endemics, including stalked popcorn-flower (*Plagiobothrys stipitatus*), common spikerush, coyote thistle (*Eryngium castrense*), white-headed navarretia (*Navarretia leucocephala*), water shamrock (*Marsilea vestida*), dwarf wooly marbles (*Psilocarphus brevissimus*), downingia (*Downingia* spp.), California damasonium (*Damasonium californicum*), vernal pool foxtail (*Alopecurus saccatus*), annual hairgrass (*Deschampsia danthonioides*), doveweed (*Eremocarpus setigerus*), smooth spike-primrose (*Epilobium pygmaeum*), Fitch's spikeweed (*Hemizonia fitchii*), Fremont's Goldfields (*Lasthenia fremontii*), and rabbitsfoot grass (*Polypogon monspeliensis*) (Stone et al. 1988; CDFG 2010). Many of these other vernal pool species however, do not appear to tolerate the hydrologic extremes of prime Orcutt grass habitat. They complete their lifecycle earlier in the season, and are therefore confined to the shallower margins or slopes of the deeper pools that support Orcutt grasses (Crampton 1959; Stone et al. 1988).

Hydrological stresses associated with vernal pools, and Orcutt grass pools specifically, exclude the majority of non-native weedy species that characterize the present-day valley annual grassland, agricultural fields, and ruderal habitats. Italian rye grass (*Lolium multiflorum*) and Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), are two non-native facultative wetland species that typically dominate disturbed wetlands and can be invasive in smaller, more ephemeral vernal pool types. They cannot however, tolerate the more extreme inundation regimes of deeper Orcutt pools. Thatch build-up from Italian rye grass, Mediterranean barley, medusa-head grass (*Taeniatherum caput-medusae*), and other non-native upland species may indirectly affect vernal pool species by lessening the amount of water entering the system through surface and subsurface flow (Robins and Vollmar 2002).

Although none are specifically reported to co-inhabit vernal pools with slender Orcutt grass "weedy species" are mentioned as a threat at several of the occurrences (CDFG 2010). Several non-native weedy hydrophytes may present future problems within the deeper portions of occupied Orcutt grass pools through competitive exclusion (as with common spikerush). Mannagrass (*Glyceria occidentalis*), an aggressive weed of irrigated agriculture and degraded vernal pools, has already been reported as a potential problem at several of the known related Sacramento Orcutt grass (*Orcuttia viscida*) populations. Additional species to consider include rosy lippia (*Phyla nodiflora* var. *rosea*), field bindweed (*Convolvulus arvensis*), common unicorn plant (*Probiscidea louisianica*), swamp pricklegrass (*Crypsis schoenoides*), Bermuda grass (*Cynodon dactylon*) and paradox canary grass (*Phalaris paradoxa*). Cocklebur (*Xanthium strumarium*), another native species, can also dominate portions of Orcutt grass-type pools (Schlising, Unger pers. comm.).

Appropriately timed dry-pasture livestock grazing regimes are generally thought to be compatible with Orcutt grass populations, and may even enhance habitat in situations where Common Spikerush may otherwise predominate (Stone et al. 1988; CDFG 2010). By grazing from late fall, into early to mid-spring months, livestock are generally kept from the occupied portions of Orcutt grass pools by standing water, inundated soil and attraction to abundant green forage in the uplands. Most problems with livestock grazing arise from later spring and summer grazing regimes, when the Orcutt grass pools have dried and flowering and fruiting plants are exposed and vulnerable to trampling and cropping (Stone et al. 1988). In addition, during the later season when the upland forage has dried, the moist bottoms of vernal pools become highly attractive and may suffer increased trampling and hoof-pocking (Dittes pers. obs).

As an example of the role of timing in response to potential disturbances, Hoover (1941) and Crampton (1959) have reported Orcuttieae populations being completely disked in dry-farmed grain fields in the late fall, without apparent detriment to the Orcuttieae populations the following growing season. It has been noted that the same disking performed during the late spring or summer growing periods may completely deplete the soil seed bank and extirpate the population if performed over successive years (Stone et al. 1988).

6.2.3 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for Sacramento Orcutt grass are identified in Table SLOG-1 and have been derived from the USFWS's list of primary constituent elements in the final rule designating critical habitat for the species (USFWS 2005) as well as input from local species experts.

Table SLOG-1
Essential Habitat Elements for Slender Orcutt Grass

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, vernal pool, and vernal swale.	Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools, providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and non-native upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

6.3 Species Distribution and Population Trends

6.3.1 Species Distribution

Slender Orcutt grass is distributed in the Sacramento Valley from eastern Sacramento County in the south, to the vicinity of Redding in Shasta County to the north. The species also occupies the adjacent Cascade Range Foothills in the region north and northeast of Red Bluff, as well as sites in the Pit River Drainage, located northeast of the Sacramento Valley. Another concentration of occurrences is located in the montane region of northern Plumas, western Lassen and eastern Shasta Counties, extending from the vicinity of Lake Almanor, north to the plateau region east and northeast of Lassen Peak. Two disjunct populations, comprising the westernmost occurrences, are located in the Inner Coast Range region of Lake County. Slender Orcutt grass is among the most widespread of the Orcuttiae grasses and exhibits the widest range in elevations (85 to 5,760 feet).

Slender Orcutt grass occurrences are distributed among five of the Geographic Subregions of the California Floristic Province, as described by Hickman (1993); the Sacramento Valley (Sacramento, Butte and Tehama Counties), Inner Coastal Range (Lake County), Cascade Range Foothill (Tehama County), High Cascade Range (Tehama, Shasta, Siskiyou, Plumas and Lassen Counties), and the non-Warner Mountain Subregion of the Modoc Plateau Region (Modoc County) (CNPS 2010).

This comparatively wide distribution may partially reflect the previously mentioned observations of Stone et al. (1988) regarding its comparatively broad habitat requirements relative to some of the other Orcutt grasses (e.g., Sacramento Orcutt grass). It may also reflect a different propensity for seed dispersal by waterfowl, or perhaps even a different "biogeographic legacy" (e.g., timeline of evolution and geographic distribution of ancestral taxon).

6.3.2 Central Valley Distribution

In the Central Valley, slender Orcutt grass occurs among five population centers. The southernmost of these, comprising three CNNDB occurrences and one yet to be recorded occurrence, is located in eastern Sacramento County. The next population center, comprised of two occurrences, is located approximately 65 miles to the north in southern Butte County. The next population center to the north, comprised of 30 occurrences, is located in Tehama County (CDFG 2010).

A large portion of the extant slender Orcutt grass occurrences are distributed among the remaining two Central Valley population centers. The northernmost, extends from the Stillwater Plains near Redding, to the Millville Plains in the vicinity of Cottonwood and Anderson to the south. The remaining Central Valley population center is located at slightly higher elevations in the Cascade Range Foothills of Tehama County, north and northeast of Red Bluff in the vicinity of Manton, Dales Lake, Dales, and Hog Lake Plateau.

6.3.3 Range within the Plan Area

Currently, there are three recorded CNDDB occurrences of slender Orcutt grass presently known within the Plan Area (Figure SLOG-1), and one occurrence that is not yet registered with the CNDDB (Witham pers.comm.). One of these (CNDDB occurrence #16) is situated on the alluvial terrace at the northern edge of Laguna Creek, southeast of the intersection of Gerber and Excelsior Roads. This occurrence, comprised of a single occupied natural vernal pool, is situated within a proposed 300-acre habitat preserve (Klotz Property). This occurrence is located within the Plan Area as well as within the Sacramento UDA. The second slender Orcutt grass occurrence within the Plan Area is located just south of the Klotz property and is also located on a property that is proposed for a preserve (occurrence #90).

The third slender Orcutt grass occurrence located within the Plan Area is situated on the terrace landscape to the east of Mather Field, between Douglas Road and Kiefer Boulevard (CNDDB occurrence #71). This occurrence, comprised of one occupied natural vernal pool, is also located within the UDA. This occurrence is not currently protected, but is proposed for inclusion within a 20-acre vernal pool mitigation preserve (Radmacher pers. comm, 2003)

A fourth occurrence not yet reported in the CNDDB is located at the Unico Radio Facility on the south side of White Rock Road. This occurrence is within the Plan Area as well as within the UDA (Radmacher pers. comm. 2003).

In Sacramento County, slender Orcutt grass is associated with the Laguna Formation. This geological landform is comprised of remnant old-terrace alluvial deposits of ancestral river channels and pediment gravels, which were deposited during the early Pleistocene, between 600,000 and 1,500,000 years ago. Table 1 shows the soil series, geological formation and landform associations for each known Occurrence. Though the distribution of the species is extremely disjunct, the range of the species in the Plan Aarea is considered to be vernal pools and vernal impoundments.

6.3.4 Population Levels and Trends

Alice Eastwood collected the type collection for slender Orcutt grass in Shasta County in 1912. Since then, a total of 90 occurrences have been recorded (CDFG 2010), including 31 in Tehama County, 24 in Shasta County, a shared occurrence in Shasta and Tehama counties, five in Lassen County, 18 in Modoc County, four in Plumas County, three in Sacramento County and two occurrences in each of Siskiyou, Butte, and Lake counties. It should be noted that an additional population not yet recorded in the CNDDB is known from Sacramento County (CDFG 2010).

Of the 90 documented CNDDB occurrences, one is possibly extirpated from Shasta County and the shared Shasta/Tehama County occurrence is possibly extirpated. In addition, downward population trends have been reported for six populations in Shasta County, two in Tehama County, and one in Plumas County. Of the 90 known occurrences, only two have been classified as "stable." The population trends for the remaining 79 occurrences are classified as "unknown." By 1991, the CDFG stated that the trend for slender Orcutt grass is one of decline (USFWS 1997).

It is impossible to determine the number of historically occurring slender Orcutt grass populations or the acreage of suitable habitat lost to historic agricultural land-use conversions, since so much had happened before these species first received attention (Stone et al. 1988). Investigators have made estimates as to the acreage of vernal pool habitat lost since historic times (Holland 1978, Jones & Stokes 1990), however owing to habitat specificity (restriction to), only a subset of the vernal pool habitat lost within the natural range of the species likely provided suitable habitat for slender Orcutt grass (Stone et al. 1988). Concerns over loss of Orcutt grass populations and habitat were expressed beginning with some of the earliest investigators (Hoover 1941; Crampton 1959, 1976; Griggs 1974).

There has been no comprehensive effort to monitor all populations of slender Orcutt grass. Various monitoring projects have been conducted by BLM, USFS, and CDFG. Stone et al. (1988) also provided estimates of populations at all Occurrences visited in 1986 and 1987.

Research conducted at other sites and on other Orcuttiae species indicate that abundance of individuals within Orcutt grass populations varies greatly between species, between populations within species, and within populations through years (Griggs and Jain 1983). This extreme population variability is attributable to interactions of seed dormancy, early seedling survivorship, and average seed set per plant, as principally determined by seasonal and between-year limitations in available moisture (Griggs and Jain 1983; Holland 1987). Fluctuations of similar magnitude are also recorded for hairy Orcutt grass (*Orcuttia pilosa*), slender Orcutt grass (*Orcuttia tenuis*), and Greene's tuctoria (*Tuctoria greenei*) at the Vina Plains Preserve in Tehama County (Alexander and Schlising 1997).

Observations made over a decade or so may provide a reasonable indication of the short-term vigor of a given Orcutt grass population. It is important to consider however, that in order to assess the trend of the species, long-term monitoring of both habitat and populations conducted over multiple cycles of wet and dry years is needed. Another aspect of population demography is the quantity and age of stored seed in the soil profile. Undoubtedly, the number of stored seeds in the soil profile has bearing on how many plants can be produced in a given favorable year.

6.4 Threats to the Species

Potential direct threats to slender Orcutt grass include loss of vernal pool habitat to agricultural or urban/industrial land-use conversions, construction and maintenance of firebreaks, roads, and utility corridors, timber harvest activities (in montane occurrences), inappropriate livestock grazing regimes (later spring/summer rotations), grassland fires, recreational vehicles, equestrian and pedestrian traffic, and refuse dumping.

Potential Indirect threats to slender Orcutt grass include hydrological alteration of sub-watersheds by surrounding developments and land uses, shifts in competitive interactions (hydrology-mediated or invasive weeds), windblown refuse accumulation, point and non-point source water pollution, air pollution, and global climate change.

The proposed Klotz Preserve encompasses approximately 300 acres of vernal pool habitat supporting one CNDDB Occurrence of slender Orcutt grass (CNDDB Occurrence #16). The proposed Were preserve encompasses approximately 160 acres of vernal pool habitat supporting one CNDDB Occurrence of slender Orcutt grass (CNDDB Occurrence #90) The other Sacramento County CNDDB Occurrence (CNDDB Occurrence #71) is currently unprotected, but is planned for inclusion within a proposed 20-acre vernal pool preserve. The fourth slender Orcutt grass occurrence known in Sacramento County, located at the Unica Radio Facility Site, is currently unprotected.

The USFWS has designated critical habitat areas for slender Orcutt grass that encompasses all of the known occurrences and a large portion of the remaining potentially suitable habitat.

6.5 Data Gaps and Conservation Implications

Grasses of the Tribe Orcuttieae, including slender Orcutt grass, are among the most studied and best known of all vernal pool plant species and vernal pool species assemblages. As previously discussed, researchers have variously addressed taxonomy and biogeography, biology, ecology, breeding system, population genetics, habitat relationships, population levels, trends and threats. Even with the attention of researchers and relatively extensive body of information, data gaps with varying implications for conservation remain including:

6.5.1 What Constitutes Population Vigor, and How to Measure?

Population vigor will need to be monitored during the life of this SSHCP, yet a good measure of Orcutt grass population vigor is difficult to define, given the highly variable year-to-year abundance within populations (Holland 1987; Griggs pers. comm. 2003). The contribution of the stored soil seed bank to population numbers and population genetic diversity is an important, but currently unknown factor as well. Furthermore, even if a trend at the population level is discerned, causative factors contributing to year-to-year population fluctuations may be very difficult to identify (Alexander and Schlising 1997).

Trends may occur that are not discernable and trends that are discerned may be unexplainable. These factors will complicate attempts to change management for benefit of the species if measured vigor shows decline.

6.5.2 Specific Hydrological Requirements of Slender Orcutt Grass

Numerical data do not exist regarding specific parameters of the annual hydrological cycle of vernal pools supporting slender Orcutt grass populations (e.g., timing of rainfall, depth of ponding, duration of ponding and soil dry down rate). At the same time, It is also important to note that slender Orcutt grass is cited as one of the more broadly adapted species of the genus, inhabiting a wider array of vernal pool sizes and types, and one of the most likely to germinate during years with marginal precipitation (Holland 1987; Griggs pers. comm.).

The general lack of numerical hydrological data limits the ability to precisely monitor or assess hydrological suitability of slender Orcutt grass-vernal pool habitat within established preserves. Similarly, assessment of potentially suitable slender Orcutt grass habitat for preserve establishment or for detection of the species at this time must rely on generalities. Once preserves for existing slender Orcutt grass populations are established, assessed and monitored over time, a more quantifiable definition of suitable slender Orcutt grass-vernal pool hydrology may be developed.

6.5.3 Baseline Hydrological Trend of Pools and Existing Indirect Effects

Several slender Orcutt grass populations throughout the state have already experienced some degree of hydrological modification resulting from development-related alterations to sub-watersheds (CDFG 2010). Without complete protection of entire vernal pool watersheds, or precise hydrological monitoring and accurate modeling on a pool complex-scale, long-term indirect effects resulting from existing alterations to sub-watershed hydrology are unknown.

Baseline slender Orcutt grass conditions for the SSHCP are not pristine, so if trends in vigor or habitat quality become apparent during the 50-year period or at some time beyond, it may be difficult to attribute trend to any specific management activity.

6.5.4 Definition of Appropriate Hydrology Buffer

There is no standard for appropriate scale of effective hydrologic buffers for vernal pool-annual grassland ecosystems, since the nature of vernal pool complexes and their geo-hydrological relations may vary substantially by geography (Holland and Dains 1990). The geo-hydrologic investigation of Hanes and Stromberg (1998), conducted at a single site over three years in eastern Sacramento County, addresses aspects of vernal pool hydrology that are important to consider in formulation of hydrological buffers (e.g., relationship between pool basin hydrology and surrounding upland soil profile).

Proposed preserve designs may not afford complete protection to the hydrological systems that support slender Orcutt grass and other species assemblages dependant on them without more information on appropriate scale hydrologic buffers.

6.5.5 Definition of Appropriate Scale Slender Orcutt Grass-Vernal Pool-Annual Grassland Preserve

There is no standard for appropriate scale of effective slender Orcutt grass-vernal pool preserves. It is a paradigm of conservation biology that “bigger is better” for a variety of well-documented reasons. Conservation challenges associated with the relatively small-scale Sacramento Orcutt grass pool preserve at Phoenix Field and Phoenix Park are well documented and reflect consequences of increase edge effect associated with smaller preserves (Clark et al. 1998).

Proposed preserve designs may not afford complete protection to the ecosystems that slender Orcutt grass and other species assemblages depend on without more information on appropriate scale of preserve area.

6.5.6 Determination of an Appropriate Livestock Grazing Regime

Livestock grazing will occur in at least some of the slender Orcutt grass-vernal pool preserves, primarily for purposes of upland annual grassland vegetation management. Specific grazing regimes have not been formulated for annual grassland pasture systems with slender Orcutt grass-occupied pools, although grazing and monitoring in similar systems have been addressed (Barry 1998, TNC 2000; Griggs 2002; Robins and Vollmar 2002; Burmester pers. comm.). It is important to note that slender Orcutt grass and other members of the Orcuttiae tribe do persist though, in historically and contemporary operating livestock ranches. At a minimum, compatibility with some level of grazing is evidenced by persistence of the species in these systems.

Presently, Witham et al. are formulating site-specific livestock grazing regimes for annual grassland-vernal pool systems in an area of Sacramento County (Witham pers. comm.). Livestock grazing regimes in slender Orcutt grass-vernal pool preserves covered under the SSHCP will tier towards the results of this work, as well as to the specific needs of slender Orcutt grass. Specific livestock grazing regimes cannot be formulated until preserve size, configuration, and soil and vegetation conditions and vegetation management goals are determined.

With regard to compatible grazing regimes, timing of grazing appears far more important than stocking rate, grazing intensity, or duration of rotation in annual grassland pasture systems that support Orcutt grass-occupied vernal pools (Stone et al. 1988; Griggs 2000; Griggs pers. comm.). During the inundated period of the vernal pool cycle (generally late fall through mid-to late spring), germinating seed and establishing aquatic-phase seedlings are afforded protection from trampling and grazing by a general aversion of cattle to standing water, as well as attractive forage in uplands. Even if some cattle congregate at the edge or meander into or across the pools while inundated, germinating seeds in the deeper portions of the pools are unaffected, the vast majority of the pool substrate escapes trampling and nothing is eaten.

Conversely, grazing during the dry-down period or terrestrial phase, when plants are flowering and setting seed can be detrimental to the season's flowering effort and seed crop (generally mid- to late spring through the summer and early fall months). Given multiple years of improperly timed grazing and seed loss (both from standing crop and exhaustion of soil seed bank), populations may decline in vigor and may even be extirpated.

6.5.7 Interactions with Non-Native Weeds and Weed Management Activities

Non-native weeds, or weedy native species reported as occurring in Orcuttiae-occupied vernal pools include western mannagrass, swamp pricklegrass, Bermuda grass, common spikerush, field bindweed, Lippia (*Phyla nodiflora*), paradox canary grass, cocklebur, and cattails. Of these, common spikerush presently co-inhabit slender Orcutt grass-occupied vernal pools in Sacramento County. Any of these and others now unknown may appear or change in abundance in slender Orcutt grass-occupied pools over time.

Potential competitive interactions with these species may affect the vigor of slender Orcutt grass populations. In addition, any eradication or control methods implemented for these species may in turn potentially affect slender Orcutt grass populations.

6.5.8 Unknown Relationship Between Landform/Soil Chemistry And Bio-Geographic Distribution

In Sacramento County, slender Orcutt grass has a geographic association with old alluvial terraces possessing soils primarily of the Redding Family (Laguna Geological Formation). Occurrences in Tehama, Lassen and Modoc Counties are associated with other landforms and soils as well. The exact nature of this relationship to landform and soil is however, unknown. Given the relatively wide distribution of this species though, it is unlikely that soil pH or other parameter of soil chemistry strongly influences slender Orcutt grass distribution and population vigor. It is more likely that large or deep vernal pools, regardless of landform, soil series and soil pH may provide suitable habitat.

From the perspective of slender Orcutt grass conservation, this uncertainty has bearing on the definition of potentially suitable habitat, which guides surveys and establishment of habitat preserves.

6.5.9 Potential Association and Compatibility with Other Rare Vernal Pool Species

It is desirable to design preserves for multi-species conservation. Suitability of slender Orcutt grass habitat for supporting other rare plant species has not been specifically addressed, although natural populations of the rare pincushion navarretia (*Navarretia myersii* ssp. *myersii*), Bogg's Lake hedge-hyssop (*Gratiola heterosepala*), and legenere (*Legenere limosa*) are documented as sharing specific vernal pools with slender Orcutt grass. Many of these pool complexes also may provide habitat for rare invertebrates, amphibians, mammals and bird species as well.

Management for the benefit of one species may conflict with management needs of other rare species. For instance, livestock grazing anytime between November 1st and May 1st may benefit slender Orcutt grass-associated pool complexes, but may be detrimental to ground-dwelling amphibians depending on those complexes (e.g., California tiger salamander).

6.5.10 Genetic Considerations (Spatial and Temporal Variation, Seed Bank, Drift, Bottlenecks)

It has been determined that *Orcuttia* populations are genetically isolated as well as diverse, the latter both within and between pools (populations), and within the "seed family" of a single reproductive plant. In addition, there is a high degree of localized adaptation and strong intra-pool selective pressures (Griggs 1980; Griggs and Jain 1983). However, investigations of slender Orcutt grass population genetics have been limited to measures of seed size and weight (genetically fixed traits) within and among populations, and electrophoretic study of seven enzyme systems in only two populations. These analyses represent a very small portion of the genome and allow limited interpretation of patterns of genetic diversity and limited inference as to uniqueness of a given population. Another potentially important consideration is that there has been no assessment of the "genetic memory" potentially associated with stored seeds in the soil seed bank. Elam (1996) provides a good overview of the myriad considerations in assessing the population genetics of vernal pool plants in the absence of empirical data for a given taxon.

Current limitations in our understanding of slender Orcutt grass population genetics have little immediate conservation implication, given that no take of slender Orcutt grass will be allowed under the SSHCP.

If experimental inoculation of pools is proposed as part of the SSHCP, or as part of the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005), appropriate measures will be developed to ensure that seed collection, seed treatment and pool inoculation methods are consistent with what we know and do not know about slender Orcutt grass ecology and population genetics.

6.5.11 Critical Population Size

Critical population size is a statistical estimate that defines the minimum number of individuals required for a population to maintain itself over generations, through time. This population parameter has been determined for assorted wildlife and some perennial plant species. The most simplistic estimations take into account recruitment rates of individuals into the population via reproduction and immigration, and removal rates of individuals from that same population via death and emigration.

Since slender Orcutt grass is an annual species, its population sizes are known to be highly variable from year to year, and the soil seed bank constitutes an important demographic component of the population, definition and assessment of a critical population size is impracticable and lacks ecological meaning.

Knowledge of critical population size provides an ecologically meaningful and quantifiable benchmark for adaptive management purposes (e.g., if monitored populations drop to within 30 percent of critical population size, site-specific analysis, appropriate management changes and additional monitoring should occur). This is not possible for annual species, so other measurable benchmarks are needed.

For purposes of the SSHCP, it may best be assumed that assessment of multi-year population vigor trends along with habitat condition may better serve as an indicator of long-term population viability, rather than trying to define what a critical number of individuals required for population viability might be.

6.5.12 Seed Longevity and Dynamics of Stored Soil Seed Bank

As previously mentioned, it appears that slender Orcutt grass populations depend on a substantial reserve of dormant seed stored in the soil as a buffer against single year and multiple-year cycles of unfavorable hydrological conditions. This population parameter has only been measured in a few pools during one growing season (Griggs 1980). There have been no other studies addressing spatial or temporal variability of seed abundance in the soil seed bank or longevity of dormant seeds.

From the perspective of conservation, knowledge of site-specific soil seed bank characteristics would allow more accurate assessment of population size and stability (vigor). This is particularly true of populations that typically support the fewest standing individuals through time.

6.5.13 Unknown Aspects of Experimental Inoculation

Since there are so few natural populations of slender Orcutt grass in Sacramento County, species viability may be significantly enhanced by inoculating unoccupied, apparently suitable pools and increasing the number of naturally self-sustaining populations. These additional populations would increase the likelihood of natural dispersal events into preserved but unoccupied slender Orcutt grass habitat, create meta-population structure at extant occurrences where single pools now support the species, and ensure existence should any natural populations become compromised.

In addition to complete protection and enhancement of natural populations, it has been suggested that experimental inoculations may be desirable for Orcuttieae conservation (Griggs and Jain 1983; Griggs pers. comm.). The experimental establishment of a Sacramento Orcutt grass population at Phoenix Field (CNDDB occurrence #15), now 25 years-old, provides some indication of the probable success of inoculating suitable habitat and creating self-sustaining populations. However, not all experimental inoculations attempted during the research of Griggs were “successful.” (Griggs pers. comm.). Inoculations of slender Orcutt grass planted in Tehama County into artificial pools have had marginal success due to excessive ponding and competitive exclusion from Cattails. These Occurrences (CNDDB Occurrence # 72, #73 and #74) are rank as “poor” and the current population trends are “unknown.” The population genetics and long-term viability of artificially inoculated population for Orcutt grasses are unknown.

Uncertainties regarding the political ramifications and ecological effectiveness of experimental inoculation lead the conservation community and Agencies to not consider experimental inoculation as an appropriate conservation goal. Given the ecological characteristics of slender Orcutt grass though, preservation of unoccupied slender Orcutt grass habitat alone will likely do little for the conservation or recovery of this species.

6.5.14 Air Pollution (Dust/Ozone/Nitric Oxide, Sulphur Dioxide)

Portions of the Central Valley of California frequently exceed State and Federal safety levels for a variety of air pollutants, including particulate matter, ozone, and others. Some of these pollutants are known to negatively affect plant physiology and health, although none have been investigated as they relate to vernal pool vegetation. Assuming that extant slender Orcutt grass occurrences are maintaining their vigor at existing ambient pollution levels, air pollution will probably not present a major threat to the viability of slender Orcutt grass, if existing air quality can be maintained. If however, California’s human population increases as projected and air pollution control measures are not developed and implemented concomitantly and effectively, these pollutants may negatively affect slender Orcutt grass and other native plant species.

If air pollution becomes such a problem that slender Orcutt grass is affected, few management options will exist to change conditions for this species.

6.5.15 Effects of Global Climate Change

The scientific community commonly accepts as valid the phenomenon of increasingly rapid global climate change. Specific climatic models for California predict an average increase in temperature over the coming decades, with concomitant unpredictability in annual rainfall patterns. There is uncertainty regarding the exact nature and extent of these changes, as well as the consequences these changes pose to conservation biology.

It is likely that given the expected global climate trends, a vigor response of some kind could be expected for slender Orcutt grass populations within the implementation period of the SSHCP, or at some time beyond.

6.5.16 Unknown Number of Undiscovered Populations

Additional unsurveyed potentially suitable habitat exists within the Plan Area, principally on the larger private dry-land ranches that harbor well-developed vernal pools and vernal pool complexes. Authorities generally consider slender Orcutt grass as one of the more completely understood species with regard to distribution and frequency (Stone, Taylor, Macdonald, Griggs, 2002 pers. comm.), owing primarily to typical association with only the best developed of vernal pools and seemingly natural restricted range; however, it is also acknowledged that a limited number of additional populations could be yet discovered as the remaining large tracts become surveyed.

It is very unlikely however, that enough populations remain to be discovered to justify a future change in the conservation status of slender Orcutt grass (Stone, Taylor, Witham, Griggs pers. comm.).

It is assumed for the SSHCP that most, but perhaps not all extant populations of slender Orcutt grass are already known. It is further assumed that since there are so few natural populations and the probability of finding a substantial number more is low, that all populations yet discovered are of great conservation importance and should receive the same protection and management.

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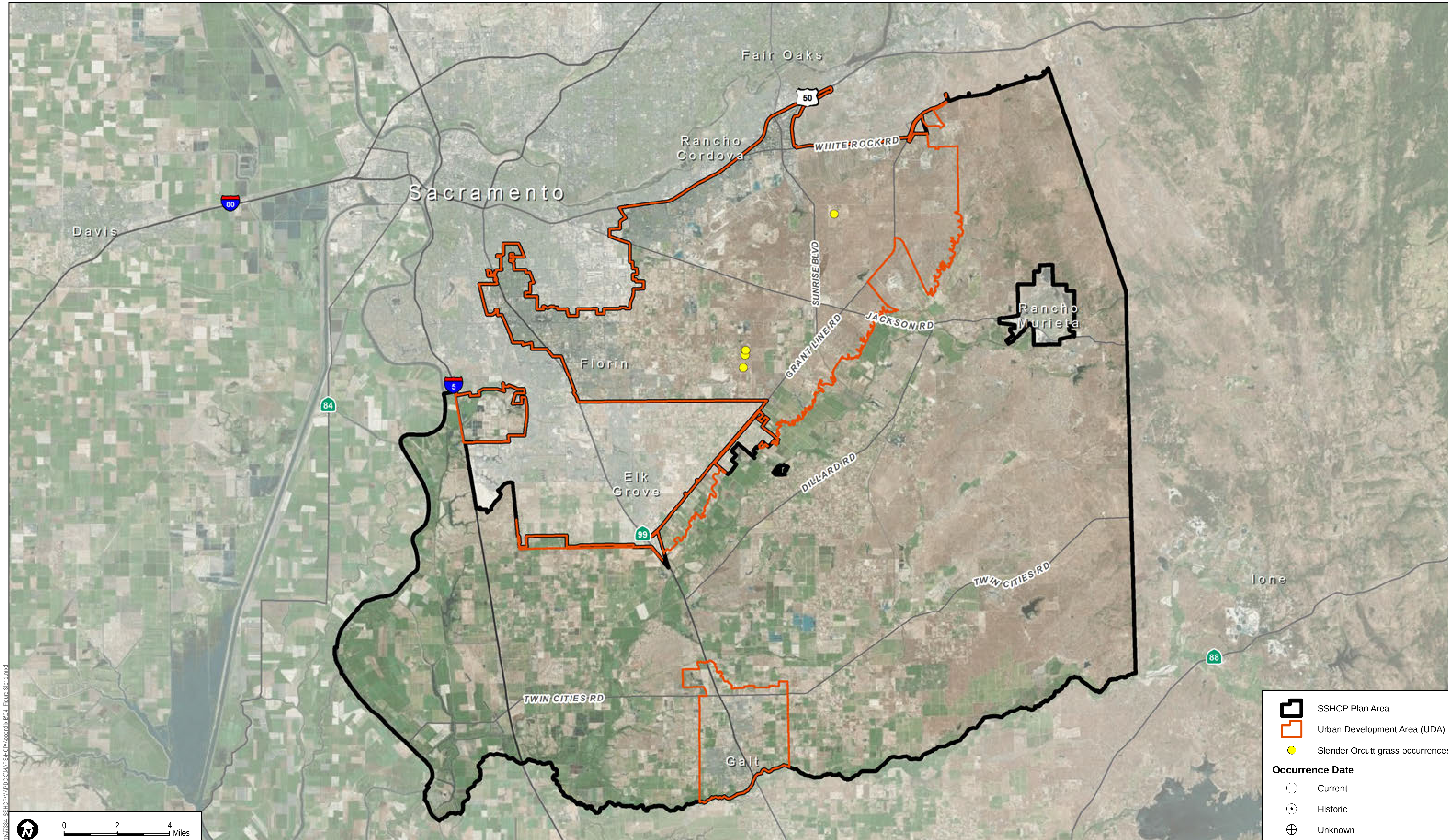

SOURCE: Bing Maps, County of Sacramento 2012

FIGURE SLOG-1

Slender Orcutt Grass Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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7 SACRAMENTO ORCUTT GRASS (SAOG)

Prepared by Dittes and Guardino Consulting (John Dittes and Josephine Guardino)

Sacramento Orcutt Grass (SAOG)
(Orcuttia tenuis)
Status USFWS: Endangered

Status CDFG: Endangered

Status CNPS: 1B.1

7.1 Legal Status

Sacramento Orcutt grass (*Orcuttia viscida*), also commonly called sticky Orcutt grass, was first listed as state Endangered by the California Department of Fish and Game (CDFG) under the California Endangered Species Act in 1988 (Stone et al. 1988), and on March 26, 1997 the species received listing by the United States Fish and Wildlife Service (USFWS) as Endangered under the Federal Endangered Species Act (USFWS 1997). The California Native Plant Society (CNPS) includes Sacramento Orcutt grass as a CNPS List 1B.1 species and has assigned an R-E-D Code of 3-3-3, meaning it is distributed in several highly restricted occurrences, or present in such small numbers that it is seldom found and reported, it is endangered throughout its range, and found only in California (CNPS 2010).

7.2 Life History and Ecology

7.2.1 Species Description and Life History

Sacramento Orcutt grass is a member of the distinctive Orcuttieae Tribe of the grass family (Poaceae), a group of nine vernal pool species endemic to California and northern Baja California. The Orcutt grasses have been long recognized by botanists as highly evolved, ecologically unusual and naturally restricted (Hoover 1941; Crampton 1959; Reeder 1965, 1980, 1982).

As with other members of the tribe, Sacramento Orcutt grass is a relatively small-stature annual species. Its three to 10 centimeter-long, densely hairy-sticky stems are tufted and mostly erect to spreading with age. Like the stems and inflorescences, the two to four millimeter-wide leaves are also hairy and densely covered with a sticky, highly aromatic exudate. Small scale-bracted flowers (florets) are arranged in dense two-ranked, flattened spikelets that are more or less overlapping and clustered together into exserted terminal three to five centimeter-long spikes (Hickman 1993).

Sacramento Orcutt grass is most readily distinguished from its closest relatives California Orcutt grass (*O. californica)* and San Joaquin Valley Orcutt grass (*O. inaequalis*) on the basis of having five unequal lemma lobes with the central lobe being the longest, the large lemma size (six to seven millimeter), lemma awn length (greater than one millimeter), and comparatively long fruit (± 2.5 millimeter) (Hickman 1993). These morphological characters were first used to circumscribe the taxon as *O. californica* var. *viscida* (Hoover 1941). Subsequent study of morphology, chromosome number and seed protein composition justified elevation of both varieties *O. tenuis* and *O.inaequalis* to specific rank (Reeder 1980, 1982).

All Orcutt grasses are very highly evolved and uniquely adapted members of the endemic vernal pool flora. Their anatomy and physiology (Keeley 1981, 1990, 1998), morphology, and life history traits (Crampton 1959; Griggs 1974, 1980, 1981) are highly adapted to the stressful, more extreme portions of the vernal pool niche. Some adaptive traits (physiology, anatomy, morphological-distinct life history stages) confer ability of individuals to survive the varied stresses of a single hydrological season, while others (e.g., annual habit, precise germination cues, stored soil seed bank, indeterminate flowering, dispersal-limiting traits) confer population stability through time in the context of year-to-year hydrological uncertainties that characterize the prevailing Mediterranean Climate (Griggs 1980; Stone et al. 1988).

Evolution of the annual growth habit is a key adaptation of Sacramento Orcutt grass to vernal pool habitat, as is the case with almost all other vernal pool plants (Griggs and Jain 1983; Holland 1987). The annual growth habit allows populations to persist through the regular and extreme summer drought that is characteristic of California's vernal pool landscape (Stone et al. 1988).

Sacramento Orcutt grass seeds germinate during the later spring months after cessation of winter rains and as the shallow water at the pool margins begins to warm and recede (Griggs 1974; Holland 1987; Stone et al. 1988). A requirement of cold stratification followed by increasingly warm fluctuating diurnal temperatures and the presence of a symbiotic aquatic fungus that has been determined necessary for Orcutt grass seed germination (Griggs 1980, 1981; Keeley 1988). Sensitivity to these environmental cues ensures germination only during years with hydrological conditions favorable for plants to complete their entire life cycle (Griggs 1980, 1981; Stone et al. 1988).

Sacramento Orcutt grass is thought to be the most specifically adapted of the genus with regard to suitable hydrology (Stone et al. 1988). It has been observed to be the least likely to germinate during years of marginal precipitation (Holland 1987). During a 14 year-long observation period at one population (CNDDB Occurrence #15), it was determined that Sacramento Orcutt grass numbers peaked in years when heavy rains (greater than 40 centimeters [15.7 inches]) occurred in the period from November through April and vernal pools remained inundated longer than usual (Holland 1987).

Members of the genus *Orcuttia* develop long (approximately 10 centimeters), thin (one to two millimeters-wide) juvenile leaves that float on the water surface when seeds germinate under shallow water or when seeds become submersed shortly after germination (Hoover 1941; Griggs 1974, 1980, 1981; Reeder 1982). By facilitating light exposure and atmospheric gas exchange for photosynthesis while submersed, these amphibious juvenile leaves maximize vegetative growth before vernal pool dry-down (Griggs 1981; Stone et al. 1988; Keeley 1990).

Orcutt grass plants are able to produce most of their above-ground vegetative growth, as well as flowers and seed as the vernal pools dry down in late spring and early to mid-summer (Crampton 1959). Vegetative and phenological demographics appear to be largely determined by pool dry-down rate (Griggs 1974, 1980; Stone et al. 1988). Thus, mature fruiting plants in drying soil above the waterline and submersed seedlings further toward the center can occur simultaneously in a single pool.

Indeterminate growth of new stems and spikelets provides for prolonged productivity as seasonally available water allows (Griggs 1974, 1980). This habit may result in smaller plants with fewer flowers and seeds maturing earlier in the season at the pool margins, and later maturing, larger, more fecund plants towards the pool center. This morphological and phenological plasticity confers an adaptive advantage in the context of extreme seasonal fluctuations and the unpredictable year-to-year variability of the Mediterranean Climate (Griggs 1980; Griggs and Jain 1983; Stone et al. 1988).

Since Orcutt grasses mature in a terrestrial setting during the hotter, more xeric late spring and summer months, possession of the C_4 photosynthetic pathway and Krantz Anatomy (Griggs 1980; Keeley 1990, 1998) are important adaptive traits. This photosynthetic pathway allows plants to exchange atmospheric gasses with increased efficiency and concomitant reduction in water loss to evaporative transpiration. This permits the extended period of vegetative growth and reproduction of Orcutt grasses into the hot arid summer months after most other vernal pool associates have completely desiccated (Griggs 1980; Stone et al. 1988).

All Orcutt grasses possess an aromatic sticky glandular exudate on the stems, leaves and inflorescences. This trait, particularly well developed in Sacramento Orcutt grass, is thought to be advantageous both as an anti-desiccation (Hoover 1941; Crampton 1959) and anti-herbivory adaptation (Griggs 1974, 1980). Grasshoppers can exert significant herbivory pressures late in the season although it has not been noted for Sacramento Orcutt grass specifically.

Sacramento Orcutt grass plants flower and set seed as the margins and basin of the vernal pools dry from April through July (CNPS 2010). Detailed pollination and breeding experiments have not been conducted on this species. Like most other grasses, Orcutt grasses are thought to be primarily wind-pollinated out-breeders as indicated by protogynous floral maturation, strongly exserted anthers and measured patterns of genetic variation (Griggs 1980; Griggs and Jain 1983; Stone et al. 1988). In one instance, native solitary bees of the family Halictidae were observed collecting pollen from Sacramento Orcutt grass plants (Griggs 1974).

Seed production of Orcutt grass plants is known to vary greatly between individuals along moisture gradients within single pools, among populations between pools, and within pools between years (Griggs 1980; Griggs and Jain 1983). Fully mature Sacramento Orcutt grass individuals can produce from 0 to over 600 seeds per plant. Seed set in Orcutt grasses appears uncertain and dependent on precise synchrony of appropriate environmental conditions and phenological development (Stone et al. 1988).

After the growing season, the mature Sacramento Orcutt grass seeds are held tightly within maternal floral structures (lemma and pelea) on the inflorescence until the mechanical action of wind, heavy rain and winter inundation shatter the inflorescences and release the mature florets. This lack of dispersal is thought to be an adaptation to the very sparsely scattered distribution of suitable large vernal pools (Griggs 1974, 1980). It is an advantage for a large proportion of the seed crop to remain within the available large-pool habitat, rather than chance loss to unsuitable uplands. Even though dispersal is naturally limited, Orcutt grass colonization of pools was probably a more frequently occurring event in the historic past when there were likely more populations, many more pools, more pool interconnectivity, exceedingly larger waterfowl migrations, and unfenced roaming ungulates (Griggs 1980).

Not all *Orcuttia* seeds germinate every year, resulting in the buildup of a dormant soil seed bank (Griggs 1974, 1980, 1981). The soil seed bank is a critical adaptive barrier against local extinction events that could otherwise result from the unpredictable occurrence and duration of favorable growing conditions (Stone et al. 1988). In a study of one Sacramento Orcutt grass population, 44 seeds were found dormant in the soil for every one growing plant present (Griggs 1980; Griggs and Jain 1983). Between-population and between-year variation in soil seed bank density and the duration of seed viability in the soil is unknown. The soil seed bank also may contribute to overall genetic diversity of populations, as seeds stored over multiple years produced under varying growth conditions may harbor adaptive allelic combinations that are infrequently expressed or selected for.

Studies of seed weight and allozyme electrophoresis indicate that Orcutt grasses possess low levels of gene flow between populations, and high levels of gene flow within (Griggs 1980, 1984; Griggs and Jain 1983). This is to be expected given the highly insular distribution and seasonally dynamic nature of vernal pool habitat (Stone et al, 1988). These studies also revealed very high levels of genetic diversity within the seed families of individual plants, with almost 50 percent of each species' genetic variation represented in samples from one plant. In addition, approximately 80 to 90 percent of the total genetic diversity of each species was represented in each population (Griggs 1980, 1984; Griggs and Jain 1983). It should be noted that this study was limited to assaying four enzyme systems from two populations of Sacramento Orcutt grass.

7.2.2 Habitat Requirements and Ecology

Like all grasses in the genus *Orcuttia*, Sacramento Orcutt grass is strictly adapted to habitats possessing vernal pool-type hydrology. The tribe is thought to be a relatively ancient evolutionary group (Griggs 1981; Reeder 1982), descendant from a perennial ancestor related to the Chlorideae Tribe (Keeley 1998). The ancestral entity is thought to have inhabited the marshy margins of the Tertiary-age sea formerly covering the Great Central Valley (Axelrod 1973; Raven and Axelrod 1978). The evolving Orcuttieae lineage adapted to the increasing seasonal stresses as the Mediterranean climate developed and the inland water body receded.

Interestingly and of potential significance to conservation, Sacramento Orcutt grass appears to be the most specific of the genus *Orcuttia* with regard to niche breadth, as indicated by restriction to the largest of pools (Stone et al. 1988), comparatively poor seed germination during marginal hydrologic-seasons (Stone et al. 1988; Holland 1987), and highly limited geographic distribution.

Sacramento Orcutt grass is restricted to the older and more weathered high terrace alluvial landform that comprises the Laguna Geologic Formation (SCS 1993). Soils associated with Sacramento Orcutt grass vernal pools include the Red Bluff-Redding Complex (0 to 5 percent slopes), Redding Gravelly Loam (0 to 8 percent slopes), Corning Complex (0 to 8 percent slopes), and Xerarents-Urban Land San Joaquin Complex (0 to 5 percent slopes). These soils tend to be strongly acidic, an indication of age and weathering (SCS 1993). In addition to being acidic, these soils are gravelly with cobble, and in many places, they possess a shallow, water-impermeable iron-silica hardpan that favors the development of vernal pools (SCS 1993).

Natural restriction of Sacramento Orcutt grass to these alluvial terrace landforms and associated soil series may reflect the propensity of these soils and landforms to develop suitably large vernal pools with appropriate hydrological regimes. Holland and Dains (1990) have shown how landform and soil relate to hydrological characteristics of vernal pools, and how these factors may influence floristic composition. This distribution may also reflect on the biogeography of an old geological surface that has remained exposed and relatively undisturbed over geological time, away from lower elevation, more recent alluvial depositions.

Orcutt grasses are strongly adapted to the more extreme hydrological cycles encountered in the spectrum of vernal pool types (e.g., they are typically associated with larger or deeper vernal pools that tend to possess more extreme regimes of inundation) (Crampton 1959; Griggs 1974). Of the members of the genus *Orcuttia*, Sacramento Orcutt grass tends to occupy the larger, more hydrologic-extreme pools. Vernal pools occupied by Sacramento Orcutt grass documented prior to 1988 range in size from 100 square meters (~120 square yards) to 10 hectares (~25 acres), and among the 10 pools measured, the median pool size was found to be 2,800 square meters (~3,349 square yards) (Stone et al. 1988). Upslope watershed area (Area of Drainage) associated with occupied pools was reported by Stone et al. (1988) to range from 0.5 to 123 acres among the known occurrences.

Since 1988, additional smaller pools within one of the pool complexes located east of Mather Air Force Base were found to support this species (CNDDB Occurrence #6) (CDFG 2010). Even though Sacramento Orcutt grass can be found in smaller pools (as measured by surface area), it is important to consider that even these are relatively deep, exhibit characteristics of well-developed vernal pool hydrology (Preston 2002 pers. comm.), and are situated in relatively close proximity to more typical, large pools within the 123-acre drainage area reported by Stone et al. (1988).

Vernal pool hydrology has not been precisely defined for any of the Orcutt grasses. In general, ponding must be of sufficient duration and under the appropriate seasonal temperature regime to release the seeds from dormancy through decomposition of maternal floral structures in the presence of a symbiotic aquatic fungus (Griggs 1980; Griggs and Jain 1983; Keeley 1988). The depth or duration of pool inundation are also likely factors excluding other less specialized, but obligate, vernal pool species from the barren micro-sites located in the deeper parts of pools that are inhabited by Sacramento Orcutt grass.

Ponding cannot be so excessive though, as to foster the recruitment and proliferation of native perennial marsh species, in particular common spikerush (*Eleocharis macrostachya*) (Crampton 1959; Stone et al. 1988; CDFG 2010). This potentially aggressive rhizomatous species is usually only found in the deepest portions of the more well developed natural vernal pools. In such cases where it co-occurs with Sacramento Orcutt grass, the latter grows mostly in barren areas lacking the spikerush (Stone et al. 1988). Prolonged duration of ponding resulting from placement of berms, construction of road surfaces, or urban development in the vicinity of natural pools appears to have resulted in increase vigor of common spikerush with concomitant loss of Sacramento Orcutt grass vigor in three pools in the complex east of Grant Line Road (CNDDB Occurrence #6) (Jones and Stokes 1990, 1998). Hydrological alteration and proliferation of common spikerush may also have negatively affected Sacramento Orcutt grass habitat at two Phoenix Field occurrences (CNDDB Occurrences #5 and 15) and the occurrence immediately east of Mather Air Force Base (CNDDB Occurrence #17; Preston pers. comm.).

Sacramento Orcutt grass occurs in pools with other vernal pool endemics, including Howell's quillwort (*Isoetes howelii*), coyote thistle (*Eryngium castrense*), dwarf wooly marbles (*Psilocarphus brevissimus*), flowering quillwort (*Lilaea scilloides*), stalked popcorn-flower (*Plagiobothrys stipitatus*), common spikerush, pincushion navarretia (*Navarretia myersii* ssp. *myersii*), Bogg's Lake hedge-hyssop (*Gratiola heterosepala*), legenere (*Legenere limosa*), white-headed navarretia (*Navarretia leucocephala*), double-horned downingia (*Downingia bicornuta*), goldfields (*Lasthenia* spp.) and hairy pepperwort (*Marsilea vestida*) (CDFG 2010). Many of these other vernal pool species however, do not appear to tolerate the hydrologic extremes of prime Sacramento Orcutt grass habitat. They complete their life cycle earlier in the season, and are therefore confined to the shallower margins or slopes of the deeper pools that support Sacramento Orcutt grass (Crampton 1959; Stone et al. 1988).

Hydrological stresses associated with vernal pools, and Orcutt grass pools specifically, exclude the majority of non-native weedy species that characterize the present-day valley annual grassland, agricultural fields, and ruderal habitats. Italian wild rye (*Lolium multiflorum*) and Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*) are two non-native facultative wetland species that typically dominate disturbed wetlands and can be invasive in smaller, more ephemeral vernal pool types. They cannot however, tolerate the more extreme inundation regimes of deeper Orcutt pools. Thatch build-up from Italian rye grass, Mediterranean barley, Medusa-head grass (*Taeniatherum caput-medusae*), and other non-native upland species may indirectly affect vernal pool species by lessening the amount of water entering the system through surface and subsurface flow (Robins and Vollmer 2001)

Several non-native weedy hydrophytes may however, present problems within the deeper portions of occupied Orcutt pools through competitive exclusion (as with common spikerush). Mannagrass (*Glyceria occidentalis*), an aggressive weed of irrigated agriculture and degraded vernal pools has already been reported as a potential problem at two of the known Sacramento Orcutt grass populations (CNDDB Occurrences #16 and #17). Although not recorded from any Sacramento Orcutt grass populations, other non-native aggressive species that can become problematic in deeper Orcutt grass-type vernal pools include rosy Lippia (*Phyla nodiflora* var. *rosea*), field bindweed (*Convolvulus arvensis*), swamp pricklegrass (*Crypsis schoenoides*), Bermuda grass (*Cynodon dactylon*) and paradox canary grass (*Phalaris paradoxa*) (Dittes pers. obs.). Cocklebur (*Xanthium strumarium*), another native species, can also come to dominate portions of Orcutt grass-type pools (Schlising, Unger pers. comm.).

Appropriately timed dry-pasture livestock grazing regimes are generally thought to be compatible with Orcutt grass populations, and may even enhance habitat in situations where Common spikerush may otherwise predominate (Stone et al. 1988; CDFG 2010). By grazing from late fall, into early to mid-spring months, livestock are generally kept from the occupied portions of Orcutt grass pools by standing water, inundated soil and attraction to abundant green forage in the uplands. Most problems with livestock grazing arise from later spring and summer grazing regimes, when the Orcutt grass pools have dried and flowering and fruiting plants are exposed and vulnerable to trampling and cropping (Stone et al. 1988). In addition, during the later season when the upland forage has dried, the moist bottoms of vernal pools become highly attractive and may suffer increased trampling and hoof-pocking (Dittes pers. obs).

As an example of the role of timing in relation to potential disturbance response, Hoover (1941) and Crampton (1959) have reported Orcuttieae populations being completely disked in dry-farmed grain fields in the late fall, without apparent detriment to the populations the following growing season. It has been noted that the same disking performed during the late spring or summer growing periods may completely deplete the soil seed bank and extirpate the population if performed over successive years (Stone et al. 1988).

7.2.3 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for Sacramento Orcutt grass are identified in Table SAOG-1 and have been derived from the USFWS's list of primary constituent elements in the final rule designating critical habitat for the species (USFWS 2005) as well as input from local species experts.

Table SAOG-1
Essential Habitat Elements for Sacramento Orcutt Grass

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, vernal pool, and vernal swale.	Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools, providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and non-native upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

7.3 Species Distribution and Population Trends

7.3.1 Species Distribution

Sacramento Orcutt grass occurs only in southeastern Sacramento County near the juncture of the Sierra Nevada foothills and eastern edge of the Sacramento Valley, qualifying it as the most geographically restricted member of the genus *Orcuttia*. There are no historic records or collections of this species made outside of this area (Stone et al. 1988; CDFG 2010). This distinction may partially reflect the previously mentioned observations of Holland (1987) and Stone et al. (1988) regarding its relatively high level of ecological specialization and comparatively narrow habitat requirements. This distribution also may reflect the fact that the largest, most hydrological stable pools located at lower topographical positions in the Central Valley were the first to have been lost to agriculture in the latter 19th and early 20th centuries, before the pioneering collections of Hoover and Crampton were made.

7.3.2 Central Valley Distribution

Sacramento Orcutt grass occurs within a narrow swath of remnant high terraces that lay near the juncture of the Northern Sierra Nevada Foothill and Sacramento Valley Biogeographic Provinces (Hickman 1993), between 110 and 270 feet in elevation (CDFG 2010). The recorded range of the species extends in a narrow band of habitat from the terrace just north of the American River in the vicinity of Orangevale, south approximately 26 miles to the vicinity of Rancho Seco Lake on the Arroyo Seco Mesa (see Figure SAOG-1 for the distribution of records of Sacramento Orcutt grass within Sacramento County).

Nine extant (and one extinct) CNDDB occurrences are recorded from within this narrow north-to-south oriented band (CDFG 2010). These ten CNDDB occurrences are clustered among three geographically defined regions, hereafter referred to as the northernmost, central, and southernmost population centers (CDFG 2010).

The northernmost of the three Sacramento Orcutt grass population centers, located on the alluvial terrace north of the American River, is comprised of three CNDDB occurrences. The northernmost occurrence, located near Orangevale, is extinct (CNDDB occurrence #4). One occurrence, comprised of one occupied vernal pool, is located further south at Phoenix Field (CNDDB occurrence #5). An artificially introduced population is located in a single vernal pool at nearby Phoenix Park (CNDDB occurrence # 15). It has been suggested that since the Phoenix Park Occurrence has established from seed derived from the Phoenix Field occurrence, the two are best considered as one genetic population. The northernmost population center (CNDDB occurrences #4, #5, and #15) is located outside of the Plan Area.

7.3.3 Range within the Plan Area

The central population center is located on the terrace landscape east of Mather Air Force Base in the vicinity of the Laguna Creek watershed. As measured by the number of CNDDB occurrences, number of occupied pools and past estimates of the number of individuals, this population center comprises the core of the species' currently known distribution (CDFG 2010; Stone pers. comm. 2002). Within an area spanning approximately seven miles by four miles, six CNDDB occurrences are known. This central Sacramento Orcutt grass population center lies within the Plan Area, however four of the occurrences are included within the UDA (CNDDB occurrences #17, #18, #19 and #20) and two occurrences are in the Keifer Landfill area outside of the UDA (CNDDB occurrences #1 and #6).

The southernmost population center, comprised of just one occurrence (CNDDB occurrence #16), is located approximately three miles north of the Sacramento-San Joaquin County Line near Rancho Seco Lake. This population is located approximately 14 miles south of the next nearest population. This southernmost site is located within the Plan Area, but outside of the Sacramento UDA. Though the distribution of the species is extremely disjunct, the range of the species in the Plan Area is considered to be vernal pools and vernal impoundments.

7.3.4 Population Levels and Trends

It is impossible to determine the number of historically occurring Sacramento Orcutt grass populations or the acreage of suitable habitat lost to historic agricultural land-use conversions, since so much had happened before these species first received attention (Stone *et. al*. 1988). Investigators have made estimates as to the acreage of vernal pool habitat lost since historic times (Holland 1978). Owing to habitat specificity (restriction to largest pools), only a subset of the vernal pool habitat lost within the natural range of the species likely provided suitable habitat for Sacramento Orcutt grass (Stone et al. 1988). Concerns over loss of Orcutt grass populations and habitat were expressed beginning with some of the earlier investigators (Hoover 1941; Crampton 1959, 1976; Griggs 1974).

The first collections of Sacramento Orcutt grass were made by Hoover in 1941. At that time, much habitat had already been lost, including some of the larger, lower terrace pools that occupied sites most favorable to agricultural development. Since 1941, a total of only 30 occupied vernal pools have been recorded, two of which (CNDDB occurrence #4 and portion of CNDDB occurrence # 6) were extirpated by 1988 (Stone et al. 1988, CDFG 2010). By 1991, the USWFS stated that the trend for Sacramento Orcutt Grass is one of rapid decline (USFWS 1997).

There has been no comprehensive effort to monitor all populations of Sacramento Orcutt grass. Informal monitoring projects have been conducted by the CDFG at the Phoenix Field Ecological Preserve, by Holland at the Phoenix Park Vernal Pool Preserve, and by Jones and Stokes at the Kiefer Landfill sites (Preston pers comm.). Stone et al. (1988) also provided estimates of populations at all occurrences visited in 1986 and 1987. Population estimates recorded for Sacramento Orcutt Grass are summarized in Table SAOG-2.

Table SAOG-2
Sacramento Orcutt Grass Population Estimates for Eastern Sacramento County

CNDDB Occurrence #	Occurrence # of pools observed	Range of population estimates
1	1	1986-87: "numerous" 1995: 400,000 1998: 138,000
5	1	1986: >200,000 1994-96: >100,000 1997: 9,500
6	6-19	1990: "thousands" 1995: >1,000,000 1998: 129,000
15	1	1978: (0) pool seeded 1985: >1,000 1986: >10,000 1991: >1,000 1995: ~ 100,000 1996: 35 1997: 1,000
16	1	1986: ~500 1987:200 1993: < 20 (M. Gause) 1995: 300
17	1	1987: >10,000 1995: >10,000
18	1	1987: 1,000
19	4	1994: "hundreds" 1995: 1,200,000
20	Unknown	Unknown

Source: CDFG 2010; Stone et al. 1988

These data (**Table SAOG-2**), and the research of others indicate that abundance within Orcutt grass populations varies greatly between species, between populations within species, and within populations through years (Griggs and Jain 1983; Holland 1987). This extreme population variability is attributable to interactions of seed dormancy, early seedling survivorship, and average seed set per plant, as principally determined by seasonal and between-year limitations in available moisture (Griggs and Jain 1983; Holland 1987). Fluctuations of similar magnitude are also recorded for hairy Orcutt grass (*Orcuttia pilosa*), slender Orcutt grass (*Orcuttia tenuis*), and Greene's tuctoria (*Tuctoria greenei*) at the Vina Plains Preserve in Tehama County (Alexander and Schlising 1997).

Observations made over a decade or so may provide a reasonable indication of the short-term vigor of a given Orcutt grass population. It is important to consider however, that in order to assess the trend of the species, long-term monitoring of both habitat and populations conducted over multiple cycles of wet and dry years is needed. Another aspect of population demography is the quantity and age of stored seed in the soil profile. Undoubtedly, the number of stored seeds in the soil profile has bearing on how many plants can be produced in a given favorable year.

7.4 Threats to the Species

Potential direct threats to Sacramento Orcutt grass include loss of vernal pool habitat to agricultural or urban/industrial land-use conversions, construction and maintenance of firebreaks, roads, and utility corridors, inappropriate livestock grazing regimes (later spring/summer rotations), grassland fires, recreational vehicles, equestrian and pedestrian traffic, and refuse dumping.

Potential Indirect threats to Sacramento Orcutt grass include hydrological alteration of sub-watersheds by surrounding developments and land uses, shifts in competitive interactions (hydrology-mediated or invasive weeds), windblown refuse accumulation, point and non-point source water pollution, air pollution, and global climate change.

Preserves currently established or in the process of becoming established that include Sacramento Orcutt grass are the Sunrise-Douglas Mitigation Bank and the Kiefer Landfill Wetland Preserve. The Sunrise-Douglas preserve encompasses approximatly 480 acres of vernal pool annual grassland habitat supporting two CNDDB occurrence (CNDDB occurrence #17 and #18). The proposed Kiefer Wetland Preserve will encompass two CNDDB occurrences (CNDDB occurrence #1 and #6), encompassing 19 occupied pools, and an undetermined number of acres of annual grassland vernal pool habitat. The remaining Sacramento Orcutt Grass Occurrences in the Plan Area (CNDDB occurrences #16, #19 and #20) remain unprotected.

The USFWS has designated critical habitat areas for Sacramento Orcutt grass that encompasses all of the known 0ccurrences and a large portion of the remaining potentially suitable habitat.

7.5 Data Gaps and Conservation Implications

Grasses of the Tribe Orcuttieae, including Sacramento Orcutt grass, are among the most studied and best known of all vernal pool plant species and vernal pool species assemblages. As previously discussed, researchers have variously addressed taxonomy and biogeography, biology, ecology, breeding system, population genetics, habitat relationships, population levels, trends and threats. Even with the attention of researchers and relatively extensive body of information, data gaps with varying implications for conservation remain including:

7.5.1 What Constitutes Population Vigor, and How to Measure?

Population vigor will need to be monitored during the life of this SSHCP, yet a good measure of Orcutt grass population vigor is difficult to define, given the highly variable year-to-year abundance within populations (Holland 1987; Griggs pers. comm. 2003). The contribution of the stored soil seed bank to population numbers and population genetic diversity is an important, but currently unknown factor as well. Furthermore, even if a trend at the population level is discerned, causative factors contributing to year-to-year population fluctuations may be very difficult to identify (Alexander and Schlising 1997). Therefore, trends may occur that are not discernable and trends that are discerned may be unexplainable. These factors will complicate attempts to change management for benefit of the species if measured vigor shows decline.

7.5.2 Specific Hydrological Requirements of Sacramento Orcutt Grass

Numerical data do not exist regarding specific parameters of the annual hydrological cycle of vernal pools supporting Sacramento Orcutt Grass populations (e.g., timing of rainfall, depth of ponding, duration of ponding and soil dry down rate). At the same time, It is also important to note that Sacramento Orcutt Grass is cited as one of the more specifically adapted species of the genus, inhabiting the more well-developed of vernal pools, and one of the least likely to germinate during years with marginal precipitation (Holland 1987; Griggs pers. comm.). The general lack of numerical hydrological data limits the ability to precisely monitor or assess hydrological suitability of Sacramento Orcutt Grass-vernal pool habitat within established preserves. Similarly, assessment of potentially suitable Sacramento Orcutt grass habitat for preserve establishment or for detection of the species at this time must rely on generalities. Once preserves for existing Sacramento Orcutt grass populations are established, assessed and monitored over time, a more quantifiable definition of suitable Sacramento Orcutt grass -vernal pool hydrology may be developed.

7.5.3 Baseline Hydrological Trend of Pools and Existing Indirect Effects

Most of the Sacramento Orcutt grass populations have already experienced some degree of hydrological modification resulting from development-related alterations to sub-watersheds. Without complete protection of entire vernal pool watersheds, or precise hydrological monitoring and accurate modeling on a pool complex-scale, long-term indirect effects resulting from existing alterations to sub-watershed hydrology are unknown. Baseline Sacramento Orcutt grass conditions for the SSHCP are not pristine, so if trends in vigor or habitat quality become apparent during the 50-year period or at some time beyond, it may be difficult to attribute trend to any specific management activity.

7.5.4 Definition of Appropriate Hydrology Buffer

There is no standard for appropriate scale of effective hydrologic buffers for vernal pool-annual grassland ecosystems, since the nature of vernal pool complexes and their geo-hydrological relations may vary substantially by geography (Holland and Dains 1990). The geo-hydrologic investigation of Hanes and Stromberg (1998), conducted at a single site over three years in eastern Sacramento County, addresses aspects of vernal pool hydrology that are important to consider in formulation of hydrological buffers (e.g., relationship between pool basin hydrology and surrounding upland soil profile).

Proposed preserve designs may not afford complete protection to the hydrological systems that support Sacramento Orcutt grass and other species assemblages dependant on them without more information on appropriate scale hydrologic buffers.

7.5.5 Definition of Appropriate Scale Sacramento Orcutt Grass -Vernal Pool-Annual Grassland Preserve

There is no standard for appropriate scale of effective Sacramento Orcutt grass -vernal pool preserves. It is a paradigm of conservation biology that “bigger is better” for a variety of well-documented reasons. Conservation challenges associated with the relatively small-scale Sacramento Orcutt grass -vernal pool preserve at Phoenix Field and Phoenix Park are well documented and reflect consequences of increase edge effect associated with smaller preserves (Clark et al. 1998). Proposed preserve designs may not afford complete protection to the ecosystems that Sacramento Orcutt grass and other species assemblages depend on without more information on appropriate scale of preserve area.

7.5.6 Determination of an Appropriate Livestock Grazing Regime

Livestock grazing will occur in at least some of the Sacramento Orcutt grass -vernal pool preserves, primarily for purposes of upland annual grassland vegetation management. Specific grazing regimes have not been formulated for annual grassland pasture systems with Sacramento Orcutt grass -occupied pools, although grazing and monitoring in similar systems have been addressed (Barry 1998; TNC 2000; Griggs 2002; Robins and Vollmar 2002; Burmester pers. comm). It is important to note that Sacramento Orcutt grass and other members of the Orcuttiae tribe do persist though, in historically and contemporary operating livestock ranches. At a minimum, compatibility with some level of grazing is evidenced by persistence of the species in these systems.

Presently, Witham et al. are formulating site-specific livestock grazing regimes for annual grassland-vernal pool systems in an area of Sacramento County (Witham pers. comm.). Livestock grazing regimes in Sacramento Orcutt grass -vernal pool preserves covered under the SSHCP will tier towards the results of this work, as well as to the specific needs of Sacramento Orcutt grass. Specific livestock grazing regimes cannot be formulated until preserve size, configuration, and soil and vegetation conditions and vegetation management goals are determined.

With regard to compatible grazing regimes, timing of grazing appears far more important than stocking rate, grazing intensity, or duration of rotation in annual grassland pasture systems that support Orcutt grass-occupied vernal pools (Stone et al. 1988; Griggs 2000; Griggs pers. comm.). During the inundated period of the vernal pool cycle (generally late fall through mid-to late spring), germinating seed and establishing aquatic-phase seedlings are afforded protection from trampling and grazing by a general aversion of cattle to standing water, as well as attractive forage in uplands. Even if some cattle congregate at the edge or meander into or across the pools while inundated, germinating seeds in the deeper portions of the pools are unaffected, the vast majority of the pool substrate escapes trampling and nothing is eaten.

Conversely, grazing during the dry-down period or terrestrial phase, when plants are flowering and setting seed can be detrimental to the season's flowering effort and seed crop (generally mid- to late spring through the summer and early fall months). Given multiple years of improperly timed grazing and seed loss (both from standing crop and exhaustion of soil seed bank), populations may decline in vigor and may even be extirpated.

7.5.7 Interactions with Non-Native Weeds and Weed Management Activities

Non-native weeds, or weedy native species reported as occurring in Orcuttiae-occupied vernal pools include western mannagrass, swamp pricklegrass, Bermuda grass, common spikerush, field bindweed, lippia, paradox canary grass and cocklebur. Of these, western mannagrass and common spikerush presently co-inhabit Sacramento Orcutt grass -occupied vernal pools. Any of these, as well as currently unknown, species may appear or change in abundance in Sacramento Orcutt grass -occupied pools over time.

Potential competitive interactions with these species may affect the vigor of Sacramento Orcutt grass populations. In addition, any eradication or control methods implemented for these species may in turn potentially affect Sacramento Orcutt grass populations

7.5.8 Unknown Relationship Between Landform/Soil Chemistry and Bio-Geographic Distribution

As previously mentioned, Sacramento Orcutt Grass has a strong geographic association with old alluvial terraces possessing soils primarily of the Redding, and to a lesser extent, Red Bluff Families (Laguna Geological Formation). This association has proven useful in predicting the location of new populations, as indicated by the southernmost discovery on Llano Seco Mesa (Stone 2002 pers. comm.). The exact nature of this relationship is however unknown. Does pH or some other factor influence Orcutt grass population vigor, or do soil associations with tendency to develop and support large vernal pools/hydrology, regardless of landform and soil pH, provide suitable habitat?_From the perspective of Sacramento Orcutt grass conservation, this uncertainty has bearing on the definition of potentially suitable habitat, which guides surveys and establishment of habitat preserves.

7.5.9 Potential Association and Compatibility with Other Rare Vernal Pool Species

It is desirable to design preserves for multi-species conservation. Suitability of Sacramento Orcutt grass habitat for supporting other rare plant species has not been specifically addressed, although natural populations of the rare pincushion navarretia, Bogg's-Lake hedge hyssop, and legenere are documented as sharing specific vernal pools with Sacramento Orcutt grass. Many of these pool complexes also may provide habitat for rare invertebrates, amphibians, mammals, and bird species as well._Management for the benefit of one species may conflict with management needs of other rare species. For instance, livestock grazing anytime between November 1st and May 1st may benefit Sacramento Orcutt grass -associated pool complexes, but may be detrimental to ground-dwelling amphibians depending on those complexes (e.g., California tiger salamander).

7.5.10 Genetic Considerations (Spatial and Temporal Variation, Seed Bank, Drift, Bottlenecks)

It has been determined that *Orcuttia* populations are genetically isolated as well as diverse, the latter both within and between pools (populations), and within the "seed family" of a single reproductive plant. In addition, there is a high degree of localized adaptation and strong intra-pool selective pressures (Griggs 1980; Griggs and Jain 1983). However, investigations of Sacramento Orcutt grass population genetics have been limited to measures of seed size and weight (genetically fixed traits) within and among populations, and electrophoretic study of four enzyme systems in only two populations. These analyses represent a very small portion of the genome and allow limited interpretation of patterns of genetic diversity and limited inference as to uniqueness of a given population. Another potentially important consideration is that there has been no assessment of the "genetic memory" potentially associated with stored seeds in the soil seed bank. Elam (1996) provides a good overview of the myriad considerations in assessing the population genetics of vernal pool plants in the absence of empirical data for a given taxon.

Current limitations in our understanding of Sacramento Orcutt grass population genetics have little immediate conservation implication, given that no take of Sacramento Orcutt grass will be allowed under the SSHCP. If experimental inoculation of pools is proposed as part of the SSHCP, or as part of the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005), appropriate measures will be developed to ensure that seed collection, seed treatment and pool inoculation methods are consistent with what we know and do not know about Sacramento Orcutt grass ecology and population genetics.

7.5.11 Critical Population Size

Critical population size is a statistical estimate that defines the minimum number of individuals required for a population to maintain itself over generations through time. This population parameter has been determined for assorted wildlife and some perennial plant species. The most simplistic estimations take into account recruitment rates of individuals into the population via reproduction and immigration, and removal rates of individuals from that same population via death and emigration.

Since Sacramento Orcutt grass is an annual species, its population sizes are known to be highly variable from year to year, and the soil seed bank constitutes an important demographic component of the population, definition and assessment of a critical population size is impracticable and lacks ecological meaning.

Knowledge of critical population size provides an ecologically meaningful and quantifiable benchmark for adaptive management purposes (e.g., if monitored populations drop to within 30 percent of critical population size, site-specific analysis, appropriate management changes and additional monitoring should occur). This is not possible for annual species, so other measurable benchmarks are needed. For purposes of the SSHCP, it may best be assumed that assessment of multi-year population vigor trends along with habitat condition may better serve as an indicator of long-term population viability, rather than trying to define what a critical number of individuals required for population viability might be.

7.5.12 Seed Longevity and Dynamics of Stored Soil Seed Bank

As previously mentioned, it appears that Sacramento Orcutt Grass populations depend on a substantial reserve of dormant seed stored in the soil as a buffer against single year and multiple-year cycles of unfavorable hydrological conditions. This population parameter has only been measured in a few pools during one growing season (Griggs 1980). There have been no other studies addressing spatial or temporal variability of seed abundance in the soil seed bank or longevity of dormant seeds. From the perspective of conservation, knowledge of site-specific soil seed bank characteristics would allow more accurate assessment of population size and stability (vigor). This is particularly true of populations that typically support the fewest standing individuals through time.

7.5.13 Unknown Aspects of Experimental Inoculation

Since there are so few natural populations of Sacramento Orcutt Grass, species viability may be significantly enhanced by inoculating unoccupied, apparently suitable pools and increasing the number of naturally self-sustaining populations. These additional populations would increase the likelihood of natural dispersal events into preserved, but unoccupied Sacramento Orcutt grass habitat, create meta-population structure at extant occurrences where single pools now support the species, and ensure existence should any natural populations become compromised.

In addition to complete protection and enhancement of natural populations, it has been suggested that experimental inoculations may be desirable for Orcuttieae conservation (Griggs and Jain 1983; Griggs pers. comm.). The experimental establishment of one population at Phoenix Field (CNDDB occurrence #15), now 25 years-old, provides some indication of the probably success of inoculating suitable habitat and creating self-sustaining populations. However, not all experimental inoculations attempted during the research of Griggs were "successful" (Griggs pers. comm.), and the population genetics and long-term viability of the artificially inoculated population are unknown.

Uncertainties regarding the political ramifications and ecological effectiveness of experimental inoculation lead the conservation community and Agencies to not consider experimental inoculation as an appropriate conservation goal. Given the ecological characteristics of Sacramento Orcutt grass though, preservation of unoccupied potentially suitable Sacramento Orcutt grass habitat alone will likely do little for the conservation or recovery of this species.

7.5.14 Air Pollution (Dust/Ozone/Nitric Oxide, Sulphur Dioxide

Portions of the Central Valley of California frequently exceed State and Federal safety levels for a variety of air pollutants, including particulate matter. ozone, and others. Some of these pollutants are known to negatively affect plant physiology and health, although none have been investigated as they relate to vernal pool vegetation. Assuming that extant Sacramento Orcutt grass occurrences are maintaining their vigor at existing ambient pollution levels, air pollution will probably not present a major threat to the viability of Sacramento Orcutt grass, if existing air quality can be maintained. If however, California's human population increases as projected and air pollution control measures are not developed and implemented concomitantly and effectively, these pollutants may negatively effect Sacramento Orcutt grass and other native plant species. If air pollution becomes such a problem that Sacramento Orcutt grass is affected, few management options will exist to change conditions for this species.

7.5.15 Effects of Global Climate Change

The scientific community commonly accepts as valid the phenomenon of increasingly rapid global climate change. Specific climatic models for California predict an average increase in temperature over the coming decades, with concomitant unpredictability in annual rainfall patterns. There is uncertainty regarding the exact nature and extent of these changes, as well as the consequences these changes pose to conservation biology. It is likely that given the expected global climate trends, a vigor response of some kind could be expected for Sacramento Orcutt grass populations within the 50-year implementation period of the SSHCP, or at some time beyond.

7.5.16 Unknown Number of Undiscovered Populations

Additional unsurveyed potentially suitable habitat exists within the Plan Area, principally on the larger private dry-land ranches that harbor well-developed vernal pools and vernal pool complexes. Authorities generally consider Sacramento Orcutt grass as one of the more completely understood species with regard to distribution and frequency (Stone, Taylor, Macdonald, Griggs, 2002 pers. comm.), owing primarily to typical association with only the best developed of vernal pools and seemingly natural restricted range. However, it is also acknowledged that a limited number of additional populations could be yet discovered as the remaining large tracts become surveyed. It is very unlikely however, that enough populations remain to be discovered to justify a future change in the conservation status of Sacramento Orcutt grass (Stone, Taylor, Witham, Griggs pers. comm.).

It is assumed for the SSHCP that most, but perhaps not all, extant populations of Sacramento Orcutt grass are already known. It is further assumed that since there are so few natural populations and the probability of finding a substantial number more is low, that all populations yet discovered are of great conservation importance and should receive the same protection and management.

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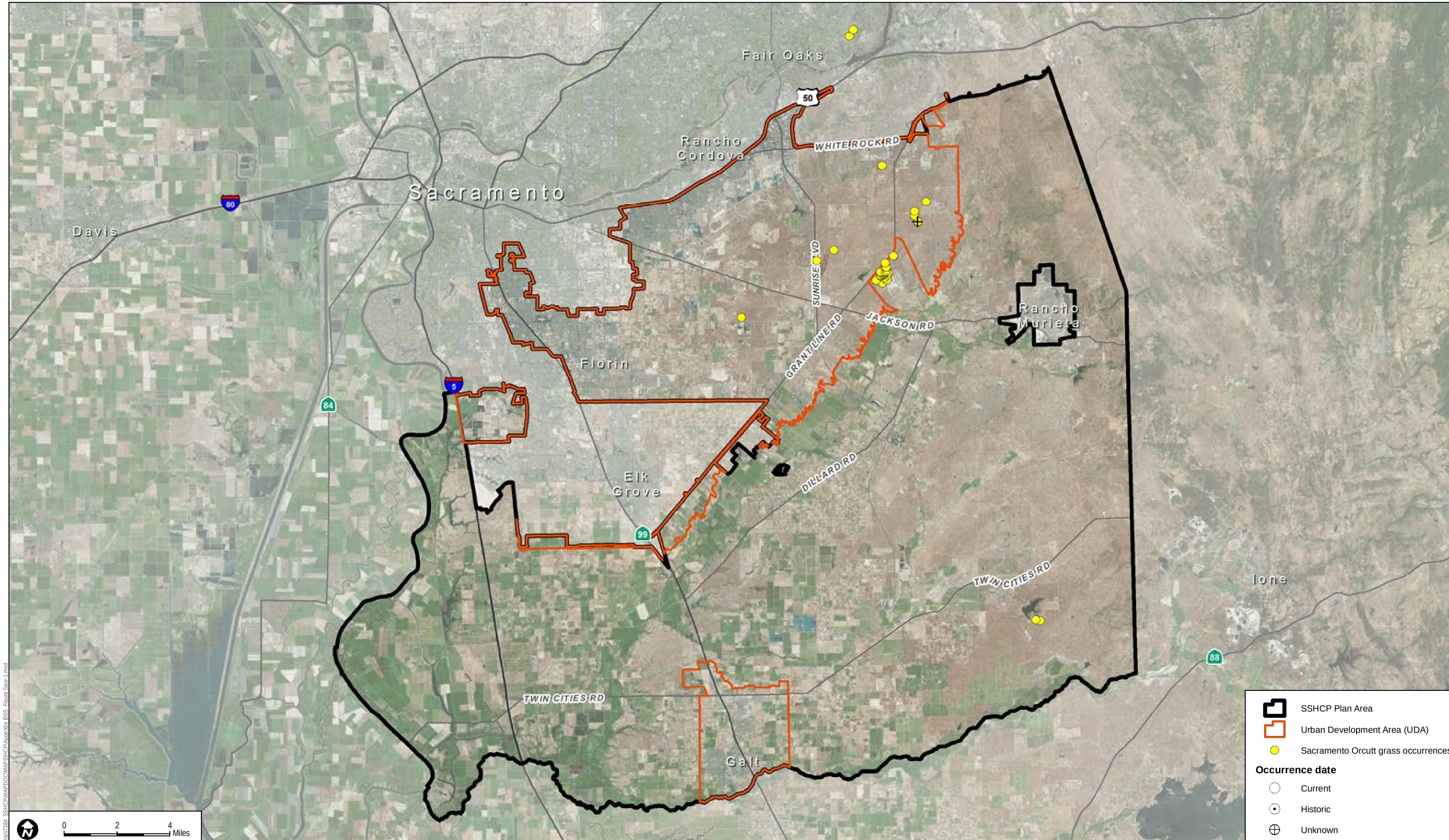

SOURCE: Bing Maps, County of Sacramento 2012

FIGURE SAOR-1

Sacramento Orcutt Grass Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

Path: Z:\Projects\Sacramento County\7384_SSHCP\MAPDOC\MAPS\HCP\Appendix B\05_Figure Saor-1.mxd

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8 SANFORD'S ARROWHEAD (SAAR)

Prepared by Dittes and Guardino Consulting (John Dittes and Josephine Guardino)

Sanford's Arrowhead (SAAR)

(Sagittaria sanfordii Green)

Status USFWS: None

Status CDFG: None

Status CNPS: List 1B.2

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8.1 Legal Status

Sanford's Arrowhead (*Sagittaria sanfordii*), an obligate wetland species, is considered to be rare, threatened or endangered throughout its range, thus qualifying its designation as a list 1B.2 species by California Native Plant Society (CNPS 2010). It has been assigned an R-E-D Code of 2-2-3, meaning it is distributed in a limited number of occurrences, occasionally more if each occurrence is small, it is endangered in a portion of its range, and entirely restricted to California.

Being a CNPS List 1B.2 plant species, Sanford's Arrowhead meets the definitions of Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 of the California Endangered Species Act (CESA) of the California Department of Fish and Game (CDFG) Code, and is eligible for state listing. It is mandatory that all CNPS 1B species be fully considered during preparation of environmental documents relating to California Environmental Quality Act (CEQA) (CNPS 2010). Owing to its relatively limited geographic range and ongoing and potential future threats, Sanford's Arrowhead may become a candidate for future agency listing.

8.2 Life History and Ecology

8.2.1 Species Description and Life History

8.2.1.1 Physical Description

Sanford's Arrowhead is a perennial member of the water plantain family (*Alismataceae*). This emergent marsh species possesses a thin elongate underground stem (rhizome) that produces small [8-15 millimeters (0.3-0.6 inches) –wide] spherical tubers (corms) at their apices. New plants (clones), comprised of a cluster of leaves and one to several inflorescence stalks, grow from these tubers at the onset of the growing season. Emergent leaves possess sheathing stalks and range from two to ten decimeters (~8-39 inches) in length. The leaves are completely linear and three-angled, or they may possess a narrowly elliptic to lanceolate blade that ranges from five to 15 centimeters (~2-5.9 inches) in length (Mason 1957; Hickman 1993). Plants tend to grow in colonial patches.

The inflorescence is comprised of a naked stem bearing several whorled-series of flowers near the apex. The lowermost inflorescence whorls are typically comprised of three female flowers and the upper whorls are comprised entirely of male flowers. Both male and female flowers possess three white roundish petals with entire margins, as well as three small green narrowly triangular sepals. The petals are deciduous, and as the fruits mature, the flower stalks elongate to two to three centimeters (0.8-1.2 inches) and curve downward relative to the inflorescence axis. Fruits are arranged in dense ovoid head-like clusters, and from a distance superficially resemble green berries. Individual fruit are narrowly flattened side-to-side and possess a small lateral beak at the apex (Mason 1957). Initially, the emergent inflorescence stalk is erect and shorter than the leaves. As the fruits mature the entire inflorescence may recline and float on the surface of the water.

Sanford’s Arrowhead is distinguished from its close relatives on the basis of its emergent leaves being narrowly linear to narrow-ovate or lanceolate, in contrast to the sagittate (arrowhead-shaped) leaves of the other Arrowhead species. In addition, only in Sanford’s Arrowhead do the stalks of the maturing fruit thicken and curve downward relative to the inflorescence axis; the others possess stalks that remain un-thickened and curved upward (Hickman 1993).

Other than basic taxonomic and biogeographic treatments (Mason 1957; Hickman 1993), Sanford’s Arrowhead is mostly unstudied. Existing biological and ecological information is derived mostly from observations of field botanists, primarily as a result of land management and agency-related resource surveys (Gause and Burmester pers. comms.).

Other species in the genus *Sagittaria*, have been variously studied with respect to breeding systems and reproduction (Wooten 1971; Kaul 1985; Delesalle and Muenchow 1992; Muenchow and Blum 1994; Muenchow 1998; Sarkissian et al. 2001; Huang 2003), dispersal and population dynamics (Gordon 1996), seed germination (Keddy and Constabel 1986; Gordon 1996; Leck 1996), seedling-hydrology relations (Keddy and Ellis 1985; Delesalle and Blum 1994), fish and wildlife interactions (Gruenhagen and Fredirickson 1990; Hohman et al. 1990; Muenchow and Delesalle 1992; Gough and Grace 1998; Evers et al. 1998), competitive interactions and community relations (Shaffer et al. 1992), and population genetics and rare plant conservation (Newberry 1991; Edwards and Sharitz 2000). Where applicable, information derived from studies of related Sagittaria species is referenced here for Sanford’s Arrowhead.

8.2.1.2 Ecological Life Cycle

Sanford's Arrowhead shares the perennial clonal growth habit with the vast majority of other endemic emergent marsh plants. Thin elongate rhizomes produce ovoid tubers (corms) at their tips that allow the plant to persist within the submersed substrate through the dormant winter season. New plants (clones) are produced from these tubers at the onset of favorable growing conditions (Mason 1957). Observations have also been made of a Sanford's Arrowhead colony reappearing with vigor following a year during which the habitat failed to flood and aerial leaves and stems were completely absent (Gause pers. comm.). The ability of this colony to withstand at least one year of unfavorable hydrologic conditions and then reappear with vigor is likely attributable to the dormant rhizome and associated tubers/corms.

8.2.1.3 Seed Germination

Seed longevity, after-ripening, dormancy characteristics, germination requirements and optima for Sanford's Arrowhead have not been investigated. Similarly, no observations have been recorded or are otherwise available relating to seed ecology, germination or seedling growth in the field. Many marsh species exhibit soil-seed banking as a dynamic of their population ecology. This trait is unknown for Sanford's Arrowhead.

8.2.1.4 Vegetative Growth

Little is known regarding the dynamics of vegetative growth of Sanford's Arrowhead (e.g., growth rates, rhizome elongation rate or rhizome length, time to reproduction, clone longevity, physiological adaptations, etc.). Sanford's Arrowhead colonies have been observed to persist in a vegetative state throughout the year, without significant seasonal dieback of leaves (Gause pers. comm.).

8.2.1.5 Reproduction

Like many perennial marsh species, Sanford's Arrowhead reproduces asexually by dispersal of fragmented rhizomes and tubers, as well as sexually, via flowering and seed production. The relative contributions of asexual and sexual reproduction to population dynamics (e.g., dispersal, colonization, population growth and maintenance) likely vary by the type of aquatic system (isolated and static versus interconnected and flowing), and the nature of seasonal disturbances (flood, scour, trampling, waterfowl foraging, dredging and other ditch maintenance, etc.).

Sanford's Arrowhead flowers from May through October. As previously mentioned, this species has separate male and female flowers within a single inflorescence. Although pollination and breeding experiments have not been carried out for Sanford's Arrowhead specifically, the separate male and female flowers and well-developed petals suggest an outcrossing breeding system. Pollination ecology of Sanford's Arrowhead has not been investigated. For two other Sagittaria species, principal flower visitors appeared to be generalist bees as well as assorted wasps and flies (Muenchow and Delesalle 1994). Fecundity has not been addressed for Sanford's Arrowhead.

8.2.1.6 Dispersal

Many perennial marsh species exhibit a comparatively wide geographic range and low morphologic variability (Mason 1957). This may reflect high dispersal potential associated with interconnected watercourses and with actions of migratory waterfowl. Waterfowl, muskrats, beavers and other wildlife readily consume all parts of some Sagittaria species, including seeds and tubers (Mason 1957). In addition, floodwaters likely disperse mature fruits and seeds, as well as fragmented rhizomes and associated tubers.

Evidence of long-distance dispersal and colonization exists in the overall geographic distribution of Sanford's Arrowhead in California, with disjunct northern and southern populations in Del Norte and Orange Counties, respectively. As with other wetland species, natural dispersal of seeds was likely a more frequent event when there were many more wetland acres, more interconnectivity, exceedingly larger waterfowl migrations and unfenced roaming native ungulates.

8.2.1.7 Seed Dormancy

Seed dormancy and stored soil seed banks are characteristics shared by many perennial marsh species. These traits however have not been investigated for Sanford's Arrowhead specifically. In perennial marsh species, the presence of a persistent soil seed bank may facilitate recolonization following prolonged periods of drought. A soil seed bank also ensures germination within barren topographic-hydrologic positions made newly available as water levels recede within drought-affected basins. Perenniating tubers/corms and rhizomes may buffer colonies against at least one year of drought; dormant seeds in the soil profile may further assure persistence over longer periods. Recruitment from persistent seed banks may also contribute over time to genetic diversity of populations that are potentially dominated by clones arising through high rates of vegetative reproduction (Edwards and Sharitz 2000).

8.2.1.8 Population Genetics

Population genetics of Sanford's Arrowhead have not been investigated, so intra- and inter-population patterns of genetic variability are unknown. Given the limited number of occurrences in the Plan Area and the widely scattered geographical distribution, all Sanford Arrowhead occurrences should be considered unique, and for the purposes of conservation, important genetic entities.

8.2.2 Habitat Requirements and Ecology

8.2.2.1 Biogeography and Landform Relations

Sanford's Arrowhead is strictly associated with freshwater marsh hydrology. Since this topographic-hydrologic setting occurs on nearly all landforms supporting rivers, creeks, lakes, ponds and irrigation channels, strong correlations with landforms should not be expected. In addition to numerous Central Valley settings, Sanford's Arrowhead is also recorded from marsh habitats in Orange and Ventura Counties of southern California and from the coastal region of Del Norte County. Sanford's Arrowhead also occurs on the Tuscan Volcanic Formation in the Cascade Range Foothills.

All marsh habitats, natural, modified and man-made, regardless of landform association, should be considered potentially suitable habitat for Sanford's Arrowhead. For the purposes of this HCP, freshwater marsh, open water, and streams/creeks are identified as land-cover types that may contain this species.

8.2.2.2 Hydrology Relations

As previously noted, Sanford's Arrowhead is strictly associated with hydrologic systems supporting emergent marsh vegetation. These include the margins of rivers, streams, ponds, reservoirs, irrigation and drainage canals and ditches, and stock-ponds. This species is reported to inhabit the cracks in concrete-lined irrigation/drainage ditches as well. Sanford's Arrowhead is also reported to occur in several seasonal wetlands with sufficient hydrology for persistence of emergent marsh species. As with other perennial marsh species, Sanford's Arrowhead likely inhabits specific zones defined by depth of ponding. Water depths are reported for only three of the 68 occurrences reported in CNDDB in 2010 (CDFG 2010); these range from four inches to two feet in depth (CDFG 2010). Observations made by some indicate preference for the relatively shallow margins of deeper marsh systems (Gause pers. comm.).

8.2.2.3 Biological Community Relations

Plant species reported as occurring with Sanford's Arrowhead include regionally common emergent marsh species, as well as non-emergent wetland species more typically associated with marsh edges, saturated soil and even disturbed irrigated pastures. At one occurrence, Sanford's Arrowhead is reported as co-occurring with species more typically associated with vernal pools, including the rare legenere (*Legenere limosa*) and dwarf downingia (*Downingia pusilla*) (CDFG 2010).

Regionally common emergent marsh species associated with Sanford's Arrowhead include cattail (*Typha* spp.), other arrowheads (*Sagittaria latifolia*, *S. montevidensis, S. rigida*), water plantain (*Alisma plantago-aquatica*), tule (*Scirpus acutus*), yellow or Montevido waterweed (*Ludwigia peploides* ssp. *peploides* or *L.p.* ssp. *montevidensis*, respectively), parrot's-feather (*Myriophyllum aquaticum*), and willow-weed (*Polygonum lapathifolium*).

Co-occurring non-emergent wetland species more typically associated with the margins of permanent marshes, and/or with seasonal marshes, include various umbrella sedges (*Cyperus difformis, C. eragrostis, Cyperus* sp.), lady's-thumb (*Polygonum persicaria*) and assorted native bearded spangletop (*Leptochloa fascicularis*), and non-native perennial grasses barnyard grass (*Echinochloa crus-galli*, purple love grass (*Eragrostis diffusa*), dallisgrass (*Paspalum dilatatum*), Johnsongrass (*Sorghum halepense*) and bristlegrass (*Setaria* sp.). Willow (*Salix* spp.) is reported to share habitat with Sanford's Arrowhead as well (CDFG 2010).

8.2.2.4 Non-Native Weed Relations

Many of the previously mentioned emergent marsh associates, native and non-native alike, can be aggressive competitors. This trait results from vigorous lateral vegetative growth, either underground via rhizomes or stolons, with branching and elongating stems in the water column, or sprawling clambering aerial stems. Some floating species can completely cover the surface of water and mud as well such as mosquito fern (*Azolla* spp.), duckweed (*Lemma* spp.), water hyacinth (*Eichornia crassipes*), young mannagrass (*Glyceria* spp.), and others. Unlike terrestrial habitats, water availability is not a limiting factor for emergent marsh species. Rather, competition between species for available rooting substrate and light impose limits on population establishment, growth and persistence.

As mentioned previously, some of the commonly reported species associated with Sanford's Arrowhead are non-native perennial grasses, many of which are relatively aggressive weeds of marsh edges, irrigation ditches, irrigated pastures, rice fields and seasonal wetlands. In addition, other aggressively weedy wetland species in the region may present competitive problems with Sanford's Arrowhead, including other arrowheads (*Sagittaria* spp.), water plantains (*Alisma* spp., *Damasonium* spp.), water pepperweeds (*Polygonum* spp.), water hyacinth, water-nymph (*Najas* spp.), burhead (*Echinodorus berteroi*), water-milfoil (*Myriophyllum* spp.), waterweeds (*Elodea* spp., *Hydrilla verticillata, Ottelia alismoides*), Brazilian waterweed (*Egeria densa*), pondweed (*Potamogeton* spp.), purple loosestrife (*Lythrum salicaria*), and others.

The perennial marsh wetland habitat is highly productive, with much potential for intense interspecies competitive interactions. Many of the component species, including Sanford's Arrowhead, can be aggressive spreaders by rhizomes, stolons, or by dispersal of fragments/propagules. Ability for rapid lateral overtopping growth is the norm in this habitat. Sanford's Arrowhead is reported to be weedy and troublesome at the Rancho Cordova Golf Course ponds (CDFG 2010); however, other information on competitive interactions is lacking.

8.2.2.5 Livestock Grazing Relations

Interactions of livestock grazing with Sanford's Arrowhead have not been specifically addressed. As with other species though, interactions likely vary according to a variety of site-specific factors and timing. For example, marsh habitats located within irrigated pastures are likely to receive less grazing and trampling pressure than would the same habitat if it were located within a non-irrigated upland annual grassland setting. Within non-irrigated upland pastures, grazing and trampling pressures within the marshy shallows probably vary by season, with relatively little tendency of livestock to enter the marshy shallows during late winter to mid-spring months when forage and water is abundant and an increased pressure from livestock as the weather dries and warms into the summer months (Dittes pers. obs.). The capacity of colonies to recover from grazing and trampling is not known; however many rhizomatous perennial marsh species have the marked capacity to re-sprout after fragmentation of rhizome mats.

Among all of the CNDDB occurrences, livestock grazing is reported as a potential threat at only two (CNDDB occurrence # 14 and 15) (CDFG 2002). Nutrient loading, algae blooms and eutrophication associated with runoff from irrigated and overstocked pastures may potentially negatively affect some aquatic plant species, including Sanford's Arrowhead.

8.2.2.6 Disturbance Response

Owing to high vegetative productivity, rhizomatous or stoloniferous spread, subterranean tubers, and seed production, many emergent marsh species are well-adapted to, and may even benefit from periodic disturbances. In the absence of disturbances and a limiting deep-water edge, some marsh habitats may diminish in emergent species diversity, and may eventually transition into semi-terrestrial and terrestrial habitat. It is likely that in addition to basin topography, periodic disturbances (sediment scour and deposition) associated with seasonal flood events are an important determinant in the succession and species composition of any given marsh, as well as the meta-population dynamics of a given emergent marsh species. These dynamics are unknown as they relate to Sanford's Arrowhead.

The foraging activities of ducks and other waterfowl have been cited as loosening the rhizome tubers of Sagittaria, thus facilitating dispersal and potential colonization events. One mention of significant foraging of Sanford's Arrowhead by ducks is given in Tehama County (CDFG 2002). All parts of some Sagittaria species are edible for waterfowl, and dispersal is facilitated by wildlife breaking off tubers and perhaps spreading seeds while foraging (Mason 1954).

8.2.2.7 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for Sanford' Arrowhead are identified in Table SAAR-1 and have been derived from input from local species experts.

Table SAAR-1
Essential Habitat Elements for Sanford's Arrowhead

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Freshwater marsh, open water, streams/creeks.	Strictly associated with hydrologic systems supporting emergent marsh vegetation, including the margins of rivers, streams, ponds, reservoirs, irrigation and drainage canals and ditches, and stock-ponds. Sanford's Arrowhead is also reported to occur in several seasonal wetlands with sufficient hydrology for persistence of emergent marsh species. As with other perennial marsh species, Sanford's Arrowhead likely inhabits specific zones defined by depth of ponding; however, additional information is needed to determine depth requirements.

8.3 Species Distribution and Population Trends

8.3.1 Species Distribution

Sanford's Arrowhead is distributed from Orange and Ventura Counties in southern California to Butte and Tehama Counties at the northern edge of the Great Central Valley. A disjunct population occurs in the most northwestern part of the state near Crescent City in Del Norte County (CNPS 2010).

Sanford's Arrowhead occurrences are distributed among six of the Geographic Sub-regions of the California Floristic Province, as described by Hickman (1993), including the San Joaquin Valley, Sacramento Valley, Cascade Range Foothills, Outer North Coast Range, Western Transverse Range, and South Coast. Sanford's Arrowhead ranges from sea level to 2,132 feet above mean sea level (CNPS 2010).

Sacramento County has the largest number of Sanford Arrowhead occurrences with 40 of the 68 occurrences (59%) represented (CDFG 2010). Calflora reports 86 records within California, 10 of which are within Sacramento County (Calflora 2010). Fresno County has the second largest number with eight occurrences (12%), followed by Butte and Merced Counties each having five occurrences reported (7% each) (CDFG 2010). Of the remaining 10 occurrences, San Joaquin and Tehama each have three (4% each), Del Norte, El Dorado, Madera, Mariposa, Orange, Placer, Shasta, and Ventura Counties each support one occurrence (<2% each) (CDFG 2010).

8.3.2 Central Valley Distribution

The Central Valley supports the majority of Sanford's Arrowhead occurrences. The northernmost Central Valley occurrences are located approximately 28 miles apart from each other in east-central and southern Butte County (CDFG 2002). Forty occurrences are located in Sacramento County (CDFG 2010). Another 15 Occurrences are distributed in the Central Valley along an arc of approximately 65 miles, extending from central Merced to northern Madera counties (CDFG 2002).

8.3.3 Range within the Plan Area

Of the 40 total (32 extant) Sanford's Arrowhead CNDDB occurrences presently recorded from Sacramento County, 23 occurrences (58%) are located within the Plan Area, 15 of which are located within the Urban Development Area (UDA) (Figure SAAR-1) (CDFG 2010). Figure SAAR-1 shows the occurrence records within Plan Area from CNDDB (CDFG 2010) and one additional occurrence (Wetland Research Associates 2004).

Occurrences of Sanford's Arrowhead in Sacramento County have been documented in the following Landform Formations: Basin deposits, lower and middle units in the Riverbank Formation, stream channel deposits, Turlock Lake Formation, and upper unit Modesto Formation/Alluvial deposits (CDFG 2002).

8.3.4 Population Levels and Trends

Of the 68 documented CNDDB Sanford's Arrowhead occurrences, one (CNDDB occurrence #2) located in Ventura County, is now reported as "extirpated". Another eight occurrences located in Sacramento County are reported as possibly extirpated (CDFG 2010). It is important to note though, that of the remaining 59 occurrences presumed extant, 11 have not been observed since between 1940 and 1958, even though the habitats were resurveyed in 1980 (CDFG 2002; none of these are in Sacramento County). One occurrence observed in 1975 was resurveyed in 1993 with no plants found (CDFG 2002). Twenty CNDDB occurrences are historic; they have not been observed in the last 20 years (CDFG 2010). Population trends are listed as unknown for all Sanford's Arrowhead Occurrences statewide.

It should be noted that Sanford's Arrowhead is a relatively cryptic emergent marsh species, the habitats are not easily surveyed, and much unsurveyed habitat is associated with agricultural and urbanized areas, neither of which are frequented by botanists. For these reasons, additional as-yet undiscovered Sanford's Arrowhead occurrences should be expected within the Plan Area.

It is impossible to determine the number of historically occurring Sanford's Arrowhead lost or the acreage of suitable habitat lost to historic agricultural land-use conversions, since so much had happened before this species first received attention. The Great Central Valley marsh system once extended from the southern edge of the Tulare Lake Basin in the southern San Joaquin Valley, almost interrupted, to the Sacramento River basin of Butte and Tehama counties in the north. Early explorers write about the extensive Tule Marsh that impeded east-west travel at most of these latitudes within the Great Central Valley. Mason reports of a 100-acre population of Sanford's Arrowhead observed in 1912 from near Tracy that by 1954 was gone and the habitat entirely under cultivation (Mason 1954). It has been estimated that by 1978 only 4% of California's pre-settlement Central Valley wetlands remained (Airola and Messick 1987 as cited by Snyder 1994). Loss of Sanford's Arrowhead populations and habitat since pre-settlement times is incalculable and without doubt, substantial.

There has been no comprehensive effort to monitor any populations of Sanford's Arrowhead over years, so variations in abundance and other population dynamics are unknown.

Observations, monitoring and research conducted on other perennial marsh species indicate that abundance of individuals within populations can vary greatly between years, with some species exhibiting even transitory behavior (Mason 1957). Furthermore, successional changes can be relatively rapid in marshes, and if a deep-water edge is not available to impede spread, and if disturbances do not remove accumulated biomass, transition into terrestrial or semi-terrestrial habitats may result. Owing to these dynamics, long-term management and monitoring of Sanford's Arrowhead and other aquatic and emergent marsh species pose unique challenges.

8.4 Threats to the Species

Potential direct threats to Sanford's Arrowhead include: loss of emergent marsh habitat owing to agricultural and urban land-use conversion, irrigation and drainage ditch maintenance, flood control activities, road widening and maintenance, inappropriate livestock grazing regimes, recreational vehicles, bicycle traffic, and refuse dumping (CDFG 2010).

Potential indirect threats to Sanford's Arrowhead include: hydrological alteration of sub-watersheds by surrounding developments and land uses; shifts in competitive interactions (hydrology-mediated or invasive non-native and weedy native species); sedimentation; windblown refuse accumulation; herbicides, nutrient loading and other point and non-point source water pollution; recreational boat waves; foraging damage by wildlife; ecological succession, air pollution, and global climate change.

Note that of the 32 occurrences presumed extant in Sacramento County (CDFG 2010), none are included within established preserves, and at least 15 are habitants of artificial or otherwise maintained irrigation, drainage, or flood control conveyances (CDFG 2002). Only 10 appear to be associated with relatively natural wetland systems (CDFG 2002).

With regard to the remaining 27 presumed extant CNNDB occurrences outside of Sacramento County, only two are encompassed within established preserves; one of these is associated with a stockpond at The Nature Conservancy's (TNC) Vina Plains Preserve in Tehama County (CNDDB occurrence # 33), and another is located on Bureau of Land Management (BLM) land at Hog Lake, Tehama County (CNDDB occurrence # 34). Of the 19 remaining occurrences, eight are associated with irrigation/drainage canals, two are in man-made reservoirs, one is located in a groundwater recharge basin, and one is associated with a stockpond (CDFG 2002). Of the remaining seven occurrences, three do not have habitat notes included (CDFG 2002). In summary, of the 27 presumed extant occurrences outside of Sacramento County (CDFG 2010), only four are associated with presumably "natural" hydrological features (CDFG 2002).

8.5 Data Gaps

It is significant to note that Sanford's Arrowhead is difficult to survey for, and it can be difficult to see when growing with other emergent marsh species. Furthermore, since it occurs in association with a variety of water body-types, including irrigation and drainage ditches and canals (habitats seldom surveyed), other occurrences are likely to be present within Sacramento County. All marsh habitats, regardless of landform association, should be considered as potentially suitable habitat for Sanford's Arrowhead. It is likely that as additional surveys are conducted, new occurrences/populations will be discovered within the Plan Area. It is impossible however, to predict the number of future discoveries in Sacramento County or elsewhere.

With exception to observations of field workers (CDFG 2010), Sanford's Arrowhead has received limited research attention. Detailed studies have not been conducted regarding the biology, ecology, breeding system, population genetics, habitat-hydrology relationships, population dynamics, trends or threats. Investigations have been conducted on the biology and ecology of other Arrowhead species, including the sometimes co-occurring wide-leaved arrowhead or tule potato (*Sagittaria latifolia*). Pertinent data gaps for Sanford's Arrowhead specifically, along with implications for conservation, and operating assumptions include:

8.5.1 Unknown Number of Undiscovered Occurrences

Additional unsurveyed and partially surveyed potentially suitable habitat exists within the Plan Area and elsewhere within the range of the species. In the Plan Area, discovery of new populations of Sanford's Arrowhead may occur anywhere that emergent marsh habitat is present, including natural drainages, artificial irrigation/drainage conveyances, reservoir and lake margins and stockponds. Potential habitat is also present within channelized natural, and artificially excavated drainages within urbanized areas. In these situations, Sanford's Arrowhead can colonize reaches that are concrete-lined; here inhabiting cracks or rooting on accumulated sediments.

8.5.2 Unknown Relationship between Landform/Soil Chemistry and Bio-Geographic Distribution

In the 2002 CNDDB in Sacramento County, 11 of the 28 Sanford's Arrowhead occurrences are associated with Lower and Middle Units of the River Bank Formation. Another four occurrences are associated with Stream Channel Deposits, three are associated with the Turlock Formation, two with the Upper Unit Modesto Formation, and one occurrence is associated with each of the Quaternary Fanglomerate (Qfa) and Basin Deposits (CDFG 2002). The nature of relationship of landform to Sanford's Arrowhead is likely attributable to factors affecting the development and persistence of emergent marsh habit. Recent alluvial deposits are associated with active watercourses.

8.5.3 Unknown Breeding System and Pollination Ecology

Pollination and breeding studies have not been conducted for Sanford's Arrowhead and specific pollinator relationships are unknown. It may be important to note that the flowers of Sanford's Arrowhead closely resemble those found in other Sagittaria species, as well as those in other genera of the family Alismataceae (*Alisma, Damasonium, Echinodorus*). Separate male and female flowers and relatively large flower petals suggest an outcrossing breeding strategy, although self-compatibility has been demonstrated for other species of Sagittaria (Muenchow and Delesalle 1994).

An investigation of pollination ecology involving the common arrowheads (*Sagittaria latifolia* and *S. australis*) in Colorado revealed that flower visitors there are principally generalist bees of the genera *Bombus, Lasioglossum, Ceratina and Augochlora*, as well as assorted flies and wasps (Muenchow and Delesalle 1994).

8.5.4 Specific Hydrological Requirements of SAAR

Numerical data do not exist regarding specific hydrological parameters associated with emergent marsh habitats supporting Sanford's Arrowhead populations in the Plan Area, or elsewhere (e.g., maximum and minimum inundation tolerances; optimal ponding depth; response to water level fluctuations; tolerance of dry-down/desiccation; wave action and other water current relationships, etc.).

8.5.5 Interactions with Non-Native Weeds (and Aggressive Natives) and Weed Management Activities

Non-native weeds, or aggressive native species reported as occurring in emergent marsh habitats with Sanford's Arrowhead are listed in Section 2.2. All of these and others not-yet known may become problematic in Sanford's Arrowhead-occupied emergent marsh preserves owing to aggressive lateral growth and strong competitive abilities. Other aquatic weeds not yet known from the region or even from North America may become problematic following potential future introductions. Interactions between Sanford's Arrowhead and associated emergent marsh species are unknown.

8.5.6 Interactions with Non-Native and Native Wildlife Species and Wildlife Management Activities

Wildlife interactions with Sanford's Arrowhead are mostly unknown. One reference is made of waterfowl heavily utilizing a Sanford's Arrowhead population (CDFG 2010). Other Sagittaria species are well documented with regard to food utilization by waterfowl (Mason 1957). In addition to waterfowl, muskrats likely utilize all parts of Sagittaria plants as well. Grazing of seedlings or young vegetation by crayfish is not known, but is likely. Other aquatic pest invertebrate and fish species not-yet known from the region, but which could become established if introduced, could threaten Sanford's Arrowhead emergent marsh habitats in the future (e.g. Asian mitten crab, jumping carp, etc.).

8.5.7 Genetic Considerations (Spatial and Temporal Variation, Seed Bank, Drift, Bottlenecks)

Population genetics for Sanford's Arrowhead are completely unknown.

8.5.8 Critical Population Size

Critical population size is a statistical estimate of the minimum number of individuals required for a population to maintain itself over generations, through time. This population parameter has been determined for assorted wildlife and some perennial plant species. The most simplistic estimations take into account recruitment rates of individuals into the population via reproduction and immigration, and removal rates of individuals from that same population via death and emigration.

Since Sanford's Arrowhead is a perennial clonal species, definition and identification of an individual plant (genetic ramet) may be impossible. Delineation of single colonies may even be difficult owing to spread of underwater/subterranean rhizomes. Other "invisible" components with demographic importance include the number of perenniating rhizome-tubers, discernment between recruited seedlings and young shoots arising from rhizomes vegetatively, and the potential existence of a dormant soil seed bank. These unknown, difficult to identify and critical demographic parameters complicate the applicability of the concept of Critical Population Size for monitoring of Sanford's Arrowhead demography for the purposes of the SSHCP.

8.5.9 Seed Longevity and Dynamics of Stored Soil Seed Bank

There have been no empirical studies addressing the presence of a soil seed bank, seed dormancy or longevity for Sanford's Arrowhead.

8.5.10 Unknown Aspects of Experimental Inoculation

Since there are few populations of Sanford's Arrowhead in Sacramento County that are not threatened, species viability may be significantly enhanced by inoculating unoccupied, apparently suitable emergent marsh habitat and increasing the number of naturally self-sustaining populations. In addition, so much Sanford's Arrowhead habitat within the Plan Area is not protected and is subject to potential impacts resulting from routine maintenance (irrigation and drainage channels), that losses of colonies and individuals could be used for conservation of the species within habitat preserves created and managed in the context of the SSHCP.

Any additional populations would increase the likelihood of natural dispersal events into preserved but unoccupied emergent marsh habitat, create meta-population structure at extant occurrences where single colonies may support the species, and help ensure existence should any natural populations become compromised. Dispersal into, and colonization of artificially created or enhanced irrigation ditches, excavations next to railroad tracks and artificial ponds has been documented (CDFG 2010). Sanford's Arrowhead has been successfully transplanted elsewhere in Sacramento County by the U.S. Army Corp of Engineers (USACE) (Burmester pers. comm.). The common tule potato and many other clonal emergent marsh species are readily transplantable where suitable marsh habitat exists.

8.5.11 Water Quality

Sanford's Arrowhead occupies habitats that are particularly subject to a variety of types of point and non-point-source water pollutants. Specific examples include sediment transport in storm-water runoff; myriad hydrocarbons from road, highway and rooftop surfaces; nutrient runoff from dairies and stockyards; fertilizer runoff from golf courses, residential landscaping and agricultural areas; herbicide runoff from roadside and highway shoulder maintenance activities; chemical and material spills from road and highway surfaces industrial areas and construction sites; myriad rain-borne air pollutants; recreational watercraft, and others. In addition, the relationship between Sanford's Arrowhead and relationships to basic physical properties of water are unknown as well, including turbidity, conductivity, pH, Biological Oxygen Demand (BOD), and others. Interestingly, the common tule potato, and several other emergent marsh species have been investigated and variously utilized in small-scale non-conventional wastewater treatment systems.

8.5.12 Air Pollution (Dust/Ozone/Nitric Oxide, Sulphur Dioxide, etc.)

Portions of the Central Valley of California frequently exceed State and Federal safety levels for a variety of air pollutants, including particulate matter, ozone, and others. Some of these pollutants are known to negatively affect plant physiology and health, although none have been investigated as they relate to emergent marsh vegetation. Assuming that extant Sanford's Arrowhead occurrences are maintaining their vigor at existing ambient pollution levels, air pollution will probably not present a major threat to the viability of Sanford's Arrowhead, if existing air quality can be maintained. If however, California's human population increases as projected and air pollution control measures are not developed and implemented concomitantly and effectively, these pollutants may negatively affect Sanford's Arrowhead and other native plant species in the future.

8.5.13 Effects of Global Climate Change

The scientific community commonly accepts as valid the phenomenon of increasingly rapid global climate change. Specific climatic models for California predict an average increase in temperature over the coming decades, with concomitant unpredictability in annual rainfall patterns. There is uncertainty regarding the exact nature and extent of these changes, as well as the consequences these changes pose to conservation biology.

8.5.14 Baseline Hydrological Trend of Emergent Marshes and Existing Indirect Effects

Extant Sanford's Arrowhead populations in the Plan Area have undoubtedly experienced some degree of hydrological modification resulting from development-related alterations to sub-watersheds (CDFG 2010). Without complete consideration and management/protection at the level of watershed, or precise hydrological monitoring and accurate modeling on a wetland complex-scale, long-term indirect effects resulting from existing alterations to sub-watershed hydrology are unknown.

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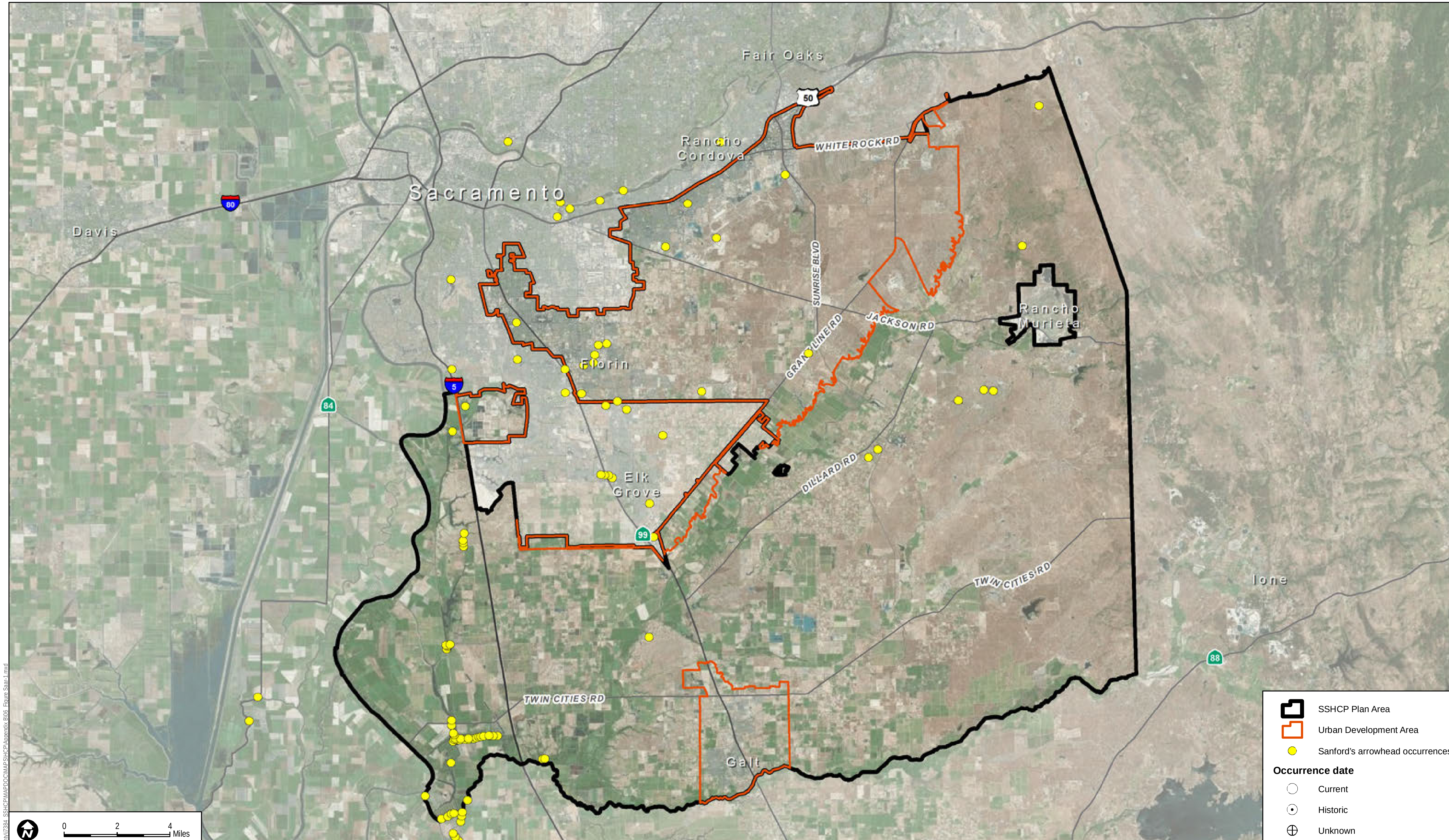

SOURCE: Bing Maps, County of Sacramento 2012

FIGURE SAAR-1

Sanford's Arrowhead Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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9 MID-VALLEY FAIRY SHRIMP (MVFS)

Prepared by Christopher Rogers

Mid-Valley Fairy Shrimp (MVFS)
(Branchinecta mesovallensis)
Status USFWS: None

Status CDFG: None

9.1 Legal Status

The mid-valley fairy shrimp meets the requirements as a "rare, threatened or endangered species" under the California Environmental Quality Act (CEQA); however, they have no formal State or Federal protected species status. Mid-valley fairy shrimp was petitioned for endangered status under the Federal Endangered Species Act (USFWS 2003), but rejected for listing (USFWS 2004).

9.2 Life History and Ecology

9.2.1 Species Description and Life History

The mid-valley fairy shrimp is a typical Branchinectid anostracan. The female's second antennae are smooth, and there are no cephalic ridges or cornices. The female's thoracic surface has two paired dorsolateral projections on the fifth to seventh segments, and a pair of single dorsolateral conical projections on the fourth segment. The brood pouch is pyriform (Eriksen and Belk 1999; Belk and Fugate 2000; Rogers 2002c). The basal fourth of the male mid-valley fairy shrimp's second antennal proximal segment bears an anteriomedial pulvillus, but otherwise is smooth (Eriksen and Belk 1999; Belk and Fugate 2000). The distal segment of the male second antennae is flattened laterally, with the bilobed apex bent medially. This bilobed apex is asymmetrical: the anterior lobe is larger than the posterior. Live animals are typically off-white to grey, although the brood pouch may be green or yellow (Rogers pers. obs.). Depending upon the rapidity of development, mature animals may vary in length from three to 38 millimeters (Rogers pers. obs.). Animals may shrink as much as 11 to 32 percent upon preservation (Rogers 2002b).

Anostracans like the mid-valley fairy shrimp are a component of the zooplanktonic community within episodic, ephemeral aquatic habitats and can occur in densities as high as 200 per liter of water (Rogers pers. obs.). The vast majority of fairy shrimp are omnivorous, indiscriminately filtering particles from the water column, including bacteria, unicellular algae, and micrometazoa (Eriksen and Belk 1999). Fairy shrimp will attempt to consume whatever material they can fit into their feeding groove, and do not discriminate based upon taste as do some other crustacean groups (Eriksen and Belk 1999). Mid-valley fairy shrimp will also rasp periphyton from sticks, stems and slender leaves (Rogers pers. obs.).

During the dry phase of their habitat, the anostracans survive as diapausing cysts (resting eggs) in and on the substrate (Sars 1896, 1898; Eriksen and Belk 1999; Rogers and Fugate 2001). When the habitat inundates from seasonal rainfall, some of the cysts hatch, and the nauplii (early larval form of anostraca) swim into the upper water column (Eriksen and Belk 1999). These larval forms are typically indistinguishable between species.

The maturation rates of the animal vary extensively depending upon temperature, and habitat type (Helm 1998; Eriksen and Belk 1999; Rogers *In review*), and the mid-valley fairy shrimp can reach maturity in as little as four days (Rogers *In review*; Rogers pers. obs.). In the genus Branchinecta, the brood pouch is truncate and as wide as the thoracic genital segments. However, when oocytes are present in the lateral pouches, the brood pouch is wider than the genital segments, forming an amplexial groove, and males can amplex the female successfully. If the oocytes are not present in the lateral pouches the female is sometimes able to wriggle out of the male's grasp (Rogers 2002b). Males approach the females from beneath to amplex. Amplexus is sustained for a second or two, as mating is rapid and the female is released immediately afterwards (Rogers 2002b). The female typically sheds her cysts as the shell forms over the fertilized oocyte (Murugan et al. 1996) and the cysts fall to the substrate.

The cysts lay dormant in the substrate until the pool dries and re-inundates during the subsequent rains. Beyond inundation of the habitat, the specific cues for hatching are unknown although temperature (Hall 1959; Belk 1977; Al-Tikrity and Grainger 1990; Belk and Nelson 1995; Helm 1998; Eriksen and Belk 1999; Rogers *In review*) and conductivity (Anderson 1958; Bowen et al. 1988; Broch 1969, 1988; Brown and Carpelan 1971; Brown 1972) are believed to play a large role. The mid-valley fairy shrimp is typically univoltine (i.e., one generation per year); however, animals of different ages may be present if a pool partially inundates allowing some cysts to hatch, and then later increases in volume, hydrating cysts that were further up-slope (Rogers pers. obs.).

Planktonic crustacea are important in the food web, as they represent a high fat, high protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. carolinensis*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Proctor 1964; Horne1966; Mellors, 1975; Silveira 1996; Dumont and Negrea 2002).

Predator consumption of fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds, amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed (Proctor 1964; Wissinger et al. 1999). If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind, and in mud carried on the feet of animals, including livestock that may wade through the habitat (Rogers in prep). This type of dispersal aids ephemeral pool crustaceans to exploit a wide variety of ephemeral habitats (Rogers 2000).

Being prey items of birds, mid-valley fairy shrimp are an intermediate host for avian cestodes (Rogers *In review*). Anostracans that are hosting a cestode tend to be bright pink in color. The change in color is due to the presence of cestode cysticercoides. The parasitic tapeworm castrates the host, which causes the host animal to accumulate lipids (probably linked to carotenoid pigments) that would otherwise be expended by the host during reproduction (Amat et al. 1991).

No specific bacterial, viral or protozoan diseases have been reported for the mid-valley fairy shrimp. Occasionally, specimens with black markings or lesions will appear in collections. These black markings, sometimes referred to as 'black disease', are actually evidence of the normal immune response of all crustacea to any bacteria, where any foreign bacteria is infused with melanin to lethal levels (Bang 1983). Branchiopod crustaceans are commonly found with phoretic ciliate protozoan colonies around the mouth and posterioventral portions of the head, which are abandoned with the exuvia by the crustacean with each molt.

Mid-valley fairy shrimp commonly co-occur with the California fairy shrimp (*Linderiella occidentalis* Dodds, 1923) (Eriksen and Belk 1999; Rogers *In review*). This species has also been reported co-occurring with the vernal pool fairy shrimp (*Branchinecta lynchi* Eng, Belk and Eriksen 1990) on three occasions, where the mid-valley fairy shrimp was probably washed into the vernal pool fairy shrimp habitat by abnormally high rainfall (Eriksen and Belk 1999). Other species of Branchinecta (*B. lindahli* Packard, 1883, *B. coloradensis* Packard, 1874, *B. mackini* Dexter, 1956, *B. lynchi*, *B. conservatio* Eng, Belk and Eriksen, 1990) occur within the range of the vernal pool fairy shrimp, but are typically found in different, although similar, habitats (Rogers *In review*).

9.2.2 Habitat Requirements and Ecology

This species is entirely dependent upon the aquatic environment provided by vernal pool wetland ecosystems. The mid-valley fairy shrimp depends upon the presence of water in the winter and early spring and the absence of water during the summer. These specific vernal pool wetlands are dependent upon intact sub-watersheds, and the surrounding uplands that support those watersheds. Vernal pool habitat is a component of the larger grassland ecosystem of the California Great Central Valley.

The mid-valley fairy shrimp needs the cold winter waters to hatch and grow in, typically appearing after the first frosts, and the dry summers to dry the resting cysts and prevent them from being attacked by fungi. Habitats supporting the mid-valley fairy shrimp are typically in Central Valley California floristic provinces below 300 meters in elevation. Typical habitat for mid-valley fairy shrimp in California includes vernal pools and seasonally ponded areas within vernal swales (Eng et al. 1990). Vernal pools that support these fairy shrimp are often grass or mud-bottomed, with clear to tea-colored water, and are often in basalt flow depression pools in grasslands (Eriksen and Belk 1999).

Mid-valley fairy shrimp have been found in habitats ranging from 0.001 to 0.5 acre in area, and typically utilizes habitats shorter in duration than is used by congeners (Eriksen and Belk 1999; Rogers pers. obs.).

Various physiochemical factors have been examined in laboratory experiments and existing mid-valley fairy shrimp habitats including alkalinity, total dissolved solids (TDS), and pH (Rogers *In review*). The importance of many of these parameters has recently been called into question with evidence that type and amount of dissolved salts may be a more important habitat requirement (Rogers *In review*). Considering the daily fluctuations in pH of a given habitat, this is to be expected. During the daylight hours, the hydrophytes are photosynthesizing, removing the CO_2 (from HCO_3) from the water, and raising the pH. During the night, the hydrophytes are respiring, increasing the CO_2 (and thereby, the HCO_3) in the water lowering the pH. If there is rainfall, the distilled precipitation will lower the pH, as will winds that cause surface action. When the habitats are drying and losing volume through evaporation, the pH, alkalinity, TDS, and electrical conductivity will increase, just as they decrease when the pools inundate or reinundate (Rogers *In review*).

Some vernal pools need a certain amount of grazing. Vernal pools that have all grazing removed become overgrown with native and exotic plants that generate deep thatch layers on the pool substrate, unless some other disturbance (i.e., weed control programs, vehicular use of pools, fire fuels control) prevents thatch deposition. As this thatch layer decomposes, it also oxidizes the water, which can suffocate gill-breathing invertebrates (Rogers 1998). Therefore, moderate grazing may be a necessary habitat component. Conversely, excessive livestock grazing can be detrimental to mid-valley fairy shrimp. Over-grazing tends to result in a large amount of manure in vernal pools. The organic waste reduces the dissolved oxygen in the water, leaving the gill-breathing invertebrates like the mid-valley fairy shrimp without oxygen (Rogers 1998, pers.

obs,). It is important not to alter grazing regimes in conservation areas until the importance of grazing to those particular systems are assessed.

Common wetland plant species that co-occur with mid-valley fairy shrimp generally need the same hydrological conditions. Therefore, the presence of these plant species within a potential habitat would imply a greater potential for a population of these shrimp to be present. These plants may include: coyote thistle (*Eryngium* spp.), downingia (*Downingia* spp.), goldfields (*Lasthenia* spp.), wooly-marbles (*Psilocarphus* spp.), hair grass (*Deschampsia* spp.), and toad rush (*Juncus bufonius*).

Similarly, pools that are dominated by vernal pool plant species that require short inundation periods may have hydrology that cannot support shrimp species. These plants may include Mediterranean barley (*Hordeum marinum* ssp, *gussoneanum*) and Italian rye grass (*Lolium multiflorum*).

Conversely, wetland habitats that support plant species that need water year round cannot support special-status shrimp species because the shrimp's cysts must dry out before they can hatch (Eriksen and Belk 1999), or if they remain wet or moist through the warmer summer months, the cysts will fungus (Rogers pers. obs.). These plants include cattails (*Typha* spp.), willow (*Salix* spp.), Fremont's cottonwood (*Populus fremontii*), duckweed (*Lemna* spp.), nut grass (*Cyperus* spp.), Baltic rush (*Juncus balticus*), and bulrush (*Schenoplectus* spp.).

Fairy shrimp are a component of a larger invertebrate community structure (Rogers 1998). This invertebrate community includes mostly planktonic crustacea dependent upon temporary wetlands including copepods, cladocerans, and ostracodes, as well as flatworms, and a suite of insect species, including: vernal pool haliplid beetle (*Apterliplus parvulus*), Scimitar backswimmers (*Buenoa scimitra*), Ricksecker's hydrochara (*Hydrochara rickseckeri*), and many others (Rogers 1998). These habitats are usually low in opportunistic species like mosquitoes and chironomid midges in the genus *Chironomus* (Rogers 1998).

Therefore, potential special-status shrimp habitat is defined as vernal pools and seasonal wetlands of sufficient size (depth and area) and seasonality that may also support specific vegetation and invertebrate community structure that indicate the potential for ponding for a sufficient duration to allow special-status shrimp species to complete their life cycles and to maintain water temperatures conducive to special-status shrimp species.

Optimal mid-valley fairy shrimp habitat tends to be small, with an abbreviated hydroperiod, neutral to slightly alkaline, clear vernal pools, low in dissolved salts, dominated with vernal pool plants, and sustains a complex vernal pool invertebrate community (Eriksen and Belk 1999; Rogers pers. obs., 1998, *In review*).

9.2.3 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for Vernal Pool Fairy Shrimp are identified in Table MVFS-1 and are largely based on the essential habitat elements for mid-valley fairy shrimp.

Table MVFS-1
Essential Habitat Elements for Mid-Valley Fairy Shrimp

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, vernal pool, and vernal swale.	Topographic features characterized by mounds and swales, and depressions within a matrix of surrounding uplands that result in complexes of continuously, or intermittently, flowing surface water in the swales connecting the pools providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water for a minimum of 18 days, in all but the driest years; thereby providing adequate water for incubation, maturation, and reproduction.

9.3 Species Distribution and Population Trends

There are more than 40 species of *Branchinecta* world-wide (Belk and Brtek 1995, 1997; Rogers and Fugate 2001; Belk and Rogers 2002) distributed throughout the Holarctic and Neotropical regions, with one species ranging into the Antarctic. The mid-valley fairy shrimp is endemic to California (Eriksen and Belk 1999; Belk and Fugate 2000).

Habitat occupied by fairy shrimp tends to exist on level open ground. This geomorphic setting tends to be the most desirable for agricultural, urban or industrial development. As a result, the grassland plateaus and floor of the Great Central Valley has been broadly converted by human use. Consequently, an unknown amount of vernal pool habitat has been lost, and an unknown number of mid-valley fairy shrimp occurrences as well, although there have been attempts to calculate the lost acreages (Holland 1978, 1988, 1998; Bauder and McMillan 1988). Due to current pressures of the increasing human populations in California, more mid-valley fairy shrimp habitat will and is being encroached upon and impacted throughout the species range.

9.3.1 Range Wide Distribution

The earliest collections of the mid-valley fairy shrimp were made by Clyde Eriksen in the late 1960's at Mather Air Force Base. Eriksen collected the mid-valley fairy shrimp with specimens of the vernal pool tadpole shrimp, *Lepidurus packardi*. The mid-valley fairy shrimp was not recognized as a new species until Anne Huber collected material from south of Mather Field and sent the specimens to Mike Fugate for identification. Fugate sent the material on to Denton Belk, who identified them as an undescribed species.

The mid-valley fairy shrimp is found in California from southern Sacramento County, west to Solano and Contra Costa Counties, and along the east side of the Central Valley south to Fresno County (Eriksen and Belk 1999). The entire range of this species is within the Central Valley.

9.3.2 Central Valley Distribution

The mid-valley fairy shrimp is endemic to California Central Valley grassland vernal pools (Belk and Fugate 2000). Known occurrences include: scattered occurrences from Mather Field area of Sacramento, south through Galt from Sacramento County; Jepson Prairie, Travis Air Force Base and Vacaville areas in Solano County: from Lodi north to the county border in San Joaquin County; the Byron Airport in Contra Costa County; the Virgina Smith Trust (Haystack Mountain) and Arena Plains National Wildlife Reserve in Merced County; one location in central Madera County; and one in northern Fresno County (Erickson and Belk 1999; Belk and Fugate 2000; Rogers in prep.). Figure MVFS-1 provides the general distribution of mid-valley fairy shrimp throughout the State as recorded by CNDDB data.

9.3.3 Range within the Plan Area

The mid-valley fairy shrimp was first officially reported from the Plan Area in the species' original description (Belk and Fugate 2000). Specimens were collected from Mather Air Force Base as early as 1967 by Dr. Clyde Eriksen (Eriksen, pers. comm.). Numerous surveys related to development projects have been conducted within and adjacent to the Plan Area (USFWS records; CDFG 2010), but the area has not been thoroughly surveyed for mid-valley fairy shrimp, and the total extent of potential habitat is unknown. Figure MVFS-1 illustrates the known recorded occurrences of mid-valley fairy shrimp within Sacramento County. The range of the species in the Plan Area is considered to be vernal habitats embedded in valley grassland and oak savannah.

9.3.4 Population Levels and Trends

An unknown amount of vernal pool habitat has been lost and with it, an unknown number of mid-valley fairy shrimp occurrences. Attempts have been made to calculate lost vernal pool acreages (Holland 1978, 1988, 1998; Bauder and McMillan 1988). Due to current pressures of the increasing human populations in California, more mid-valley fairy shrimp habitat will and is being encroached upon and impacted throughout the species' range.

Adequate determination of remaining mid-valley fairy shrimp occurrences throughout the animal's range as well as population trends is difficult. Eriksen and Belk (1999) present a map of localities for the mid-valley fairy shrimp with less than 30 localities represented, with the greatest density of occurrences in southern Sacramento County.

The California Natural Diversity Data Base (CNDDB) vernal pool crustacean records (CDFG 2010) may be somewhat misleading, due to the inconsistency of the data presented. Some records refer to individual pools, while others refer to pool complexes, and others still refer to groups of complexes. Additionally, the CNDDB does is not updated when a particular site or population is extirpated. Because of issues such as these, it is difficult to determine what actually constitutes a "population" or "occurrence" in any attempt at impact analysis.

In addition, survey maps and records tend to show where vernal pool crustaceans are, and do not emphasize where they are not. Compounding these difficulties, records are typically a reflection of where surveys have been conducted, rather than a delineation of special-status shrimp distribution. Therefore, it is difficult to establish baseline conditions for this species across the entire species range, as well as within the Plan Area. None of this is to say that vernal pool crustaceans are not threatened, endangered, or should not be protected. The issue is that where a paucity of adequate data exists, consistent data reporting would help prevent ambiguous interpretation or mischaracterization of species conservation needs.

9.4 Threats to the Species

As described previously, the greatest threat to vernal pool invertebrates is the elimination, loss, or modification of their habitat by development. The filling of vernal pools or modification of the watershed that supports those pools either eliminates the habitat or disrupts the pool ecosystem to where it is overcome by opportunistic invertebrate species and invasive, opportunistic and non-native plants, that out compete the obligatory vernal pool species (Rogers 1998).

Excessive livestock grazing in vernal pool terrain can be detrimental to vernal pool invertebrate communities. Over grazing tends to result in large amounts of manure in vernal pools. The organic waste reduces the dissolve oxygen in the water during decomposition, leaving gill-breathing invertebrates without oxygen (Rogers 1998, pers. obs,). Conversely, vernal pool grasslands are disturbance systems, and need a certain amount of grazing. Vernal pools that have all grazing removed may become overgrown with native (i.e.; Eleocharis sp., Eryngium sp.) and exotic plants (i.e.; Glyceria sp. Lolium multiflorum) that generate deep thatch layers on the pool substrate. As this thatch layer decomposes, it also reduces the dissolved oxygen in the water, which can suffocate gill-breathing invertebrates (Rogers 1998). Both lack of and excessive grazing cause an increase in organic matter in the habitat that eliminates the natural vernal pool invertebrate community, and promotes opportunistic and invasive species, that outcompete the obligatory vernal pool species (Rogers 1998). Therefore, moderate grazing, or other disturbance may be a necessary habitat suitability component, and the removal of grazing or excessive grazing are threats to the mid-valley fairy shrimp.

Damage to the watershed that supports vernal pools and vernal pool complexes will impact vernal pool invertebrate communities. Elimination of the watershed will not allow the pools to pond properly and will curtail the movement of nutrients into the pool from overland flow (Rogers 1998). Road run-off entering the watershed and conveyed to occupied habitat through the watershed may carry petroleum by-product residue or sediment from vehicles or paving or road maintenance activities. Furthermore, pesticide, herbicide, fertilizer, and sediment run-off from agricultural activities that may enter the watershed and be conveyed to occupied habitat, and may be injurious to vernal pool invertebrates. Ground disturbance from development activities may loosen soil that that may enter the watershed and be conveyed to occupied habitat as sediment.

Non-native invasive species are a threat to vernal pool invertebrate communities. There is concern that Bullfrogs (Rana catesbeiana) may feed upon federally protected vernal pool crustaceans (Balfour and Morey 1999). Manna grass and Italian rye grass are both exotic plants that occur in vernal pools. These species tend to produce heavy thatch and eventually organic loads upon decomposition, which reduce available oxygen in the water (Rogers 1998). In addition, people may introduce the non-discriminating predatory mosquitofish (Gambusia affinis) into vernal pools to control perceived local mosquito problems (Rogers pers. obs.).

Habitat fragmentation is a threat to vernal pool invertebrates in that the development surrounding small pool complexes may prevent waterfowl or shorebirds from feeding at the pools, thereby preventing genetic flow between occupied habitats. Furthermore, small pool complexes surrounded by development will not be buffered against the run-off from developed areas, and concomitant changes in the watershed hydrology.

Additional threats to the vernal pool invertebrate community structure include off-road vehicle use of vernal pool habitat for recreational “mud-bogging,” conversion of vernal pools into deep stock tanks that do not dry during the summer, and draining of vernal pools.

9.5 Data Gaps and Conservation Implications

Restoration and creation of mid-valley fairy shrimp habitat has been demonstrated to be feasible (Rogers 1998). Specific habitat parameters for this and other vernal pool invertebrate species are still poorly understood. For example, there appears to be a need by this species to have a minimum pool volume and a minimum pool surface area within a given habitat to be occupied.

Since this species has been found in a wide variety of natural and artificial vernal pool habitats, it is likely that it is in some respects an opportunist, as most temporary water fauna must be.

The primary data gap regarding conservation of vernal pool invertebrates is lack of distributional data for the species within and adjacent to the Plan Area. Since the SSHCP is assuming that all potential habitat within the Plan Area is occupied by mid-valley fairy shrimp, and it is not feasible economically or temporally to survey the entire Plan Area, it may be expedient to estimate mid-valley fairy shrimp distribution through aerial photographic interpretation. Some specific areas will need to be physically verified as to whether they support potential mid-valley fairy shrimp habitat. Additionally, artificial habitats like railroad toe-drains, stock tanks, and roadside scrapes will also need to be verified. In addition, quantitative bioassessment may be necessary to determine the ecological functions and values of selected preserve area vernal pools to assess their suitability and value as preservation habitats.

Other data gaps include the role of the surrounding uplands in vernal pool habitats, and the role, seasonality and intensity of grazing and other disturbances in vernal pool ecosystems. Furthermore, quantitative bioassessment may be necessary to determine the ecological functions and values of selected preserve area vernal pools to assess their suitability and value as preservation habitats.

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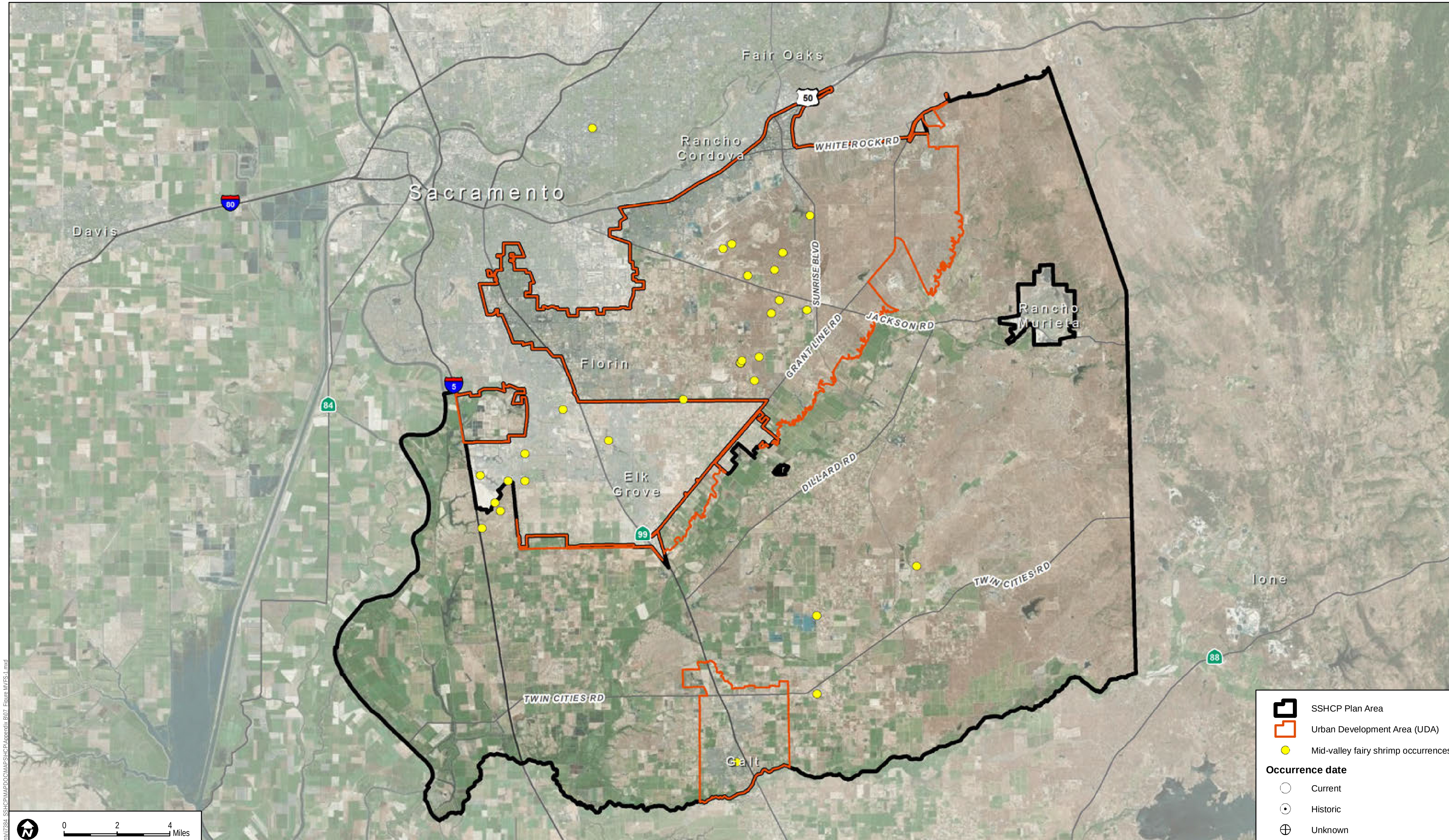

SOURCE: Bing Maps 2015, County of Sacramento 2014, CDFG 2012, C. Witham 2011, Foothill Associates 2010, Kassis-Sylva 2011, Vollmar 2012

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

FIGURE MVFS-1

Midvalley Fairy Shrimp Documented Occurrences

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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10 VERNAL POOL FAIRY SHRIMP (VPFS)

Prepared by Christopher Rogers

Vernal Pool Fairy Shrimp (VPFS)

(Branchinecta lynchi)

Status USFWS: Threatened

Status CDFG: None

www.nd.water.ca.gov

10.1 Legal Status

The vernal pool fairy shrimp (*Branchinecta lynchi*) was federally listed as threatened on 19 September 1994 (56 CFR 48136).

10.2 Life History and Ecology

10.2.1 Species Description and Life History

The vernal pool fairy shrimp is a typical Branchinectid anostracan. The female's second antennae are smooth, and there are no cephalic ridges or cornices. The female's thoracic surface has two paired dorsolateral projections on the third, and fifth to eleventh segments, and a pair of single dorsolateral conical projections on the fourth segment. The broodpouch is pyriform (Eng et al. 1990; Rogers 2002c). The basal fourth of the male vernal pool fairy shrimp's second antennal proximal segment bears an anteriomedial pulvillus and a posteriobasal transverse 'ridge-like' apophysis (Eng et al. 1990; Eriksen and Belk 1999). The medial surface of the distal third of the proximal second antennal segment has a small sparsely spined tubercle. Live animals are typically off-white to grey, although the broodpouch may be green or yellow (Rogers pers. obs.). Depending upon the rapidity of development, mature animals may vary in length from three to 38 millimeters (Rogers pers. obs.). Animals may shrink as much as 11 to 32 percent upon preservation (Rogers 2002b).

Anostracans like the vernal pool fairy shrimp are a component of the zooplanktonic community within episodic, ephemeral aquatic habitats and can occur in densities as high as 200 per liter of water (Rogers pers. obs.). The vast majority of fairy shrimp are omnivorous, indiscriminately filtering particles from the water column, including bacteria, unicellular algae, and micrometazoa (Eriksen and Belk 1999). Vernal pool fairy shrimp will attempt to consume whatever material they can fit into their feeding groove, and do not discriminate based upon taste as do some other crustacean groups (Eriksen and Belk 1999). Vernal Pool Fairy shrimp will also rasp periphyton from sticks, stems and slender leaves (Rogers pers. obs.).

During the dry phase of their habitat, the anostracans survive as diapausing cysts (resting eggs) in and on the substrate (Sars 1896, 1898; Eriksen and Belk 1999; Rogers and Fugate 2001). When the habitat inundates from seasonal rainfall, some of the cysts hatch, and the nauplii (early larval form of anostraca) swim into the upper water column (Eriksen and Belk 1999). These larval forms are typically indistinguishable between species.

The maturation rates of the animal vary extensively depending upon temperature and habitat (Gallagher 1996; Helm 1998; Eriksen and Belk 1999; Rogers 2002a). Gallegher (1996) and Helm (1998) reported the vernal pool fairy shrimp as reaching maturity in 14 and 18 days respectively; however, Rogers (pers. obs.) observed this species reaching maturity in as little as six days under high temperatures. In the genus *Branchinecta*, the brood pouch is truncate and as wide as the thoracic genital segments. When oocytes are present in the lateral pouches, the brood pouch is wider than the genital segments, forming an amplexial groove, and males can amplex the female successfully. If the oocytes are not present in the lateral pouches the female is sometimes able to wriggle out of the male's grasp (Rogers 2002b). Males approach the females from beneath to amplex. Amplexus is sustained for a second or two, as mating is rapid and the female is released immediately afterwards (Rogers 2002b). The female typically sheds her cysts as the shell forms over the fertilized oocyte (Murugan et al. 1996) and the cysts fall to the substrate.

The cysts lay dormant in the substrate until the pool dries and re-inundates during the subsequent rains. Beyond inundation of the habitat, the specific cues for hatching are unknown although temperature (Hall 1959; Belk 1977; Al-Tikrity and Grainger 1990; Belk and Nelson 1995; Eriksen and Belk 1999) and conductivity (Anderson 1958; Bowen et al. 1988; Broch 1969, 1988; Brown and Carpelan 1971; Brown 1972) are believed to play a large role. The vernal pool fairy shrimp is typically univoltine (i.e., one generation per year); however animals of different ages may be present if a pool partially inundates allowing some cysts to hatch, and then later increases in volume, hydrating cysts that were further up-slope (Rogers pers. obs.).

Planktonic crustacea are important in the food web, as they represent a high fat, high protein resource for migratory waterfowl. Mallard, Green-Winged Teal, Bufflehead, Greater Yellowlegs, and Killdeer all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Proctor 1964; Horne1966; Mellors, 1975; Silveira 1996; Dumont & Negrea 2002).

Predator consumption of fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds, amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed (Proctor 1964; Wissinger et al. 1999). If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind, and in mud carried on the feet of animals, including livestock that may wade through the habitat (Rogers *in prep*). This type of dispersal aids ephemeral pool crustaceans to exploit a wide variety of ephemeral habitats (Rogers 2000).

Being prey items of birds, vernal pool fairy shrimp are an intermediate host for avian cestodes (Rogers 2002a). Anostracans that are hosting a cestode tend to be bright pink in colour. The change in colour is due to the presence of cestode cysticercoides. The parasitic tapeworm castrates the host, which causes the host animal to accumulate lipids (probably linked to carotenoid pigments) that would otherwise be expended by the host during reproduction (Amat et al. 1991).

No specific bacterial, viral or protozoan diseases have been reported for the vernal pool fairy shrimp. Occasionally, specimens with black markings or lesions will appear in collections. These black markings, sometimes referred to as “black disease,” are actually evidence of the normal immune response of all crustacea to any bacteria, where any foreign bacteria is infused with melanin to lethal levels (Bang 1983). Branchiopod crustaceans are commonly found with phoretic ciliate protozoan colonies around the mouth and posterioventral portions of the head, which are abandoned with the exuvia by the crustacean with each molt.

Vernal pool fairy shrimp commonly co-occur with the California fairy shrimp (*Linderiella occidentalis*) (Dodds 1923; Eriksen and Belk 1999). This species has also been reported co-occurring with the mid-valley fairy shrimp (*Branchinecta mesovallensis* Belk and Fugate 2001) on three occasions, where the Mid-Valley Fairy Shrimp was probably washed into the vernal pool fairy shrimp habitat by abnormally high rainfall (Eriksen and Belk 1999). Other species of Branchinecta (*Branchinecta lindahli* Packard 1883, *B. coloradensis* Packard 1874, *B. mackini* Dexter 1956*, B. mesovallensis, B. conservatio* Eng, Belk and Eriksen 1990, *B. longiantenna* Eng, Belk, and Eriksen 1990) occur within the range of the vernal pool fairy shrimp, but are typically found in different, although similar, habitats (Rogers 2002a).

10.2.2 Habitat Requirements and Ecology

This species is entirely dependent upon the aquatic environment provided by vernal pool wetland ecosystems. The vernal pool fairy shrimp depends upon the presence of water in the winter and early spring and the absence of water during the summer. These specific vernal pool wetlands are dependent upon intact sub-watersheds, and the surrounding uplands that support those watersheds. Vernal pool habitat is a component of the larger grassland ecosystem of the California Great Central Valley.

The vernal pool fairy shrimp needs the cold winter waters to hatch and grow in, typically appearing after the first frosts, and the dry summers to dry the resting cysts and prevent them from being attacked by fungi. Habitats supporting the vernal pool fairy shrimp are typically in Central Valley California floristic provinces below 300 m elevation. Typical habitat for vernal pool fairy shrimp in California include vernal pools, seasonally ponded areas within vernal swales, rock outcrop ephemeral pools, playas and alkali flats (Eng et al. 1990). Vernal pool fairy shrimp have also been found in water pooled in sandstone outcrops and in alkaline vernal pools. Vernal pools that support these fairy shrimp are often grass or mud bottomed, with clear to tea-colored water, including basalt flow depression pools in grasslands (USFWS 1994; Eriksen and Belk 1999).

Pool volume is important in determining potential shrimp habitat because deeper pools with a large surface area can more easily maintain their dissolved oxygen levels. Similarly, deep pools will pond long enough to allow the shrimp to complete their life cycle. Vernal pool fairy shrimp have been found in pools ranging from 0.1 to 1.5 ac (Eriksen and Belk 1999; Rogers pers. obs.).

Various physiochemical factors have been examined in existing vernal pool fairy shrimp habitats including alkalinity, total dissolved solids (TDS), and pH (Keely 1984; Collie and Lathrop 1976; Eriksen and Belk 1999). The USFWS (1994) described the water in pools occupied by vernal pool fairy shrimp as having low conductivity and chloride; however, specific data were not provided. Eriksen and Belk (1999) presented a range of attributes measured by different workers, reporting alkalinity ranging from 22 to 274 parts per million (ppm), TDS of 48 to 481 ppm, and pH ranging from 6.3 to 8.5 inches occupied habitats. However, the importance of many of these parameters has recently been called into question with evidence that type and amount of dissolved salts may be a more important habitat requirement (Rogers 2002a). Considering the daily fluctuations in pH of a given habitat, this is to be expected. During the daylight hours, the hydrophytes are photosynthesizing, removing the CO2 (from HCO3) from the water, and raising the pH. During the night, the hydrophytes are respiring, increasing the CO2 (and thereby, the HCO3) in the water lowering the pH. If there is rainfall, the distilled precipitation will lower the pH, as will winds that cause surface action. When the habitats are drying and losing volume through evaporation, the pH, alkalinity, TDS, and electrical conductivity will increase, just as they decrease when the pools inundate or reinundate (Rogers 2002a).

Some vernal pools need a certain amount of grazing. Vernal pools that have all grazing removed become overgrown with native and exotic plants that generate deep thatch layers on the pool substrate, unless some other disturbance (i.e., weed control programs, vehicular use of pools, fire fuels control) prevents thatch deposition. As this thatch layer decomposes, it also oxidizes the water, which can suffocate gill-breathing invertebrates (Rogers 1998). Therefore, moderate grazing may be a necessary habitat suitability component. Conversely, excessive livestock grazing can be detrimental to vernal pool fairy shrimp. Over-grazing tends to allow a great deal of manure into vernal pools. The organic waste oxidizes the water, leaving the gill-breathing invertebrates like the vernal pool fairy shrimp without oxygen (Rogers 1998). It is important not to alter grazing regimes in conservation areas until the importance of grazing to those particular systems are assessed.

Common wetland plant species that co-occur with special-status shrimp species generally need the same hydrological conditions. Therefore, the presence of these plant species within a potential habitat would imply a greater potential for a population of these shrimp to be present. These plants may include coyote thistle (*Eryngium* spp.), downingia (*Downingia* spp.), goldfields (*Lasthenia* spp.), common spikerush (*Eleocharis macrostachya*), wooly-marbles (*Psilocarphus* spp.), hair grass (*Deschampsia* spp.), and aquatic buttercup (*Ranunculus aquatilis*).

Similarly, pools that are dominated by vernal pool plant species that require short inundation periods may have hydrology that cannot support shrimp species. These plants may include Mediterranean barley (*Hordeum marinum* ssp, *gussoneanum*), toad rush (*Juncus bufonius*), false dandelion (*Hypochoeris radicata*), and Italian rye grass (*Lolium multiflorum*).

Conversely, wetland habitats that support plant species that need water year round cannot support special-status shrimp species because the shrimp's cysts must dry out before they can hatch (Eriksen and Belk 1999), or if they remain wet or moist through the warmer summer months, the cysts are subject to attack by fungi (Rogers pers. obs.). These plants include cattails (*Typha* spp.), willow (*Salix* spp.), Fremont's cottonwood (*Populus fremontii*), duckweed (*Lemna* spp.), nut grass (*Cyperus* spp.), Baltic rush (*Juncus balticus*), and bulrush (*Schenoplectus* spp.).

The vernal pool fairy shrimp is a component of a larger invertebrate community structure (Rogers 1998). This invertebrate community includes mostly planktonic crustacea dependant upon temporary wetlands including copepods, cladocerans, and ostracodes, as well as flatworms, and a suite of insect species, including vernal pool haliplid beetle (*Apterliplus parvulus*), Scimitar backswimmers (*Buenoa scimitra*), Ricksecker's hydrochara (*Hydrochara rickseckeri*), and many others (Rogers, 1998). These habitats are usually low in opportunistic species like mosquitoes and chironomid midges in the genus *Chironomus* (Rogers 1998).

Therefore, potential habitat for special-status shrimp is defined as vernal pools and seasonal wetlands of sufficient size (depth and area) and seasonality that may also support specific vegetation and invertebrate community structure that indicate the potential for ponding for a sufficient duration to allow special-status shrimp species to complete their life cycles and to maintain water temperatures conducive to development and reproduction.

Optimal habitat for vernal pool fairy shrimp tends to be neutral to slightly alkaline, clear vernal pools, low in dissolved salts, dominated with vernal pool plants, and sustains a complex vernal pool invertebrate community (Eriksen and Belk 1999; Rogers pers. obs., 1998, 2001a). Unfortunately, little effort has been made to accurately quantify these parameters.

10.2.3 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for vernal pool fairy shrimp are identified in Table VPFS-1 and have been derived from the USFWS's list of primary constituent elements in the final rule designating critical habitat for the species (USFWS 2005) as well as input from local species experts.

Table VPFS-1
Essential Habitat Elements for Vernal Pool Fairy Shrimp

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, vernal pool, and vernal swale.	Topographic features characterized by mounds and swales, and depressions within a matrix of surrounding uplands that result in complexes of continuously, or intermittently, flowing surface water in the swales connecting the pools providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water for a minimum of 18 days, in all but the driest years; thereby providing adequate water for incubation, maturation, and reproduction.

10.3 Species Distribution and Population Trends

There are more than 40 species of *Branchinecta* world-wide (Belk and Brtek 1995, 1997; Rogers and Fugate 2001; Belk and Rogers 2002) distributed throughout the Holarctic and Neotropical regions, with one species ranging into the Antarctic. The vernal pool fairy shrimp is endemic to Oregon and California (Eng et al. 1990; Eriksen and Belk 1999).

Habitat occupied by fairy shrimp tends to exist on level open ground. This geomorphic setting tends to be the most desirable for agricultural, urban or industrial development. As a result, the grassland plateaus and floor of the Great Central Valley has been broadly converted by human use. Consequently, an unknown amount of vernal pool habitat has been lost, and an unknown number of vernal pool fairy shrimp occurrences as well, although there have been attempts to calculate the lost acreages (Holland 1978, 1988, 1998; Bauder and McMillan 1988). Due to current pressures of the increasing human populations in California and Oregon, more vernal pool fairy shrimp habitat will and is being encroached upon and impacted throughout the species range.

10.3.1 Range Wide Distribution

The earliest collections of the vernal pool fairy shrimp on record were made by Dr. G. Eisen at "San Francisco" in 1874 (Lilljeborg 1889; Linder 1941), which were misidentified as *Branchinecta coloradensis* (Eng et al. 1990). Linder (1941) used Eisen's misidentified material for his sketch of *B. coloradensis*; on page 191 of Linder's definitive monograph of the anostraca the vernal pool fairy shrimp is clearly pictured.

The vernal pool fairy shrimp is found in California from the Redding/Bella Vista area of Shasta County in the north, throughout the Central Valley, and west to the central Coast Ranges, from northern Solano County to Pinnacles National Monument in San Benito County. Disjunct occurrences were also reported to occur in San Luis Obispo County, Santa Barbara County, and Riverside County, and from near Rancho California and the Santa Rosa Plateau in Riverside County. A disjunct population(s) has been reported in Jackson County near Medford Oregon (Eng et al. 1990; USFWS 1994; Eriksen and Belk 1999).

The existence of recently discovered occurrences near Medford, Oregon (Eriksen and Belk 1999) may indicate that there are other undiscovered occurrences between Shasta County, California and Medford.

10.3.2 Central Valley Distribution

In 1994, the USFWS reported that there were 32 occurrences of the vernal pool fairy shrimp ranging from the Stillwater Plain in Shasta County through most of the length of the Central Valley to Paisley in Tulare County (USFWS 1994).

Since then, vernal pool fairy shrimp have been reported from throughout Sacramento, Colusa and Glenn Counties, as well as Central Valley portions of the following counties: Tehama, Butte, Sutter, Yuba, Placer, Stanislaus, Madera, Fresno and Tulare on the east side of the valley (Eriksen and Belk 1999), and Alameda, Solano, Yolo, Colusa and Glenn on the west side (Eriksen and Belk 1999).

10.3.3 Range within the Plan Area

The vernal pool fairy shrimp were first officially reported from the Plan Area in 1982 (CDFG 2010). Specimens were collected from near Mather Air Force Base as early as 1967 by Dr. Clyde Eriksen (Eriksen, pers. comm.). Numerous surveys related to development projects have been conducted within and adjacent to the Plan Area (USFWS records; CDFG 2010), but the area has not been thoroughly surveyed for vernal pool fairy shrimp, and the total extent of potential habitat is unknown. Figure VPFS-1 illustrates the known recorded occurrences of vernal pool fairy shrimp within Sacramento County. The range of the species in the Plan Area is considered to be vernal habitat embedded in valley grassland and oak savannah.

10.3.4 Population Levels and Trends

An unknown amount of vernal pool habitat has been lost and with it, an unknown number of vernal pool fairy shrimp occurrences. Attempts have been made to calculate lost vernal pool acreages (Holland 1978, 1988, 1998; Bauder and McMillan 1988). Due to current pressures of the increasing human populations in California and Oregon, more vernal pool fairy shrimp habitat will and is being encroached upon and impacted throughout the species' range.

Adequate determination of remaining vernal pool fairy shrimp occurrences throughout the animal's range as well as population trends is difficult. The USFWS (1994) listed 32 known occurrences of the vernal pool fairy shrimp. These data were collected during a prolonged drought in California. Sugnet and Associates (1993) submitted a study claiming 178 "discrete locations" supporting the vernal pool fairy shrimp, however as specific localities were not divulged, the data are unverifiable and therefore not scientifically useful in any type of analyses. Eriksen and Belk (1999) present a map of localities for the vernal pool fairy shrimp with more than 200 localities represented, with the greatest density of occurrences in Sacramento County.

The California Natural Diversity Data Base (CNDDB) vernal pool crustacean records (CDFG 2010) may be somewhat misleading, due to the inconsistency of the data presented. Some records refer to individual pools, while others refer to pool complexes, and others still refer to groups of complexes. Additionally, the CNDDB is not updated when a particular site or population is extirpated. Because of issues such as these, it is difficult to determine what actually constitutes a "population" or "occurrence." when using this data.

In addition, survey maps and records tend to show where vernal pool crustaceans are, and do not emphasize where they are not. Compounding these difficulties, records are typically a reflection of where surveys have been conducted, rather than a delineation of special-status shrimp distribution. Therefore, it is difficult to establish baseline conditions for this species across the entire species range, as well as within the Plan Area. None of this is to say that vernal pool crustaceans are not threatened, endangered, or should not be protected. The issue is that where a paucity of adequate data exists, consistent data reporting would help prevent ambiguous interpretation or mischaracterization of species conservation needs.

10.4 Threats to the Species

As described previously, the greatest threat to vernal pool invertebrates is the elimination, loss, or modification of their habitat by development. The filling of vernal pools or modification of the watershed that supports those pools either eliminates the habitat or disrupts the pool ecosystem to where it is overcome by opportunistic invertebrate species and invasive, opportunistic and non-native plants, that out compete the obligatory vernal pool species (Rogers 1998).

Excessive livestock grazing in vernal pool terrain can be detrimental to vernal pool invertebrate communities. Overgrazing tends to result in a large amount of manure in vernal pools. The organic waste oxidizes the water, leaving gill-breathing invertebrates without oxygen (Rogers 1998). Conversely, vernal pool grasslands are disturbance systems, and need a certain amount of grazing. Vernal pools that have all grazing removed may become overgrown with native (e.g., *Eleocharis* sp., *Eryngium* sp.) and exotic plants (e.g., *Glyceria* sp. *Lolium multiflorum*) that generate deep thatch layers on the pool substrate. As this thatch layer decomposes, it lowers the dissolved oxygen in the water, which can suffocate gill-breathing invertebrates (Rogers 1998). Both lack of and excessive grazing cause an increase in organic matter in the habitat that eliminates the natural vernal pool invertebrate community, and promotes opportunistic and invasive species, that outcompete the obligatory vernal pool species (Rogers 1998). Therefore, moderate grazing, or other disturbance may be a necessary habitat component, and the removal of grazing or excessive grazing are threats to the vernal pool fairy shrimp.

Damage to the watershed that supports vernal pools and vernal pool complexes will impact vernal pool invertebrate communities. Elimination of the watershed will not allow the pools to pond properly and will curtail the movement of nutrients into the pool from overland flow (Rogers 1998). Road run-off entering the watershed and conveyed to occupied habitat through the watershed may carry petroleum by-product residue or sediment from vehicles, paving or road maintenance activities. Furthermore, pesticide, herbicide, fertilizer, and sediment run-off from agricultural activities may enter the watershed and be conveyed to occupied habitat, and may be injurious to vernal pool invertebrates. Ground disturbance from development activities may loosen soil that that may enter the watershed and be conveyed to occupied habitat as sediment.

Non-native invasive species are a threat to vernal pool invertebrate communities. There is concern that bullfrogs (*Rana catesbeiana*) may feed upon federally protected vernal pool crustaceans (Balfour and Morey 1999). Manna grass (*Glyceria declinata*) and Italian rye grass are both exotic plants that occur in vernal pools, tend to produce heavy thatch and eventually create organic loads upon decomposition which reduce dissolved oxygen in the water (Rogers 1998). In addition, people may introduce the non-discriminating predatory mosquitofish (*Gambusia affinis*) into vernal pools to control perceived local mosquito problems (Rogers pers. obs.).

Habitat fragmentation is a threat to vernal pool invertebrates in that the development surrounding small pool complexes may prevent waterfowl or shorebirds from feeding at the pools, thereby preventing genetic flow between occupied habitats. Furthermore, small pool complexes surrounded by development will not be buffered against the run-off from developed areas, and concomitant changes in the watershed hydrology.

Additional threats to the vernal pool invertebrate community structure includes: off-road vehicle use of vernal pool habitat for recreational "mud-bogging;" conversion of vernal pools into deep stock tanks that do not dry during the summer; and draining of vernal pools.

10.5 Data Gaps and Conservation Implications

Restoration and creation of vernal pool fairy shrimp habitat has been demonstrated to be feasible (Rogers 1998). However, specific habitat parameters for this and other vernal pool invertebrate species are still poorly understood. For example, there appears to be a need by this species to have a minimum pool volume and a minimum pool surface area within a given habitat to be occupied. Since this species has been found in a wide variety of natural and artificial vernal pool habitats, it is likely that it is in some respects an opportunist, as most temporary water fauna must be.

The primary data gap regarding conservation of vernal pool invertebrates is lack of distributional data for the species within and adjacent to the Plan Area. Since the SSHCP is assuming that all potential habitat within the Plan Area is occupied by vernal pool fairy shrimp, and it is not feasible economically or temporally to survey the entire Plan Area, it may be expedient to estimate vernal pool fairy shrimp distribution through aerial photographic interpretation. Some specific areas will need to be physically verified as to whether they support potential vernal pool fairy shrimp habitat. Additionally, artificial habitats like railroad toe-drains, stock tanks, and road-side scrapes will also need to be verified. In addition, quantitative bioassessment may be necessary to determine the ecological functions and values of selected preserve area vernal pools to assess their suitability and value as preservation habitats.

Other data gaps include the role of the surrounding uplands in vernal pool habitats, and the importance of seasonality and intensity of grazing and other disturbances in vernal pool ecosystems. Furthermore, quantitative bioassessment may be necessary to determine the ecological functions and values of selected preserve area vernal pools to assess their suitability and value as preservation habitats.

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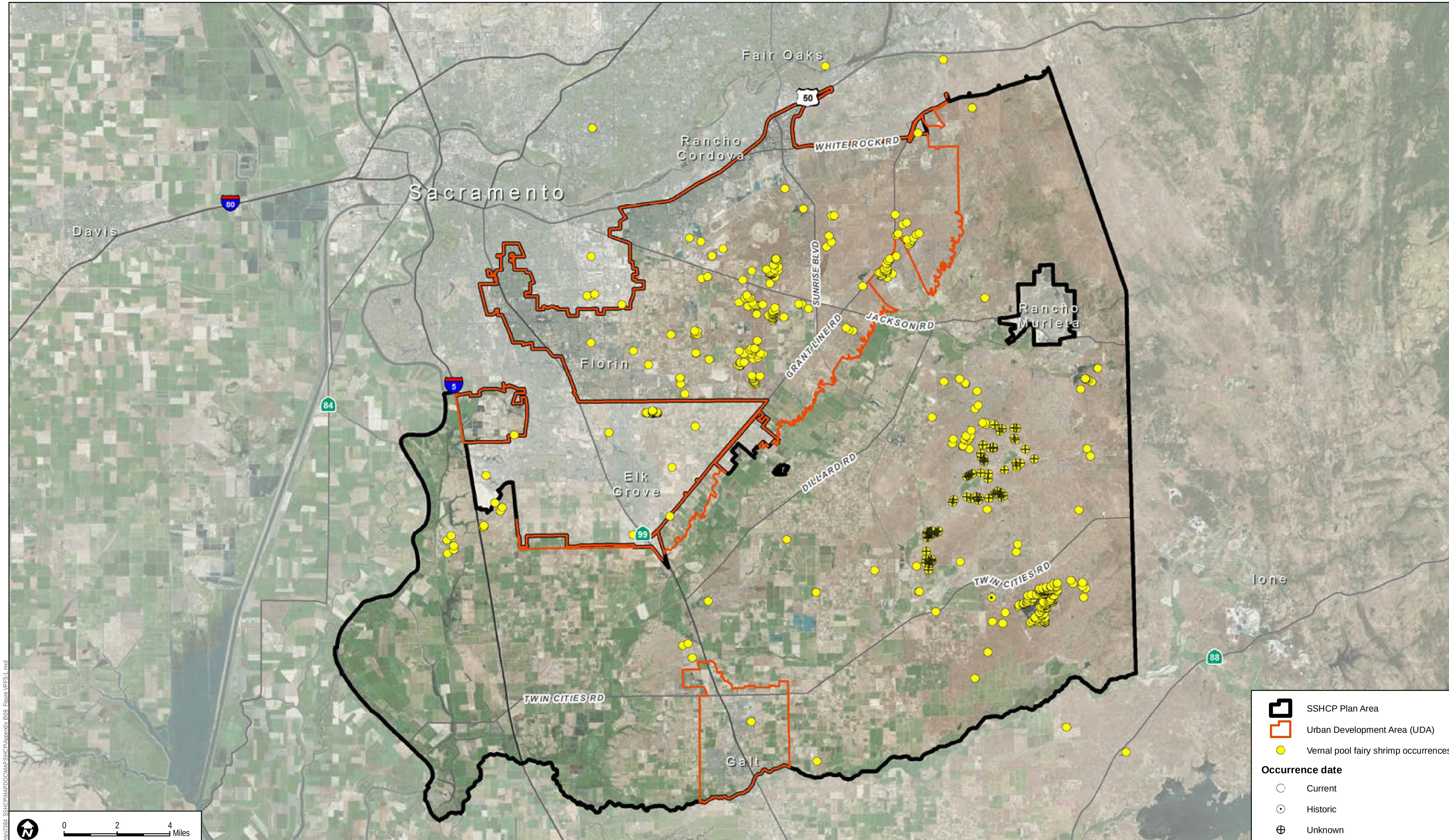

SOURCE: Bing Maps 2015, County of Sacramento 2014, CDFG 2012, C. Witham 2011, ECORP 2009, EcoAnalysts 2008, Foothill Associates 2011, Helm 2007, Kassis-Sylva 2011, Gibson & Skordal 1994, Sugnet 1996, Richard Hill 1999 Kiefer 2011, LSA 2011, Vollmar 2011, USFWS 2014, Wildlands 2010

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

FIGURE VPFS-1

Vernal Pool Fairy Shrimp Documented Occurrences

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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11 VALLEY ELDERBERRY LONGHORN BEETLE (VELB)

Prepared by Christopher Rogers

Valley Elderberry Longhorn Beetle (VELB)

(Desmocerus californicus dimorphus)

Status USFWS: Threatened

Status CDFG: None

11.1 Legal Status

The Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*) (VELB) was federally listed as a threatened species on August 8, 1980 (50 CFR part 17, 52803 – 52807).

11.2 Life History and Ecology

11.2.1 Physical Description and Taxonomy

VELB is an atypical lepturine Cerambycid beetle. The Cerambycidae are the longhorned wood boring beetles. The subfamily Lepturinae is comprised mostly of small, showy, diurnal, species that are commonly found on flowers through the spring and summer, although they are generally more abundant at higher altitudes. Elderberry beetles are in the genus *Desmocerus*, the sole genus in the Lepturine tribe (*Desmocerini* Linsley and Chemsak 1972; Monné and Hovore 2001). This tribe is separated from all other Lepturine tribes by the form of the mandibles, which are broad and short, without internal pubescence (Linsley and Chemsak 1972).

The California elderberry longhorn beetle (*D. californicus*) was originally described by Horn in 1881. This beetle is black in color, with red to orange margins on the elytra in living animals, fading to yellow in death. The pronotum disc is plane, with confluent punctations. The elytra are densely punctate or rugose. Adult beetles range from 14 to 25 millimeters in length (Linsley and Chemsak 1972).

VELB was described as a separate species by Fisher (1921) and was reduced to subspecific status by Doane et al. (1936). The majority of male VELB can be separated from the nominate subspecies by the short, suberect, pale setae on the antennae (as opposed to dark setae), and having the black elytral markings reduced to a single elongated apical dot and a single elongated basal dot per each elytron (Linsley and Chemsak 1972). Although it has been reported that a percentage of VELB males have identical elytral patterns to the nominate form (Linsley and Chemsak 1972; Eya 1976; Barr 1991), there is no explanation as to how this percentage is separated from the nominate form. The female VELB cannot be separated morphologically from the nominate subspecies. The larva has not been described, but the life history and immature stages of the nominate taxon were detailed by Davis and Comstock (1924).

This species has been confused with females of the common and widespread Lepturine *Anastrangalia laetifica* (LeConte) 1859, which is smaller (8 to 13 millimeters), much more elongated, and is similarly colored, except that the elytra have a subbasal, sutural, elongated black marking, and an elongated black marking near the elytral margin.

11.2.2 Reproduction

The VELB is univoltine. The female oviposits between eight and 20 eggs in bark crevices on the host plant (Burke 1921; Barr 1991). The host plant is the elderberry (*Sambucus* spp.) (Burke 1921; Linsley and Chemsak 1972, 1997; Barr 1991). The eggs are 3.5 to 1.25 millimeters in diameter, oblong (football shaped), with a small knob at each end, and have wavy, longitudinal ridges, white initially, and then darkening to reddish brown (Burke 1921; Barr 1991). The egg is attached to the shrub by a thin secretion and the larva ecloses within 30 to 40 days (Burke 1921).

The newly emerged larvae bore into the wood of the host plant (Linsley and Chemsak 1972; Barr 1991). Burke (1921) and Eya (1976) reported that the larvae take two years to mature, however Halstead (1991) believes that one year is the norm. The larva typically bores into the central pith of stems and feeds there; however, on large trunks the larvae feed upon the wood (Burke 1921). The larvae create an elongated, longitudinal gallery through the heart of the stems, filling it with frass and shredded wood (Barr 1991). When the larva is ready to pupate it chews a circular to slightly oval exit hole (7 to 10 millimeters in diameter) to the outside, which it plugs with frass. Then the larva backs up into the gallery and constructs a pupal chamber out of shredded wood and frass (Barr 1991). Jones and Stokes (1985, 1986, 1987a, and 1987b) and Halstead (1991) reported that 70 percent of exit holes are within 1.2 meters of the ground in stems greater than 13 mm in diameter; however holes may be as high as three meters above the ground (Barr 1991, Rogers pers. obs.). Pupae can be found between January and April, and the pupal stage lasts about one month (Burke 1921).

After pupation, the teneral adult remains in the pupal cell for several weeks prior to emergence (Burke 1921). The adult eventually emerges from the pupal chamber, through the exit hole (Barr 1991). The adults readily fly from shrub to shrub. VELB is most often seen on, in, or immediately under the host plant's inflorescences; however, copulation occurs on the lower parts of the stems (Barr 1991; Rogers pers. obs.). The adults feed on the leaves, and to a lesser extent on the flowers (Linsley and Chemsak 1972; Barr 1991). The adults are active from March to early June.

11.2.3 Ecological Relationships

There are no known diseases of VELB. Numerous species of Cleridae (checkered beetles), Cucujidae (flat bark beetles), Ostomatidae (bark-gnawing beetles), Elateridae (click beetles), Asilidae (robber flies), Phymatidae (ambush bugs), Reduviidae (ambush bugs), and some Thysanoptera (thrips) are known predators of Cerambycid beetles (Linsley 1961). All are common in the Central Valley, but none have been reported feeding on VELB.

The non-native invasive Argentine ant (*Linepithema humile*) has been observed attacking and killing VELB larvae. The ants enter the exit hole that the beetle makes prior to pupation, and remove the larva (Huxel 2000).

Birds that hunt insect larvae in wood, such as woodpeckers, creepers, and nuthatches, may also prey upon VELB, but no observations of this have been reported. Adult beetles may not be taken by birds due to their warning colors. Whether these warning colors are genuine or represent Batesian mimicry is unknown.

11.2.4 Habitat Requirements and Ecology

The VELB is completely dependent upon its host plant, the elderberry (*Sambucus glauca, S. mexicana, S. caerulea*) (Linsley and Chemsak 1972, 1997; Eng 1984; Barr 1991; Collinge et al. 2001) using no other recorded larval host plant. This shrub is a component of riparian forests throughout the Central Valley. Although this shrub occasionally occurs outside of riparian areas, shrubs supporting the greatest beetle densities are where the shrubs are abundant and interspersed among dense riparian forest, including species such as Fremont's cottonwood (*Populus fremontii*), box elder (*Acer negundo*), western sycamore (*Platanus racemosa*), California black walnut (*Juglans hindsii* var. *californica*), white alder (*Alnus rhombifolia*), willow (*Salix* spp.), button-willow (*Cephalanthus occidentalis*), Oregon ash (*Fraxinus latifolia*), wild grape (*Vitis californicus*), California hibiscus (*Hibiscus lasiocarpos*), and western poison-oak (*Toxicodendron diversilobum*) (Barr 1991; USFWS 1999; Collinge *et a*l. 2001). Isolated elderberry shrubs separated from contiguous habitat by extensive development are not typically considered to provide viable habitat for VELB (USFWS 1998; Collinge et al. 2001).

Although VELB can be found wherever elderberry shrubs are found, the VELB is also a component of a larger community structure dependent upon riparian forest (Eya 1976; USFWS 1984, 1999; Barr 1999; Huxel 2000; Collinge et al. 2001). This community includes numerous other invertebrates dependent upon riparian corridors including other invertebrates like the Sierra sideband snail *(Monodenia mormonum)*, bumblebee scarab *(Licnanthe rathvoni)*, flat headed borers (*Buprestis viridisuturalis* and *Buprestis laeviventris)*, the oak root borers *(Prionus lecontei* and *Prionus californicus)*, monarch butterfly (*Danaus plexippus)*, California dogface *(Zerene eurydice)*, western tiger swallowtail (*Papilio rutulus)*, and Argiope orb weavers (Rogers, pers, obs.), as well as vertebrates such as yellow-billed cuckoo and least Bell's vireo.

Therefore, suitable VELB habitat is defined as elderberry shrubs that are adjacent to, or contiguous with riparian forest, flood plains or relict elderberry savannah that measure greater than or equal to one inch in diameter measured at ground level.

11.2.5 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment which are needed for survival and propagation of the species. The essential habitat elements for VELB are identified in Table VELB-1 and have been derived from input from local species experts.

Table VELB-1
Essential Habitat Elements for Valley Elderberry Longhorn Beetle

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Mine tailing riparian woodland, valley oak riparian woodland, mixed riparian woodland, and mixed riparian scrub.	Requires elderberry shrubs (*Sambucus glauca*, *S. mexicana, S. caerulea*); generally in a matrix of other continuous to semi-continuous riparian vegetation.

11.3 Species Distribution and Population Trends

Habitat occupied by VELB tends to form and exist in riparian corridors and on the level open ground of periodic flood plains. This geomorphic setting historically has been desirable for agricultural, urban or industrial development. As a result, much of this habitat type has been converted through dams and levees for use as developable land. Although it has been estimated that 90 percent of California riparian habitat has been lost over the last century and a half (Barr 1991; Barbour et al. 1991; Smith 1980; Reiner and Griggs 1989; TNC 1990; Jacobs 1992; Naiman et al. 1993; Naiman and Décamps 1997) it is difficult to accurately quantify in terms of direct VELB habitat losses. Therefore, an unknown amount of riparian forest and elderberry savannah habitat has been lost, and an unknown number of VELB metapopulations as well (Collinge et al. 2001).

Long-term datasets on VELB occupancy are limited to those collected by Collinge et al. (2001) who, in 1997, re-surveyed sites visited by Barr (1991). Both found about 25 percent occupancy of elderberry groups and 20 percent occupancy of sites. However, decreases in the number of sites with elderberry (at seven fewer re-visited sites: a 10 percent decline) and in density of elderberry between surveys, resulted in lower total numbers of occupied sites and shrub groups (Collinge et al. 2001). Considering elderberry loss, and VELB extirpations (exit holes no longer found) and colonizations (exit holes found in 1997 where there were none in 1991) at sites that still had elderberry, Collinge et al. (2001) counted extirpations at nine of 72 re-visited sites (12.5 percent over six years, or about 2.5 percent of sites per year), and colonizations at four of 43 previously unoccupied sites revisited (nine percent over six years or about 1.5 percent of sites per year). colonizations only were identified within major drainage systems.

Lang et al. (1989) found much lower occupancy rates along the southern half of the Sacramento River than in the northern half and attributed the lower rates to the loss and narrowing of riparian corridors associated with agricultural development. This pattern may also reflect changes that have occurred through time. Loss of over 90 percent of riparian habitat (Katibah et al. 1984; GIC 2003) and subsequent fragmentation in the VELB's range may have resulted in not only loss of populations occurring in destroyed areas, but also degradation and declines in occupancy rates within remnants of habitat.

11.3.1 Range Wide Distribution

Desmocerus californicus is one of three species of *Desmocerus* in North America. VELB is one of two subspecies of *D. californicus*. The nominate subspecies is widespread in coastal California, ranging from Mendocino County southward to western Riverside and northern San Diego Counties, and also into the southern Sierra Nevada range (Kern and Tulare Counties). The VELB subspecies is a narrowly defined endemic taxon, limited distributionally to portions of the California Central Valley and Sacramento-San Joaquin River Delta (USFWS 1999). Studies to assess the distribution and extent of the valley subspecies began in the late 1970's (Eya 1976) and the USFWS proposed the species for listing in 1978. Since VELB was listed in 1980, numerous distributional studies have been conducted (summarized in Barr 1991; Halstead and Oldham 2000). This subspecies is endemic to California, occurring below 900 meters elevation (USFWS 1999).

11.3.2 Central Valley Distribution

In the Central Valley proper, VELB was first collected from "Sacramento, California," the precise location being unknown (Fisher 1921). Additional material was identified from Putah Creek in Solano and Yolo counties, and from along the Lower American River in Sacramento County (Linsley and Chemsak 1972). Linsley and Chemsak (1972) also reported a single female from the Merced River; however, since the females cannot be separated to subspecific level, the identification is considered unverified.

Subsequent to various surveys throughout the Central Valley, the USFWS (1999) prepared a map of the presumed range of VELB. This map encompasses the entire Central Valley, and the Sacramento-San Joaquin River Delta, below 900 meters in elevation. Additionally the CNDDB identifies 201 occurrences in a continuous band from Shasta County in the north to Kern County in the southern portion of the State (CDFG 2010).

11.3.3 Range within Plan Area

Because comprehensive surveys for VELB in the Plan Area have not been conducted and because known occurrences throughout the species range are based mostly on incidental observations, the population size and locations of this species in the Plan Area are not known. Few surveys focused on VELB have been conducted within and adjacent to the Plan Area, and the total extent of potential habitat (i.e., elderberry shrubs) is unknown. Of the 22 known occurrences of VELB recorded within the CNDDB from Sacramento County 15 are located north and outside of the Plan Area in proximity to the American River. Of the remaining seven CNDDB occurrences located within the Plan Area, five CNDDB occurrences are located along the Cosumnes River/Deer Creek riparian corridor, one along Highway 50 in Rancho Cordova, and one is located along Dry Creek east of the City of Galt (CDFG 2010). There were also several documented exit holes within the mine tailing riparian woodland in Rancho Cordova on the Aerojet property (Talley et al. 2007) and along the Cosumnes River near Rancho Murieta (Talley 2003). There are no previously recorded occurrences along the Sacramento River within the County (CDFG 2010).

It is important to note that much of the Plan Area encompasses privately owned property, a majority of which has not been surveyed for the presence of VELB; therefore, there is a high probability that future surveys will identify additional occurrences within the Plan Area.

Figure VELB-1 illustrates the recorded distribution of known VELB occurrences (based primarily on exit holes) within Sacramento County (CDFG 2010; Talley et al. 2007; Talley 2003). Recently made exit holes can be identified and are commonly used as an indicator of species presence. As noted above, extensive mapping efforts on public and private lands within the Plan Area have not been conducted and would be needed to fully characterize the distribution of VELB in the Plan Area. For the purposes of the SSHCP, the range of the species within the Plan Area is considered to be the entire Plan Area (particularly since isolated elderberry shrubs may occur almost anywhere).

11.3.4 Population Levels and Trends

The VELB is known from a total of 201 CNDDB occurrences, which include 23 in Fresno County; 22 in Sacramento County; 21 in Tehama County; 18 each in Butte and Yolo

Counties; 17 in San Joaquin County; 13 Yuba County; 12 in Glenn County; ten in Tulare County; nine in Solano County; eight in Stanislaus County; seven each in Colusa, Placer, and Sutter Counties; six each in Madera and Tuolumne Counties, four each in Kern, Merced, Napa, and Shasta Counties; two in El Dorado County; and one each in Amador Calaveras, and Mariposa Counties (CDFG 2010).

Of the 201 CNDDB occurrences recorded, all are listed as presumed extant (CDFG 2010). Only one recorded occurrence, which is located in Sacramento County along State Highway 50, is listed as experiencing a decreasing trend the rest are listed as trend unknown (CDFG 2010); this occurrence has Argentine ants which have killed two newly emerged VELB (Calderaro pers.obs.).

An unknown amount of riparian forest and elderberry savannah has been lost, and with it, an unknown number of VELB occurrences. Due to current pressures of the increasing human populations in California, more VELB habitat is being and will continue to be encroached upon and impacted throughout the species range. Although it has been estimated that 90 percent of California riparian habitat has been lost over the last century and a half (Barr 1991) it is difficult to adequately quantify. It is not unreasonable to assume that as riparian habitat is lost, VELB will experience a decreasing trend in population.

11.4 Threats to the Species

The greatest threat to VELB is the elimination, loss, or modification of their habitat by development and other activities, which reduce or eliminate their host plants. Levees, dams or other structures or activities that alter the hydrology of riparian areas may lead to the direct loss of riparian forests and elderberry shrubs. Habitat fragmentation also may pose a threat to the VELB, as development which isolates small patches of riparian forest may prevent VELB movement and genetic flow between occupied areas of habitat, isolating metapopulations (Collinge et al. 2001). Furthermore, small areas of habitat, which are surrounded by development may not be buffered against run-off and other degrading effects from adjacent developed areas, such as storm run-off contaminants.

Opportunistic invasive non-native plants like the Himalayan blackberry (*Rubus discolor*) may overwhelm elderberry shrubs by the sheer mass of their growth form, and may shade out the leaves, killing the shrub, or prevent VELB from moving between shrubs, or dispersing to other shrubs. Excessive livestock grazing in riparian areas can be detrimental to riparian communities. Cattle and horses chew on elderberry and other riparian forest species, often girdling shrubs and trees, and eventually killing them.

Pesticide drift from agriculture or direct fogging of riparian areas by mosquito abatement districts or the State Health Department to control encephalitis mosquitoes may affect VELB.

11.5 Data Gaps and Conservation Implications

The ecology, status, and management of VELB have received increased attention in recent years; however, there are several sources of uncertainty regarding VELB and its requirements in the Plan Area. The primary data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

11.5.1 Population and Habitat Distribution within the Plan Area

VELB occur in suitable habitat within the Plan Area; however, comprehensive surveys for VELB in the Plan Area have not been conducted and the existing occurrence data are based primarily on incidental observations (particularly the presence of exit holes which may or may not be associated with VELB). Consequently, the population size and distribution of the species throughout the Plan Area are not known. Although the distribution of different land cover-types is mapped and quantifiable, the quality of habitat (particularly as it relates to essential habitat components such as elderberry shrubs and stem size) for VELB within most of these areas is unknown. These information gaps limit our ability to identify the best lands available for preserving VELB habitat and accurately estimate the impacts resulting from covered activities.

Until this data gap is remedied, the conservation value for VELB will be considered relatively high in lands that support (or recently supported) known occurrences and/or are adjacent to these areas.

11.5.2 Determining Threat Severity

Although certain factors are known to contribute to VELB decline range wide, exactly how and to what extent these factors contribute to the decline of the VELB are largely unknown. Activities that directly remove or replace suitable habitat with incompatible land uses are more easily quantifiable than factors that indirectly affect an area or population (e.g., adjacent use of pesticides and herbicides); therefore, to improve conservation planning efforts for VELB in the Plan Area and elsewhere, additional empirical data are needed, specifically when analyzing factors that indirectly affect known populations and their habitats.

11.5.3 Effectiveness of Habitat Enhancement and Restoration Techniques in Creating Suitable Habitat for VELB

Achieving the conservation goals and objectives for VELB will require successful enhancement and restoration of suitable habitat as well as maintenance of dispersal corridors.

The function of habitat (e.g., connectivity, biodiversity, etc.) is an important factor for suitability of VELB. Whether restored or enhanced habitats can retain the structural attributes suitable for VELB is unknown.

If habitat restoration and enhancement techniques cannot eventually create habitats with functional characteristics suitable for VELB, then those lands would not support sustainable populations.

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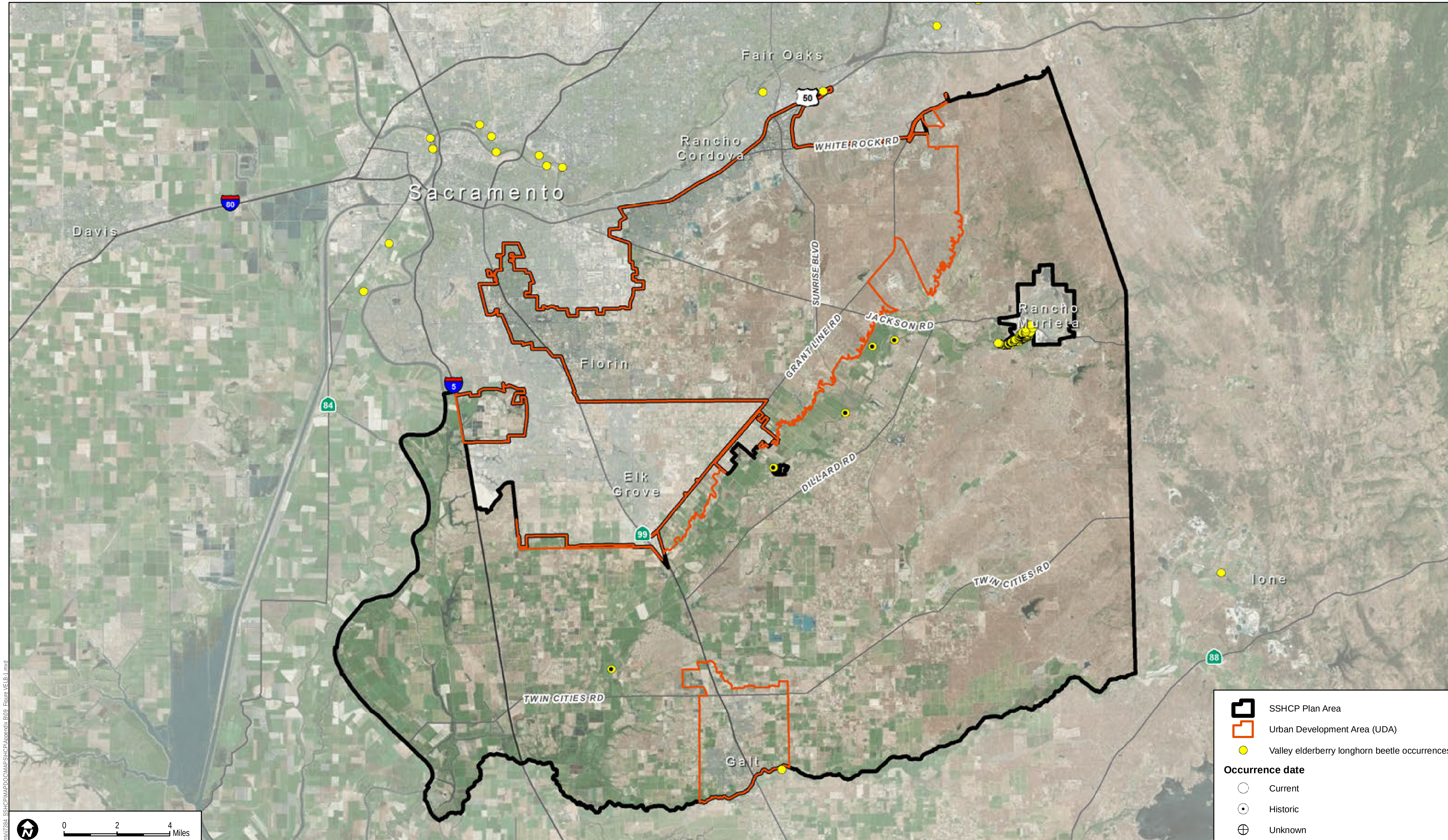

SOURCE: Bing Maps, County of Sacramento 2014, CDFG 2012, T. Talley 2003

FIGURE VELB-1

Valley Elderberry Longhorn Beetle Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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12 RICKSECKER'S WATER SCAVENGER BEETLE (RWSB)

Prepared by Christopher Rogers

Ricksecker's Water Scavenger Beetle (RWSB)

(Hydrochara rickseckeri)
Status USFWS: Species of Concern

Status CDFG: None

12.1 Legal Status

The Ricksecker's water scavenger beetle (hydrochara) (*Hydrochara rickseckeri*) is considered a special animal by the California Department of Fish and Game.

12.2 Life History and Ecology

12.2.1 Species Description and Life History

Ricksecker's hydrochara was originally described in the genus *Hydrocharis* (in error) by Horn in 1895. Leech (1956) moved it to the genus *Hydrochara*. The Ricksecker's hydrochara is a typical aquatic Hydrophilid beetle. The sexes are not readily separable. The Ricksecker's hydrochara is 10 to 12 millimeters in length, and dorsally convex. The overall color is black. Dorsally the beetle has metallic green reflections, and the lateral margins of the pronotum and elytra are testaceous to yellow. Ventrally, the keel is short, ending in a sharp spine (Smetana 1980). Underwater, the black ventral surface appears silvery due to the air trapped on the ventral setae. This species can readily be confused with the widespread *Tropisternus lateralis* Fabricius 1775, which is slightly smaller, is less convex, and has a much more elongated ventral keel. The larva has not yet been formally described; however, it can be separated from all other Hydrophilid genera by the five segmented legs, symmetrical mandibles, reduced gula, lateral abdominal projections, and tracheal gills absent (Archangelski 1997; Rogers and Serpa *in prep*).

The vast majority of Hydrophilid beetles, including the Ricksecker's hydrochara, are predatory as larvae and omnivorous as adults. Ricksecker's hydrochara is a component of the benthic community within episodic, ephemeral aquatic habitats (Rogers pers. obs.). Ricksecker's hydrochara larvae indiscriminately attack anything their size or smaller, and attempt to consume it, including other insects, crustaceans, amphibian larvae, and other Ricksecker's hydrochara larvae (Rogers pers. obs.; Serpa pers. obs.). Like other Hydrophilid species, the larvae tend to keep to shallow margins and heavily vegetated areas, and upon making a kill, carry the prey item to the surface and hold it out of the water while consuming it (Plague 1996; Rogers pers. obs.). Adults feed on common frog-fruit (*Phyla nodiflora*), and dead insects and tadpoles (Serpa pers. obs.; Rogers pers. obs.).

The Ricksecker's hydrochara is univoltine. Oviposition and eclosion have not been observed. Early instar larvae appear in the pools three to four weeks after the pools first fill (Rogers pers. obs.). The larvae grow quickly, usually requiring only two or three meals to molt to each subsequent instar. When temperatures begin to rise (typically March) the late instar larvae leave the pool, and construct a burrow in the adjacent uplands, typically where the soil is slightly moist, and pupate therein (Rogers pers. obs.). Pupation lasts two to four days, depending upon temperature. Upon emergence, the adults fly to a different vernal pool and mate (Rogers pers. obs.). The ovisac of other *Hydrochara* spp. is constructed by the female at the water surface, in vegetation. The ovisac is typically off-white, roughly subspherical, 10 to 18 millimeters in length, with a slender mast (Archangelski 1997). The mast and operculum are brownish. The adults may die after mating and oviposition, as dead adults have been found as the pools are drying (Rogers pers. obs).

There are no known diseases, parasites or predators of the Ricksecker's hydrochara, other than the species' own cannibalistic larvae.

Ricksecker's hydrochara co-occurrs with the following fairy shrimps: California fairy shrimp (*Linderiella occidentalis* Dodds, 1923), mid-valley fairy shrimp (*Branchinecta mesovallensis* Belk and Fugate 2001), vernal pool fairy shrimp (*B. lynchi* Eng, Belk and Eriksen, 1990) and Conservancy fairy shrimp (*B. conservatio* Eng, Belk and Eriksen, 1990), as well as vernal pool tadpole shrimp (*Lepidurus packardi* Simon, 1886) (Rogers pers. obs.).

12.2.2 Habitat Requirements and Ecology

This species is entirely dependent upon the aquatic environment provided by vernal pool wetland ecosystems. The Ricksecker's hydrochara depends upon the presence of water in the winter and early spring and the absence of water during the summer. These specific vernal pool wetlands are dependent upon intact sub-watersheds, and the surrounding uplands that support those watersheds. Vernal pool habitat is a component of the larger grassland ecosystem of the California Great Central Valley.

Habitats supporting the Ricksecker's hydrochara are typically in Central Valley California floristic provinces below 300 meters in elevation. The physical parameters that affect the suitability of aquatic habitats for Ricksecker's hydrochara have not been described. Collection records suggest that the Ricksecker's hydrochara is not sensitive to the size of vernal pools or other aquatic habitats, and primarily utilizes vernal pools and swales, seasonal wetlands and other ephemeral habitats, as well as constructed vernal pools (Serpa pers. obs.; Rogers pers. obs.). Adults have been observed to burrow into the substrate at the bottoms of pools (Serpa pers. obs.; Rogers pers. obs.). It is probable that, like other vernal pool insects, the larvae, pupae or adults may over-summer in burrows at or above the vernal pool water line, or the eggs may be dessication resistant and lay dormant in the pool bottom. Neither larvae nor adults have been found in similar habitat in nearby permanent waters, although similar Hydrophilid beetle species have been found in these situations.

Excessive livestock grazing may be detrimental to Ricksecker's hydrochara . Overgrazing tends to result in large amounts of manure in vernal pools. The decomposition of this organic waste reduced the dissolved oxygen in the water, leaving the gill-breathing invertebrates like the Ricksecker's hydrochara without oxygen (Rogers 1998). Conversely, most vernal pool grasslands need a certain amount of grazing. Vernal pools that have all grazing removed become overgrown with native and exotic plants that generate deep thatch layers on the pool substrate, unless some other disturbance (i.e., weed control programs, vehicular use of pools, fire fuels control) prevents thatch deposition. As this thatch layer decomposes, it also reduces the dissolved oxygen in the water, which can suffocate gill-breathing invertebrates (Rogers 1998). Therefore, moderate grazing may be a necessary habitat suitability component.

Common wetland plant species that co-occur with Ricksecker's hydrochara generally need the same hydrological conditions. Therefore, the presence of these plant species within a potential habitat would imply a greater potential for a population of this species to be present. These plants may include coyote thistle (*Eryngium* spp.), downingia (*Downingia* spp.), common frogfruit (*Phyla* spp.), goldfields (*Lasthenia* spp.), common spikerush (*Eleocharis macrostachya*), wooly-marbles (*Psilocarphus* spp.), hair grass (*Deschampsia* spp.), and aquatic buttercup (*Ranunculus aquatilis*).

Similarly, pools that are dominated by vernal pool plant species that require short inundation periods will have hydrology that cannot support this species. These plants may include Mediterranean barley (*Hordeum marinum* ssp, *gussoneanum*), toad rush (*Juncus bufonius*), false dandelion (*Hypochoeris radicata*), and Italian rye grass (*Lolium multiflorum*).

Conversely, wetland habitats that support plant species that need water year round do not appear to support Ricksecker's hydrochara (Rogers pers. obs.). These plants include cattails (*Typha* spp.), willow (*Salix* spp.), Fremont's cottonwood (*Populus fremontii*), duckweed (*Lemna* spp.), nut grass (*Cyperus* spp.), Baltic rush (*Juncus balticus*), and bulrush (*Schenoplectus* spp.).

The Ricksecker's hydrochara is a component of a larger invertebrate community structure dependant on vernal pools (Rogers, 1998). This invertebrate community includes mostly planktonic crustacea dependant upon temporary wetlands including copepods, cladocerans, and ostracodes, as well as Flatworms, and a suite of insect species, including vernal pool haliplid beetle (*Apterliplus parvulus*), Scimitar backswimmers (*Buenoa scimitra*), Ricksecker's hydrochara (*Hydrochara rickseckeri*), and many others (Rogers, 1998). These habitats are usually low in opportunistic species like mosquitoes and chironomid midges in the genus *Chironomus* (Rogers, 1998).

Therefore, potential Ricksecker's hydrochara habitat is defined as vernal pools and seasonal wetlands of sufficient size (depth and area) and seasonality that also support specific vegetation and invertebrate community structure that indicate the potential for ponding for a sufficient duration to allow Ricksecker's hydrochara to complete its life cycle.

Optimal Ricksecker's hydrochara habitat tends to be neutral to slightly alkaline, clear vernal pools, low in dissolved salts, dominated with vernal pool plants, sustaining a complex vernal pool invertebrate community (Rogers pers. obs., 1998). Unfortunately, little effort has been made to accurately quantify these parameters.

12.2.3 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for Ricksecker's hydrochara are identified in Table RWSB-1 and have been derived from input from local species experts.

Table RWSB-1
Essential Habitat Elements for Ricksecker's hydrochara

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, vernal pool, and vernal swale.	Topographic features characterized by mounds and swales, and depressions within a matrix of surrounding uplands that result in complexes of continuously, or intermittently, flowing surface water in the swales connecting the pools providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water for a minimum of 18 days, in all but the driest years; thereby providing adequate water for incubation, maturation, and reproduction.

12.3 Species Distribution and Population Trends

Habitat occupied by Ricksecker's hydrochara tends to exist on level open ground. This geomorphic setting tends to be the most desirable for agricultural, urban or industrial development. As a result, the grassland plateaus and floor of the Great Central Valley has been broadly converted by human use. Consequently, an unknown amount of vernal pool habitat has been lost, and an unknown number of Ricksecker's hydrochara occurrences as well, although there have been attempts to calculate the lost acreages (Holland 1978, 1988, 1998; Bauder and McMillan 1988). Due to current pressures of the increasing human populations in California, more Ricksecker's hydrochara habitat is being and will be encroached upon and impacted throughout the species range.

12.3.1 Range Wide Distribution

Ricksecker's hydrochara is the smallest species in the genus Hydrochara, which currently has 22 currently recognized species reported from North America, Eurasia, and Africa (Smetana 1980; Archangelski 1997). Only two species occur in California.

Ricksecker's hydrochara was redescribed by Smetana in 1980, at which time only 14 specimens were known, all of which were collected from the San Francisco Bay region. Smetana grouped Ricksecker's hydrochara with Hydrochara similis (d'Orchymont), a species from India, into the Similis Group, a sub-group within the genus Hydrochara.

Ricksecker's hydrochara was originally described as endemic to the San Francisco Bay region, occurring in Alameda, Marin, San Mateo, and Sonoma Counties (Smetana 1980). Recent collections have been made in Solano County at the Jepson Prairie Preserve, and from vernal pools in Sacramento and Placer counties (Rogers pers. obs.; Serpa pers. obs.; CDFG 2010).

12.3.2 Central Valley Distribution

In the Central Valley proper, Ricksecker's hydrochara have been collected from Solano, Sacramento and Placer Counties (Rogers pers. obs., Serpa pers. obs.). In Solano County, all records are from the Jepson Prairie Preserve and vicinity (Rogers pers. obs.; Serpa pers. obs.). In Sacramento County, this species has been collected from Plan Area (Rogers pers. obs.; Serpa pers. obs.; Witham pers. obs.), and from Blue Ravine in Folsom (Rogers pers. obs.). The single Placer County record comes from just south of Lincoln, at the Twelve Bridges Preserve (Rogers pers. obs.).

12.3.3 Range in the Plan Area

Figure RWSB-1 illustrates the known recorded occurrences of Ricksecker's water scavenger beetle within Sacramento County. The Ricksecker's hydrochara were first reported from the Plan Area from Mather Field (Rogers pers. obs.). This species has been collected from Mather Field on three additional occasions (Rogers pers. obs.; Serpa pers. obs.; Witham pers. obs.), from Ranch Seco (Rogers pers. obs.), Howard's Ranch (TNC Rare Species Survey) and from Peterson Ranch (Serpa pers. obs.).

No surveys focused on Ricksecker's hydrochara have been conducted within and adjacent to the Plan Area and the total extent of potential habitat is unknown. Therefore, the range of the species in the Plan Area is considered to be vernal habitats embedded in valley grassland and oak savannah.

12.3.4 Population Levels and Trends

An unknown amount of vernal pool habitat has been lost, and with it, an unknown number of Ricksecker's hydrochara occurrences. Attempts have been made to calculate lost vernal pool acreages (Holland 1978, 1988, 1998; Bauder and McMillan 1988). Due to current pressures of the increasing human populations in California, more Ricksecker's hydrochara habitat will be and is being encroached upon and impacted throughout the species range. Adequate determination of remaining Ricksecker's hydrochara populations throughout the animal's range as well as population trends is difficult, as no specific surveys have ever been conducted outside of the locations listed above

12.4 Threats to the Species

As described previously, the greatest threat to vernal pool invertebrates is the elimination, loss, or modification of their habitat by development. The filling of vernal pools or modification of the watershed that supports those pools either eliminates the habitat or disrupts the pool ecosystem until it is overcome by opportunistic invertebrate species and invasive, opportunistic and non-native plants, that out compete the obligatory vernal pool species (Rogers 1998).

Excessive livestock grazing in vernal pool terrain can be detrimental to vernal pool invertebrate communities. Overgrazing tends to result in large amounts of manure in vernal pools. The organic waste oxidizes the water, leaving gill breathing invertebrates without oxygen (Rogers 1998). Conversely, vernal pool grasslands are disturbance systems, and need a certain amount of grazing. Vernal pools that have all grazing removed may become overgrown with native (e.g., *Eleocharis* sp., *Eryngium* sp.) and exotic plants (e.g., *Glyceria* sp. *Lolium multiflorum*) that generate deep thatch layers on the pool substrate. As this thatch layer decomposes, it lowers the dissolved oxygen in the water, which can suffocate gill-breathing invertebrates (Rogers 1998).

Both lack of grazing and excessive grazing cause an increase in organic matter in the habitat that eliminates the natural vernal pool invertebrate community, and promotes opportunistic and invasive species, that out compete the obligate vernal pool species (Rogers 1998). Therefore, moderate grazing, or other disturbance may be a necessary habitat component, and the removal of grazing or excessive grazing may be threats to the Ricksecker's hydrochara .

Damage to the watershed that supports vernal pools and vernal pool complexes will impact vernal pool invertebrate communities. Elimination of the watershed will not allow the pools to pond properly and will curtail the movement of nutrients into the pool from overland flow (Rogers 1998). Road run-off entering the watershed and conveyed to occupied habitat through the watershed may carry petroleum by-product residue or sediment from vehicles, paving or road maintenance activities. Furthermore, pesticide, herbicide, fertilizer, and sediment run-off from agricultural activities may enter the watershed and be conveyed to occupied habitat, and may be injurious to vernal pool invertebrates. Ground disturbance from development activities may loosen soil that that may enter the watershed and be conveyed to occupied habitat as sediment.

Non-native invasive species are a threat to vernal pool invertebrate communities. manna grass and Italian rye grass are both exotic plants that occur in vernal pools, tend to produce heavy thatch and eventually create organic loads upon decomposition, which reduce dissolved oxygen in the water upon decomposition (Rogers 1998). In addition, people may introduce the non-discriminating predatory mosquitofish into vernal pools to control perceived local mosquito problems (Rogers pers. obs.).

Habitat fragmentation is a threat to vernal pool invertebrates in that the development surrounding small pool complexes may prevent waterfowl or shorebirds from feeding at the pools, thereby preventing genetic flow between occupied habitats. Furthermore, small pool complexes surrounded by development will not be buffered against the run-off from developed areas, and concomitant changes in the watershed hydrology.

Additional threats to the vernal pool invertebrate community structure includes: off-road vehicle use of vernal pool habitat for recreational 'mud-bogging'; conversion of vernal pools into deep stock tanks that do not dry during the summer; and draining of vernal pools.

12.5 Data Gaps and Conservation Implications

Restoration and creation of vernal pool habitat has been demonstrated to be feasible (Rogers 1998). Specific habitat parameters for this and other vernal pool invertebrate species are still poorly understood.

The primary data gap regarding conservation of vernal pool invertebrates is lack of distributional data for the species within and adjacent to the Plan Area. Since the SSHCP is assuming that all potential habitat within the Plan Area is occupied by Ricksecker's hydrochara , and it is not feasible economically or temporally to survey the entire Plan Area, it may be expedient to estimate Ricksecker's hydrochara distribution through aerial photographic interpretation. Some specific areas will need to be physically verified as to whether they support potential Ricksecker's hydrochara habitat. Additionally, artificial habitats like railroad toe-drains, stock tanks, and roadside scrapes will also need to be verified. In addition, quantitative bioassessment may be necessary to determine the ecological functions and values of selected preserve area vernal pools to assess their suitability and value as preservation habitats.

Other data gaps include the role of the surrounding uplands in vernal pool habitats, and the importance of seasonality and intensity of grazing and other disturbances in vernal pool ecosystems. Furthermore, quantitative bioassessment may be necessary to determine the ecological functions and values of selected preserve area vernal pools to assess their suitability and value as preservation habitats.

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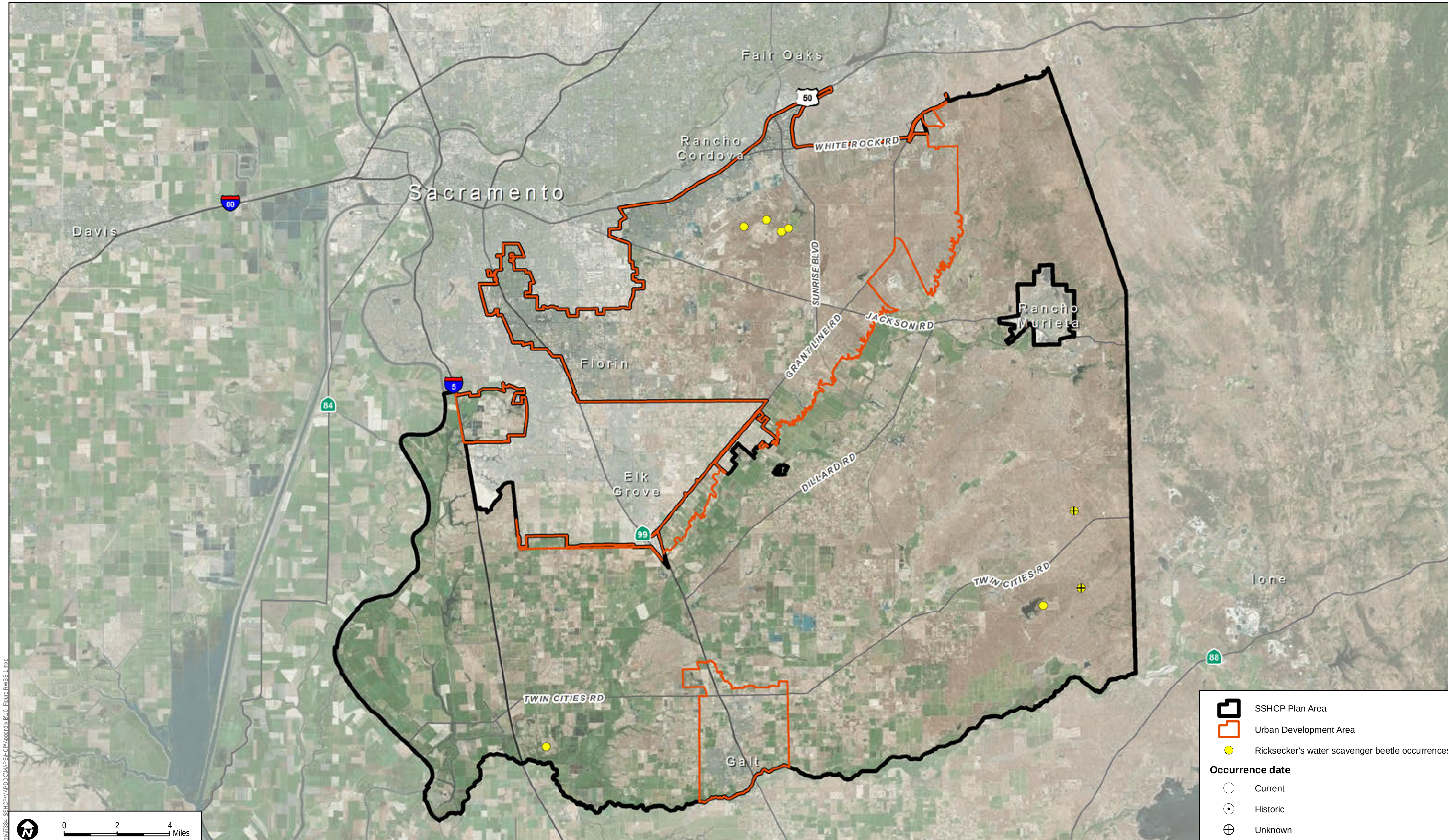

SOURCE: Bing Maps, County of Sacramento 2014, CDFG 2012, Chris Rogers 2000, TNC

FIGURE RWSB-1

Ricksecker's Water Scavenger Beetle Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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13 VERNAL POOL TADPOLE SHRIMP (VPTS)

Prepared by Christopher Rogers

Vernal Pool Tadpole Shrimp (VPTS)

(Lepidurus packardi)

Status USFWS: Endangered

Status CDFG: None

13.1 Legal Status

The vernal pool tadpole shrimp (*Lepidurus packardi*) was federally listed as endangered on 19 September 1994 (56 CFR 48136).

13.2 Life History and Ecology

13.2.1 Species Description and Life History

The vernal pool tadpole shrimp is a typical member of the genus *Lepidurus*. Like some other tadpole shrimp species, this species appears to be unisexual (Rogers 2001).

The vernal pool tadpole shrimp was considered a subspecies of the Eurasian *Lepidurus apus* by Longhurst (1955). Lynch (1972) commented that the vernal pool tadpole shrimp was separate from *L. apus*, but did not provide a quantitative analysis. Rogers quantitatively reinstated the vernal pool tadpole shrimp as a separate species in 2001.

The vernal pool tadpole shrimp is separated from most other nearctic *Lepidurus* species by having the nuchal organ (a large tubercle behind the eyes) intersected by a line drawn between the posterior apices of eyes, and 24 to 29 body rings and 30 to 35 pairs of legs. The caudal lamina is truncate, 0.3 to 0.1 times the length of carapace. Mature specimens have the sulcus spines triangular, as long as broad, separated by at least twice their width, with numerous small spines of varying shapes, sometimes in double rows, separating the larger spines. Smaller specimens have large acute spines, 1.2 to 1.5 times as long as broad. Old specimens may have the largest sulcus spines rounded. The endites three, four and five of the second thoracic appendages project beyond the carapace margin. The adult length is 15 to 86 millimeters from anterior margin of carapace to tip of caudal lamina.

Lepidurus cryptus Rogers 2001 is inseparable morphologically from the vernal pool tadpole shrimp. This species had been previously confused with The vernal pool tadpole shrimp (Linder 1952; Lynch 1972). Analysis of 12S rDNA and allozyme data, performed by King and Hanner (1998), demonstrates that it is genetically distinct from the vernal pool tadpole shrimp (Rogers 2001).

The vernal pool tadpole shrimp may vary in coloration depending upon habitat, although it is most commonly green. In highly turbid water, this species may be nearly translucent to buff colored with brown mottles. In slightly turbid to clear water it may range from light green to dark green, dark green mottled with brown, chocolate brown, brown with green mottles, and black. The vernal pool tadpole shrimp can on occasion reach very large sizes. One specimen from Stanislaus County measured 86 millimeters from the anterior carapace margin to the apex of the caudal lamina (Rogers 2001).

Notostracans like the vernal pool tadpole shrimp are a component of the zooplanktonic community within episodic, ephemeral aquatic habitats; although the larger they grow the more time they spend at or near the bottom (Rogers pers. obs.). Tadpole shrimp are omnivorous, with a strong preference for animal matter, and will capture and consume live invertebrates, amphibian larvae, or carrion (Longhurst 1955). Vernal pool tadpole shrimp will also filter detritus for micrometazoa (Rogers pers. obs.).

During the dry phase of their habitat, Notostracans survive as diapausing cysts (resting eggs) in and on the substrate (Sars 1896, 1898; Eriksen and Belk 1999; Rogers and Fugate 2001). When the habitat inundates from seasonal rainfall, some of the cysts hatch, and the nauplii (early larval form of crustacea) swim into the upper water column (Eriksen and Belk 1999). These early instars are typically indistinguishable between species. The maturation rates of vernal pool crustaceans vary extensively depending upon temperature (Eriksen and Belk 1999; Rogers 2002), and the vernal pool tadpole shrimp can reach maturity in 19 days (Rogers pers. obs.). Vernal pool tadpole shrimps may persist as adults right up to the point when the pool dries.

Contrary to Ahl (1991), each individual is capable of producing viable cysts without sexual reproduction (Longhurst 1955; Rogers 2001). Populations are probably made up of either parthenogenic females, amphigenic females (females with lobes of testicular tissue on the ovaries) or both (Bernard 1889; Longhurst 1954; Sassaman 1991, 1995; Maeda-Martinez, et al., 2000; Rogers 2001). The cysts are produced by the ovaries into a marsupium on the 11th thoracopods, made from a modification of the subapical lobe, which holds the cysts, and the exopodite, which forms the "lid" of the marsupium (Fryer 1988). The female typically sheds her cysts as the shell forms over the fertilized oocyte (Murugan et al. 1996) and the cysts fall to the substrate.

The cysts lay dormant in the substrate until the pool dries and re-inundates during the subsequent rains. Beyond inundation of the habitat, the specific cues for hatching are unknown although temperature (Hall 1959; Belk 1977; Al-Tikrity and Grainger 1990; Belk and Nelson 1995; Eriksen and Belk 1999) and conductivity (for example: Anderson 1958; Bowen et al. 1988; Broch 1969, 1988; Brown and Carpelan 1971; Brown 1972) are believed to play a large role. The vernal pool tadpole shrimp is typically univoltine (i.e., one generation per year), however animals of different ages may be present if a pool partially inundates allowing some cysts to hatch, and then later increases in volume, hydrating cysts that were further up-slope (Rogers pers. obs.).

Planktonic crustacea are important in the food web, as they represent a high fat, high protein resource for migratory waterfowl. Mallard, Green-winged Teal, Bufflehead, Greater Yellowlegs, and Killdeer all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Proctor 1964; Horne1966; Mellors, 1975; Silveira 1996; Dumont and Negrea 2002).

Predator consumption of cysts aids in distributing populations of vernal pool crustaceans. Predators (e.g., birds, amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed (Proctor 1964; Wissinger et al. 1999). If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind, and in mud carried on the feet of animals, including livestock that may wade through the habitat (Rogers in prep). This type of dispersal aids ephemeral pool crustaceans to exploit a wide variety of ephemeral habitats (Rogers 2000).

Vernal pool tadpole shrimp are an intermediate host for the metacercariae of an echinostome fluke (Ahl 1991) which also infects co-occurring gastropods. The parasitic fluke castrates the vernal pool tadpole shrimp. This fluke is most likely a bird parasite.

No specific bacterial, viral or protozoan diseases have been reported for the vernal pool tadpole shrimp. Occasionally, specimens with black markings or lesions will appear in collections. These black markings, sometimes referred to as “black disease,” are actually evidence of the normal immune response of all crustacea to any bacteria, where any foreign bacteria is infused with melanin to lethal levels (Bang 1983). Branchiopod crustaceans are commonly found with phoretic ciliate protozoan colonies around the mouth and posterioventral portions of the head, which are abandoned with the exuvia by the crustacean with each molt.

Vernal pool tadpole shrimp commonly co-occur with fairy shrimp such as *Linderiella occidentalis* (Dodds 1923), *Branchinecta conservatio* Eng, Belk, and Eriksen 1990, *B. lindahli* Packard 1883, *B. coloradensis* Packard 1874, and vernal pool fairy shrimp (*B. lynchi* Eng, Belk, and Eriksen 1990). The mid-valley fairy shrimp (*B. mesovallensis* Belk and Fugate 2001) and *B.*

longiantenna Eng, Belk, and Eriksen 1990 both occur within the range of the vernal pool tadpole shrimp, but are typically found in different habitats (Rogers pers. obs.).

13.2.2 Habitat Requirements and Ecology

This species is entirely dependent upon the aquatic environment provided by vernal pool wetland ecosystems. The Vernal pool tadpole shrimp depends upon the presence of water in the winter and early spring and the absence of water during the summer. These specific vernal pool wetland characteristics are dependent upon intact sub-watersheds, and the surrounding uplands that support those watersheds. Vernal pool habitat is a component of the larger grassland ecosystem of the California Great Central Valley.

The Vernal pool tadpole shrimp needs the cold winter waters to hatch and develop, typically appearing after the first frosts, and the dry summers to dry the resting cysts and prevent them from being attacked by fungi. Habitats supporting the Vernal pool tadpole shrimp are typically in Central Valley California floristic provinces below 300 m elevation. Typical habitat for Vernal pool tadpole shrimp in California include vernal pools, seasonally ponded areas within vernal swales, rock outcrop ephemeral pools, playas and alkali flats (Eriksen and Belk 1999; Rogers 2001). Vernal pool tadpole shrimp have also been found in alkaline vernal pools. Vernal pools that support these shrimp may be grass or mud-bottomed with clear to tea-colored or highly turbid water, and are often in grassland depression pools (USFWS 1994; Rogers 2001).

Pool volume is important in determining potential shrimp habitat because deeper pools with a large surface area can more easily maintain their dissolved oxygen levels. Similarly, deeper pools will pond long enough to allow the shrimp to complete their life cycle. Vernal pool tadpole shrimp have been found in pools ranging from 0.1 to 80+ acres (USFWS 1994; Eriksen and Belk 1999; Rogers pers. obs.).

Various physiochemical factors have been examined in existing Vernal pool tadpole shrimp habitats including alkalinity, total dissolved solids (TDS), and pH (Collie and Lathrop 1976; Eriksen and Belk 1999). The U.S. Fish and Wildlife Service (1994) described the water in pools occupied by vernal pool tadpole shrimp as having low conductivity and chloride, however specific data were not provided. In addition, the importance of many of these parameters has recently been called into question with evidence that type and amount of dissolved salts may be a more important habitat requirement for vernal pool crustaceans (Rogers 2002). Considering the daily fluctuations in pH of a given habitat, this is to be expected. During the daylight hours, the hydrophytes are photosynthesizing, removing the CO_2 (from HCO_3) from the water, and raising the pH. During the night, the hydrophytes are respiring, increasing the CO_2 (and thereby the HCO_3) in the water lowering the pH. If there is rainfall, the distilled precipitation will lower the pH, as will winds that cause surface action. When the habitats are drying and losing volume through evaporation, the pH, alkalinity, TDS, and electrical conductivity will increase, just as they decrease when the pools inundate or reinundate (Rogers 2002).

Some vernal pools need a certain amount of grazing. Vernal pools that have all grazing removed become overgrown with native and exotic plants that generate deep thatch layers on the pool substrate, unless some other disturbance (i.e., weed control programs, vehicular use of pools, fire fuels control) prevents thatch deposition. As this thatch layer decomposes, it reduces the dissolved oxygen in the water, which can suffocate gill-breathing invertebrates (Rogers 1998). Therefore, moderate grazing may be a necessary habitat suitability component. Conversely, excessive livestock grazing can be detrimental to vernal pool tadpole shrimp. Over-grazing tends to result in a large amount of manure in vernal pools. The decomposition of this organic waste removes oxygen from the water, leaving the gill-breathing invertebrates like the vernal pool tadpole shrimp without oxygen (Rogers 1998). It is important not to alter grazing regimes in conservation areas until the importance of grazing to those particular systems are assessed.

Common wetland plant species that co-occur with special-status shrimp species generally need the same hydrological conditions. Therefore, the presence of these plant species within a potential habitat would imply a greater potential for a population of these shrimp to be present. These plants may include coyote thistle (*Eryngium* spp.), downingia (*Downingia* spp.), goldfields (*Lasthenia* spp.), common spikerush (*Eleocharis macrostachya*), wooly-marbles (*Psilocarphus* spp.), hair grass (*Deschampsia* spp.), and aquatic buttercup (*Ranunculus aquatilis*).

Similarly, pools that are dominated by vernal pool plant species that require short inundation periods may have hydrology that cannot support shrimp species. These plants may include Mediterranean barley (*Hordeum marinum* ssp, *gussoneanum*), toad rush (*Juncus bufonius*), false dandelion (*Hypochoeris radicata*), and Italian rye grass (*Lolium multiflorum*).

Conversely, wetland habitats that support plant species that need water year round cannot support special-status shrimp species because the shrimp's cysts must dry out before they can hatch (Eriksen and Belk 1999), or if they remain wet or moist through the warmer summer months, the cysts will be attacked by fungi (Rogers pers. obs.). These plants include cattails (*Typha* spp.), willow (*Salix* spp.), Fremont's cottonwood (*Populus fremontii*), duckweed (*Lemna* spp.), nut grass (*Cyperus* spp.), Baltic rush (*Juncus balticus*), and bulrush (*Schenoplectus* spp.).

The vernal pool tadpole shrimp is a component of a larger invertebrate community structure (Rogers 1998). This invertebrate community includes mostly planktonic crustacea dependant upon temporary wetlands including copepods, cladocerans, and ostracodes, as well as flatworms, and a suite of insect species, including vernal pool haliplid beetle (*Apterliplus parvulus*), Scimitar backswimmers (*Buenoa scimitra*), Ricksecker's hydrochara (*Hydrochara rickseckeri*), and many others (Rogers 1998). These habitats are usually low in opportunistic species like mosquitoes and chironomid midges in the genus *Chironomus* (Rogers 1998).

Therefore, potential special-status shrimp habitat is defined as vernal pools and seasonal wetlands of sufficient size (depth and area) and seasonality that may also (but does not have to) support specific vegetation and invertebrate community structure that indicate the potential for ponding for a sufficient duration to allow special-status shrimp species to complete their life cycles and to maintain water temperatures conducive to development and reproduction.

Optimal vernal pool tadpole shrimp habitat tends to be neutral to slightly alkaline, clear vernal pools, low in dissolved salts, dominated with vernal pool plants, and sustains a complex vernal pool invertebrate community (Rogers pers. obs., 1998, 2001). Unfortunately, little effort has been made to accurately quantify these parameters.

13.2.3 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for Vernal pool tadpole shrimp are identified in Table VPTS-1 and have been derived from the USFWS's list of primary constituent elements in the final rule designating critical habitat for the species (USFWS 2005) as well as input from local species experts.

Table VPTS-1
Essential Habitat Elements for Vernal Pool Tadpole Shrimp

Essential Activities	Land Cover Types	Habitat Elements
Entire life cycle	Vernal impoundment, vernal pool, and vernal swale.	Topographic features characterized by mounds and swales, and depressions within a matrix of surrounding uplands that result in complexes of continuously, or intermittently, flowing surface water in the swales connecting the pools providing for dispersal and promoting hydroperiods of adequate length in the pools. Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water for a minimum of 18 days, in all but the driest years; thereby providing adequate water for incubation, maturation, and reproduction.

13.3 Species Distribution and Population Trends

There are six species of *Lepidurus* in North America (Rogers 2001) distributed throughout arctic Canada, Alaska, and Greenland and western portions of the United States and Mexico. The vernal pool tadpole shrimp is endemic to California (Rogers 2001).

Habitat occupied by tadpole shrimp tends to exist on level open ground. This geomorphic setting tends to be the most desirable for agricultural, urban or industrial development. As a result, the grassland plateaus and floor of the Great Central Valley has been broadly converted by human use. Consequently, an unknown amount of vernal pool habitat has been lost, and an unknown number of vernal pool tadpole shrimp occurrences as well, although there have been attempts to calculate the lost acreages (Holland 1978, 1988, 1998; Bauder and McMillan 1988). Due to current pressures of the increasing human populations in California, more habitat for vernal pool tadpole shrimp will and is being encroached upon and impacted throughout the species range.

13.3.1 Range Wide Distribution

The vernal pool tadpole shrimp was originally described by Simon (1886) from "California," and the types were apparently lost (Rogers 2001). Linder (1952) reported the vernal pool tadpole shrimp from the California Central Valley one mile north of Davis, Yolo County, and from the California Great Basin. Longhurst (1955) synonymized both the vernal pool tadpole shrimp and *Lepidurus couesii* with the Eurasian *L. apus* (Linneaus) 1756. Lynch (1972) redescribed *L. couesii* and provided specific morphological characters for the genus *Lepidurus* in North America, emphasizing that both the vernal pool tadpole shrimp and *L. couesii* are taxa distinct from each other and from *L. apus.* Lynch deposited material at the U. S. National Museum of Natural History identified as the vernal pool tadpole shrimp from the Great Basin Regions of south central Oregon.

The USFWS gave the vernal pool tadpole shrimp protection as an endangered species in 1994 (59 FR 48153). It was reported at that time that the vernal pool tadpole shrimp was known only from 14 occurrences in the Central Valley of California, but did not mention the Linder or Lynch references or material, although the references were cited.

Helm (1998) reported *L. couesii* from the east side of the Cascade Mountains in Lassen County, California, and *Lepidurus* n. sp., the "Modoc Plateau Tadpole Shrimp" from two locations in Modoc County, California, citing King pers. comm. as his source for the shrimp's identification. King and Hanner (1998) performed 12S rDNA and allozyme analysis of *Lepidurus* populations throughout western North America, reporting a taxon they referred to as "*L. couesii*-1" from Klamath County, Oregon, and the east side of the Casacade Mountains in Shasta and Lassen counties, California. In addition, they mention Linder's Lassen County vernal pool tadpole shrimp material, but do not comment on its implications. King and Hanner concluded that *L. couesii* populations from Manitoba, Canada may represent a separate species from "*L. couesii*-1" in the Sierra Nevada, Cascade Mountains and Great Basin regions of northeastern California and south-central Oregon. Furthermore, King and Hanner stated: "Because our Oregon locality. . . seems to be the same as one of the sites from which Linder (1952) examined material (i.e., near Klamath Falls, OR) we suggest that the California/Oregon clade should retain the name *L.*

couesii." However, Rogers (2001) demonstrated that the specimens from King and Hanner's "*L. couesii*-1" localities are morphologically distinct from the type specimens of *L. couesii* from Montana and thus their suggestion that the specific name *couesii* be applied to the taxon they call "*L. couesii*-1"cannot be accepted. Furthermore, Rogers demonstrated that the *Lepidurus* that Linder and Lynch had identified as the vernal pool tadpole shrimp were actually an unrecognized cryptic species, which he described. This cryptic species *Lepidurus cryptus* Rogers 2001, is morphologically indistinguishable from the vernal pool tadpole shrimp, and hence the confusion. Rogers (2001) quantitatively established the vernal pool tadpole shrimp as endemic to the Central Valley of California.

13.3.2 Central Valley Distribution

In 1994, the USFWS reported that there were 14 known occurrences of the vernal pool tadpole shrimp ranging from the Vina Plains in Tehama County, through most of the length of the Sacramento Valley to Sacramento, and west to Solano County at the Jepson Prairie (59 FR 48153).

Since then, vernal pool tadpole shrimp have been reported from throughout Sacramento, Colusa and Glenn Counties, as well as Central Valley portions of Tehama County, Butte County, Sutter County, Yuba County, Placer County, Stanislaus County, Madera County, Fresno County and Tulare County on the east side of the valley (Eriksen and Belk 1999), and Alameda County, Solano County, Yolo County, Colusa County and Glenn County on the west side (Rogers 2001).

13.3.3 Range within the Plan Area

The vernal pool tadpole shrimp was first officially reported from the Plan Area in 1982 (CDFG 2010); however, specimens were collected from near Mather Air Force Base as early as 1967 by Dr. Clyde Eriksen (Eriksen, pers. comm.). Numerous surveys related to development projects have been conducted within and adjacent to the Plan Area (USFWS records; CDFG 2010), but the area has not been thoroughly surveyed for vernal pool tadpole shrimp, and the total extent of potential habitat is unknown. Figure VPTS-1 illustrates the known recorded occurrences of vernal pool tadpole shrimp within Sacramento County. The range of the species in the Plan Area is considered to be vernal habitats embedded in grassland and oak savannah.

13.3.4 Population Levels and Trends

An unknown amount of vernal pool habitat has been lost and with it an unknown number of vernal pool tadpole shrimp occurrences. Attempts have been made to calculate lost vernal pool acreages (for example: Holland 1978, 1988, 1998; Bauder and McMillan 1988). Due to current pressures of the increasing human populations in California and Oregon, more habitat for vernal pool tadpole shrimp will be and is being encroached upon and impacted throughout the species range.

Adequate determination of remaining vernal pool tadpole shrimp occurrences throughout the animal's range as well as population trends is difficult. The USFWS (1994) listed 14 known occurrences of the vernal pool tadpole shrimp. These data were collected during a prolonged drought in California. Sugnet and Associates (1993) submitted a study claiming 345 'discrete locations' supporting the vernal pool tadpole shrimp, however as specific localities were not divulged, the data are unverifiable and therefore not scientifically useful in any type of analyses. Rogers (2001) presents a map and a list of 23 specific localities for the vernal pool tadpole shrimp represented.

The California Natural Diversity Data Base (CNDDB) vernal pool crustacean records (CDFG 2010) may be somewhat misleading, due to the inconsistency of the data presented. Some records refer to individual pools, while others refer to pool complexes, and others still refer to groups of complexes. Additionally, the CNDDB does is not updated when a particular site or population is extirpated. Because of issues such as these, it is difficult to determine what actually constitutes a "population" or "occurrence" in any attempt at impact analysis.

In addition, survey maps and records tend to show where vernal pool crustaceans are, and do not emphasize where they are not. Compounding these difficulties, records are typically a reflection of where surveys have been conducted, rather than a delineation of special-status shrimp distribution. Therefore, it is difficult to establish baseline conditions for this species across the entire species range, as well as within the Plan Area. None of this is to say that vernal pool crustaceans are not threatened, endangered, or should not be protected. The issue is that where a paucity of adequate data exists, consistent data reporting would help prevent ambiguous interpretation or mischaracterization of species conservation needs.

13.4 Threats to the Species

As described previously, the greatest threat to vernal pool invertebrates is the elimination, loss, or modification of their habitat by development. The filling of vernal pools or modification of the watershed that supports those pools either eliminates the habitat or disrupts the pool ecosystem so that it is overcome by opportunistic invertebrate species and invasive, opportunistic and non-native plants, that outcompete the obligatory vernal pool species (Rogers 1998).

Excessive livestock grazing in vernal pool terrain can be detrimental to vernal pool invertebrate communities. Overgrazing tends to result in large amounts of manure in vernal pools. The decomposition of organic waste removes oxygen from the water, leaving gill-breathing invertebrates without oxygen (Rogers 1998, pers. obs,). Conversely, vernal pool grasslands are disturbance systems, and need a certain amount of grazing. Vernal pools that have all grazing removed may become overgrown with native (e.g., *Eleocharis* sp., *Eryngium* sp.) and exotic plants (e.g., *Glyceria* sp. *Lolium multiflorum*) that generate deep thatch layers on the pool substrate. As this thatch layer decomposes, it also removes oxygen from the water, which can suffocate gill-breathing invertebrates (Rogers 1998). Both lack of and excessive grazing cause an increase in organic matter in the habitat that eliminates the natural vernal pool invertebrate community, and promotes opportunistic and invasive species, that outcompete the obligatory vernal pool species (Rogers 1998). Therefore, moderate grazing, or other disturbance may be a necessary habitat suitability component, and the removal of grazing or excessive grazing are threats to the vernal pool tadpole shrimp.

Damage to the watershed that supports vernal pools and vernal pool complexes will impact vernal pool invertebrate communities. Elimination of the watershed will not allow the pools to pond properly and will curtail the movement of nutrients into the pool from overland flow (Rogers 1998). Road run-off entering the watershed and conveyed to occupied habitat through the watershed may carry petroleum by-product residue or sediment from vehicles, paving, or road maintenance activities. Furthermore, pesticide, herbicide, fertilizer, and sediment run-off from agricultural activities may enter the watershed and be conveyed to occupied habitat, and may be injurious to vernal pool invertebrates. Ground disturbance from development activities may loosen soil that that may enter the watershed and be conveyed to occupied habitat as sediment.

Non-native invasive species are a threat to vernal pool invertebrate communities. There is concern that bullfrogs (*Rana catesbeiana*) may feed upon federally protected vernal pool crustaceans (Balfour and Morey 1999). Manna grass (*Glyceria declinata*) and Italian rye grass are both exotic plants that occur in vernal pools, tend to produce heavy thatch and eventually create organic loads upon decomposition, which reduce dissolved oxygen in the water (Rogers 1998). In addition, people may introduce the non-discriminating predatory mosquitofish (*Gambusia affinis*) into vernal pools to control perceived local mosquito problems (Rogers pers. obs.).

Habitat fragmentation is a threat to vernal pool invertebrates in that the development surrounding small pool complexes may prevent waterfowl or shorebirds from feeding at the pools, thereby preventing genetic flow between occupied habitats. Furthermore, small pool complexes surrounded by development will not be buffered against the run-off from developed areas, and concomitant changes in the watershed hydrology.

Additional threats to the vernal pool invertebrate community structure includes: off-road vehicle use of vernal pool habitat for recreational "mud-bogging;" conversion of vernal pools into deep stock tanks that do not dry during the summer; and draining of vernal pools.

13.5 Data Gaps and Conservation Implications

Restoration and creation of habitat for vernal pool tadpole shrimp has been demonstrated to be feasible (Rogers 1998). However, specific habitat parameters for this and other vernal pool invertebrate species are still poorly understood. For example, there appears to be a need by this species to have a minimum pool volume and a minimum pool surface area within a given habitat to be occupied. Since this species has been found in a wide variety of natural and artificial vernal pool habitats, it is likely that it is in some respects an opportunist, as most temporary water fauna must be.

The primary data gap regarding conservation of vernal pool invertebrates is lack of distributional data for the species within and adjacent to the SSHCP Study Area. Since the SSHCP is assuming that all potential habitat within the SSHCP study area is occupied by vernal pool tadpole shrimp, and it is not feasible economically or temporally to survey the entire SSHCP Study Area, it may be expedient to estimate vernal pool tadpole shrimp distribution through aerial photographic interpretation. Some specific areas will need to be physically verified as to whether they support potential habitat for vernal pool tadpole shrimp. Additionally, artificial habitats like railroad toe-drains, stock tanks, and roadside scrapes will also need to be verified. In addition, quantitative bioassessment may be necessary to determine the ecological functions and values of selected preserve area vernal pools to assess their suitability and value as preservation habitats.

Other data gaps include the role of the surrounding uplands in vernal pool habitats, and importance of seasonality and intensity of grazing and other disturbances in vernal pool ecosystems. Furthermore, quantitative bioassessment may be necessary to determine the ecological functions and values of selected preserve area vernal pools to assess their suitability and value as preservation habitats.

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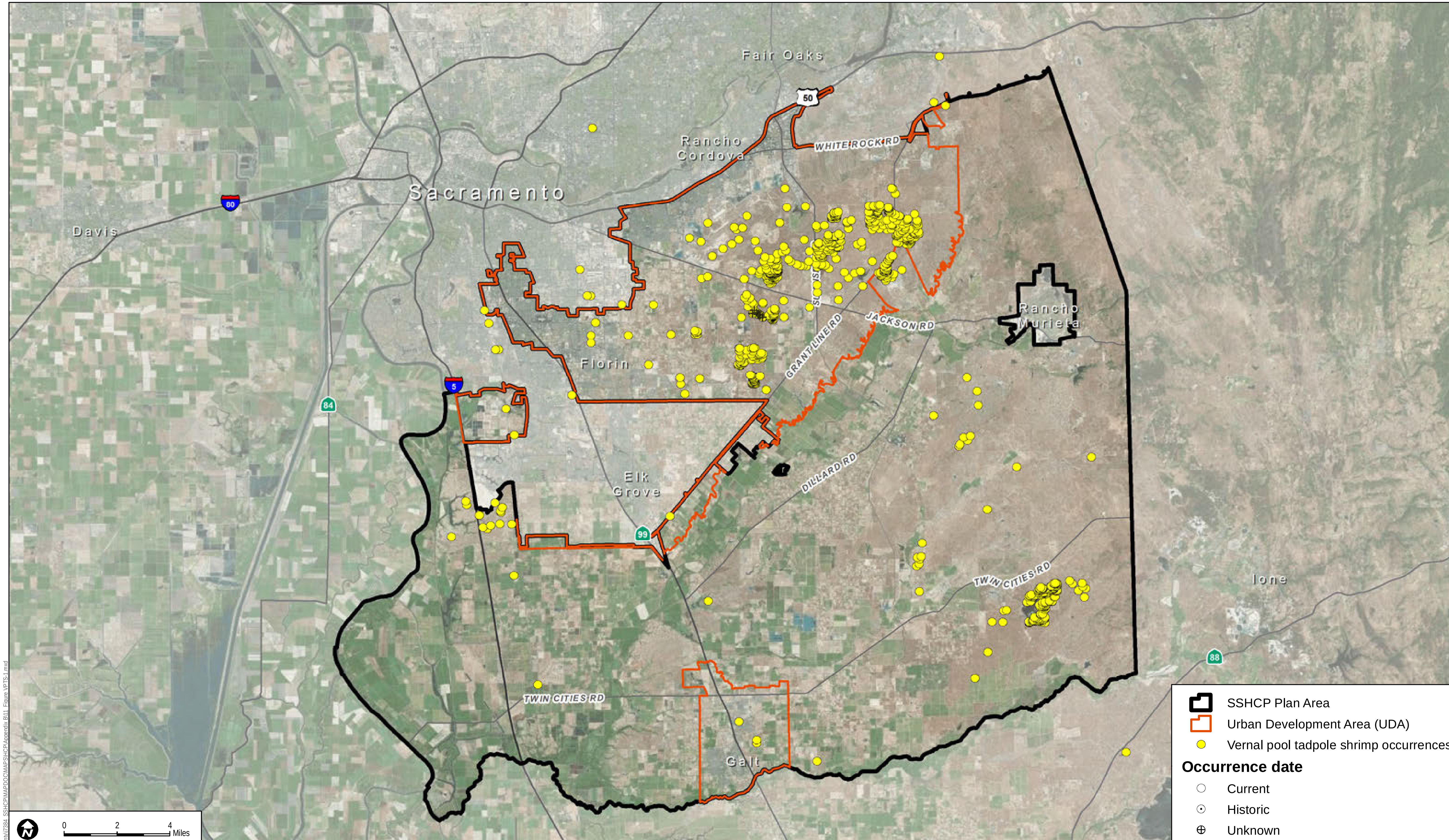

SOURCE: Bing Maps, County of Sacramento 2014, CDFG 2012, C. Witham 2011, C. Little 2011,ECORP 2012, EcoAnalysts 2008, Foothill Associates 2011, Gibson & Skordal 2011, Helm 2011, Richard Hill 1999, Sugnet & Associated 1997, Kassiss-Sylva 2011, Kiefer 2011, LSA 2009, USFWS 2014, Vollmar 2011, Wildlands 2010

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

FIGURE VPTS-1

Vernal Pool Tadpole Shrimp Documented Occurrences

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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14 CALIFORNIA TIGER SALAMANDER (CTS)

Prepared by May Consulting (Jamison Watts)

California Tiger Salamander (CTS)

(Ambystoma californiense)

Status USFWS: Threatened

Status CDFG: Threatened

14.1 Legal Status

In August 2004, the United States Fish and Wildlife Service (USFWS) listed the California tiger salamander (*Ambystoma californiense)* as threatened range-wide, downgrading the status of the Santa Barbara and Sonoma Counties populations from endangered to threatened. To promote conservation efforts of the California Tiger Salamander (CTS), the USFWS also adopted a special rule under section 4(d) of the Federal Endangered Species Act (ESA) of 1973, which allows the Secretary of the Interior to issue a "special rule" tailored to meet the conservation needs of a particular threatened species (special rules cannot be issued for endangered species). Based on the 4d rule, "take" of the threatened CTS caused by existing routine ranching activities on private, State or tribal lands is exempt from the prohibitions of the ESA. The intent of the 4d rule is to allow landowners and ranchers to continue activities that are important for livestock operations, as those activities also maintain habitat for the CTS.

In March 2010, the California Fish and Game Commission (Commission) voted that listing of the CTS pursuant to the California Endangered Species Act (CESA) was warranted. The CDFG will initiate the formal listing process by preparing an Initial Statement of Reasons for Regulation Change (or Pre-publication of Notice Statement) according to Government Code Section 11346.4 for consideration by the Commission. This preparation includes an assessment of the potential for adverse economic impacts. This is likely to occur prior to the next commission meeting with the document issued at that meeting. Once approved by the Commission, a 45-day comment period will follow upon publication of the notice of proposed rulemaking in the California Regulatory Notice Register. If the CDFG modifies the proposed rule following the comment period, then it will notice an additional 15-day comment period on any new material relied upon and on the proposed modifications. The next steps are then adoption by the Commission and review by the Office of Administrative Law. While this process could move quickly, final action could still be many months away in the future. Technically, the CTS is not a listed species until the Commission adopts the final rule. However, until then, it remains protected as a candidate species, meaning that take of CTS is prohibited under CESA without CDFG authorization.

14.2 Life History and Ecology

14.2.1 Species Description and Life History

14.2.1.1 Taxonomy

In 1853, Gray first described CTS as *Ambystoma californiense* based on specimens that he collected in Monterey, California (Grinnell and Camp 1917). Storer (1925) and Bishop (1943) also considered CTS to be a distinct species; however, Dunn (1940), Gehlbach (1967) and Frost (1985) believed CTS to be a subspecies of the more widespread eastern tiger salamander (*A. tigrinum*). Nonetheless, based on recent studies of the geographic distribution, phylogenetics, and ecological differences among the members of the *A. tigrinum* complex, the CTS has been determined to represent a distinct species (Shaffer and Stanley 1991; Jones 1993; Shaffer et al. 1993; Shaffer and McKnight 1996; Irschick and Shaffer 1997; Petranka 1998). Furthermore, the range of this amphibian does not naturally overlap with any other species of tiger salamander (*Ambystoma* spp.) (Stebbins 1985; Petranka 1998).

14.2.1.2 Species Description

CTS is a large, stocky terrestrial salamander with small eyes and a broad, rounded snout. Adults may reach a total length of 208 millimeters (8.2 inches), with males generally averaging 203 millimeters (8 inches) in total length, and females averaging 173 millimeters (6.8 inches) in total length. For both sexes, the average snout-to-vent length is approximately 91 millimeters (3.6 inches). The small eyes have black irises and protrude from the head. Coloration consists of white or pale yellow spots or bars on a black background on the back and sides. Ventral coloration varies from almost uniform white or pale yellow to a variegated pattern of white or pale yellow and black. Males can be distinguished from females, especially during the breeding season, by their swollen cloacae, larger tails, and larger overall size (Stebbins 1962; Loredo and Van Vuren 1996).

14.2.1.3 Reproduction

Adult CTS breed in vernal pools and similar seasonal water bodies. The females lay their eggs in the water (Twitty 1941; Shaffer et al. 1993; Petranka 1998) in groups of two to four, on twigs, grass stems, vegetation, or debris (Storer 1925; Twitty 1941). In ponds with little or no vegetation, females may attach eggs to objects under the water, such as rocks and boards on the pool's bottom (Jennings and Hayes 1994). In the East San Francisco Bay Area (Bay Area), CTS may lay eggs twice, once in December and again in February (Bobzien 2003). After breeding, adults leave the pool and return to small mammal burrows in surrounding uplands (Loredo et al. 1996; Trenham 1998a), where they may continue to come out nightly for approximately the next two weeks to feed (Shaffer et al. 1993). In drought years, seasonal pools may not form and the adults may not breed (Barry and Shaffer 1994).

The eggs hatch in 10 to 14 days with newly hatched CTS larvae ranging in size from 11.5 to 14.2 millimeters (0.5 to 0.6 inches) in total length (Petranka 1998). The larvae are aquatic, yellowish gray in color and have a broad fat head, large, feathery external gills, and broad dorsal fins that extend well onto the back. They feed on zooplankton, small crustaceans, and aquatic insects for approximately six weeks after hatching, after which time they begin foraging for larger prey (P. Anderson 1968). Larger larvae have been known to consume smaller tadpoles of Pacific treefrogs (*Pseudacris regilla*) and California red-legged frogs (*Rana draytonii*) (J. Anderson 1968). CTS larvae are among the top aquatic predators in seasonal pool ecosystems. Often resting on pool bottoms in shallow water, larvae also may be found at different layers in the water column in deeper water. Young CTS are wary and commonly dart into vegetation on the bottom of pools when approached by potential predators (Storer 1925).

As most seasonal ponds and pools dry up during the summer, the larval stage of CTS usually lasts three to six months (Petranka 1998), although some larvae in Contra Costa and Alameda Counties may remain in their breeding sites over the summer (Shaffer and Trenham 2002). The absence of paedomorphism (mature adults that retain larval characteristics) in the species suggests that CTS are unable to express this life history trait, presumably because most of their evolutionary history has been spent in seasonal vernal pool habitats (Shaffer and Trenham 2002).

Before they can metamorphose (change into a different physical form) into the terrestrial stage, amphibian larvae must reach a critical minimum body size (Wilbur and Collins 1973). Larvae collected near Stockton in the Central Valley during the spring varied from 47 to 58 millimeters (1.9 to 2.3 inches) in length (Storer 1925). Feaver (1971) found that larvae metamorphosed and left the breeding pools 60 to 94 days after the eggs had been laid, with larvae developing faster in smaller, more rapidly drying pools. The longer the inundation period, the larger the larvae and metamorphosed juveniles are able to grow, and the more likely they are to survive and reproduce (Semlitsch et al. 1988; Pechmann et al. 1989; Morey 1998; Trenham 1998b). Pechmann et al. (1989) found a strong positive correlation between inundation period and total number of metamorphosing juvenile amphibians. P. Anderson (1968) and Feaver (1971) determined that CTS larvae perish, if a site dries before they complete metamorphosis. In Madera County, Feaver (1971) found that only 11 of 30 pools sampled supported larval CTS, and five of these dried before metamorphosis could occur. Out of the original 30 pools, only six (20 percent) provided suitable conditions for successful reproduction that year. Size at metamorphosis is positively correlated with stored body fat and survival of juvenile amphibians, and negatively correlated with age at first reproduction (Semlitsch et al. 1988; Scott 1994; Morey 1998).

Lifetime reproductive success for CTS and other tiger salamanders is low. Trenham et al. (2000) found the average female bred 1.4 times and produced 8.5 young that survived to metamorphosis per reproductive effort. This resulted in roughly 11 metamorphic offspring over the lifetime of a female. Preliminary data suggest that most individuals of CTS require two years to become sexually mature, but some individuals may be slower to mature (Shaffer et al. 1993). Some animals do not breed until they are four to six years old. While individuals may survive for more than 10 years, many breed only once, and in some populations, less than five percent of marked juveniles survive to become breeding adults (Trenham 1998b). With such low recruitment, isolated populations can decline greatly from unusual, randomly occurring natural events as well as from human caused factors that reduce breeding success and individual survival. Furthermore, factors that repeatedly lower breeding success in isolated ponds that are too far from other ponds for migrating individuals to replenish the population have the potential of quickly extirpating a population.

14.2.1.4 Diet and Foraging

Post-metamorphic juveniles and adults of CTS appear to be “sit-and-wait” predators similar to the closely related *Ambystoma tigrinum*, taking earthworms, snails, insects, fish, and even small mammals (Stebbins 1972). CTS larvae prey on vernal pool macroinvertebrates (Stebbins 1972), but also take other amphibian larvae once they attain sufficient size.

14.2.1.5 Dispersal and Migration

Movements made by CTS can be grouped into two main categories: (1) breeding migration, and (2) post-metamorphosis dispersal. Breeding migration is the movement of adult CTS between a breeding pond and the surrounding upland habitat during a reproductive cycle while post-metamorphosis dispersal involves recently metamorphosed individuals leaving their natal pond and moving into the surrounding upland habitat. CTS are also known to exhibit what has been termed interpond dispersal, but this is considered to be a breeding migration. Though not yet supported by empirical data, it is believed that dispersing post-metamorphs sometimes encounter other suitable breeding ponds during dispersal and then return to these other ponds upon maturing rather than return to their natal pond (Bumgardner pers. comm.). The benefits of such an evolutionary strategy are apparent when considering that seasonal wetlands appear and disappear over time as older pools fill and new pools are created. Following breeding, adult CTS return to upland habitats, where they may live for one or more years before breeding again (Trenham et al. 2000). Adult CTS have been observed up to 2,092 meters (1.3 miles) from breeding ponds (S. Sweet *in litt.* 1998), which may be vernal pools, stock ponds, or other seasonal or perennial water bodies. A recent trapping effort in Contra Costa County captured CTS 805 meters (2,641 feet) to 1,207 meters (3,960 feet) from the nearest breeding aquatic habitat (USFWS 2004b). Trenham et al. (2001) observed CTS moving up to 670 meters (2,200 feet) between breeding ponds in Monterey County. Similarly, in an experimental study, Trenham and Shaffer (2005) found that 95 percent of CTS resided within 640 meters (2,100 feet) of their breeding pond at Jepson Prairie in Solano County. Trenham et al. (2001) recommended that plans to maintain local populations of CTS should include pond(s) surrounded by at least 173-meter (567-feet) wide buffers of terrestrial habitat occupied by burrowing mammals. The distance between the upland and breeding sites is thought to depend on local topography and vegetation, and the distribution of California ground squirrel or other rodent burrows (Stebbins 1989). The rate of natural movement of salamanders among breeding sites depends on the distance between the ponds or complexes of ponds and on the quality of intervening habitat (e.g., salamanders may move more quickly through sparsely covered and open grassland than they can through densely vegetated lands) (Trenham 1998a).

After metamorphosis, juveniles move away from breeding ponds into the surrounding uplands, where they live continuously for several years. Upon reaching sexual maturity, most individuals return to their natal (birth) pond to breed, while others disperse to other ponds (Trenham et al. 2001). Some data suggest that juvenile CTS disperse further into upland habitats than adult CTS. A trapping study conducted in Solano County during winter 2002–03 found that juveniles used upland habitats further from breeding ponds than adults (Trenham and Shaffer 2005). More juvenile CTS were captured at distances of 100, 200, and 400 meters (300, 600, and 1,300 feet) respectively, from a breeding pond than at 50 meters (160 feet). Approximately 20 percent of the total captures were found 400 meters (1,300 feet) from a breeding pond. Fitting a distribution curve to the data revealed that 95 percent of juvenile CTS could be found within 640 meters (2,000 feet) of the pond, with the remaining five percent being found at even greater distances. In the same study, post-breeding movements away from breeding ponds by adults appear to be much shorter. During post-breeding emigration, radio-equipped adult CTS were tracked to burrows 19 to 248 meters (62 to 813 feet) from their breeding ponds (Trenham 2001). These reduced movements may be due to adult CTS having depleted physical reserves post-breeding, the drier weather conditions that are typical of the period when adults leave the ponds, or reduced reproductive/bioenergetic benefits from traveling further away from a breeding pond.

When studying interpond dispersal, documented dispersers moved no more than 670 meters (2,200 feet) from breeding sites in Monterey County, and based on a projected exponential relationship between dispersal probability and distance, less than one percent of dispersers were likely to move between ponds separated by 1,160 meters (0.70 miles) (Trenham et al. 2001). The frequency of dispersal among known extant occurrences or subpopulations ultimately depends on the distance between the ponds or complexes and on the intervening habitat (Trenham et al.

2001). Moreover, the distance between upland refugia and breeding sites depends on local topography and vegetation, and the distribution of California ground squirrel or other rodent burrows (Stebbins 1989). Unlike other ambystomatid salamanders, CTS and other tiger salamanders are grassland animals and do not favor forested areas as corridors for movement or long-term residence. Trenham (2001) found that radio-tracked adults favored grasslands with scattered large oaks over more densely wooded areas. Based on the Monterey County study, Trenham et al. (2001) recommends that plans to maintain local populations of CTS should include pond(s) surrounded by at least 173-meter (567-foot) wide buffers of terrestrial habitat occupied by fossorial (burrowing) mammals.

14.2.1.6 Survivorship

Individual CTS have been known to live more than 10 years (Stebbins 1951; Trenham et al. 2000) and at least one specimen was known to live beyond 20 years (USFWS 2004a). CTS eggs are susceptible to desiccation, and predation by fish, crayfish, and insect larva (Stebbins 1972; Zeiner et al. 1988). CTS larvae are preyed upon by native frogs, garter snakes, egrets, herons (Zeiner et al. 1988) and the introduced bullfrog (*Rana catesbeiana*) (Anderson 1968). In addition, current research has suggested a negative correlation between larvae and the presence of predatory fishes including mosquitofish (*Gambusia affinis*) (USFWS 2004b). During their seasonal migration to ponds, adult CTS are preyed upon by raccoons (*Procyon lotor*) (USFWS 2004a). Adults are also highly susceptible to mortality from vehicle traffic if roads are constructed between their breeding and aestivation sites (Shaffer et al. 1993).

14.2.2 Habitat Requirements and Ecology

Rangewide, suitable habitat for CTS includes vernal pools, and seasonal and perennial ponds, and surrounding upland areas in grassland, oak savannah, edges of mixed hardwood-conifer woodland and low elevation coniferous forest plant communities from sea level to about 1,067 meters (3,600 feet) (Stebbins 1989; Stebbins 2003; Shaffer et al. 1993; Jennings and Hayes 1994; Petranka 1998; CDFG 2010; Bobzien 2003; USFWS 2004a).

14.2.2.1 Wetland Habitat and Aquatic Ecology

Once fall or winter rains begin, adult CTS emerge from their upland refugia at night to feed and migrate to the breeding ponds (Stebbins 1985, 1989; Shaffer et al. 1993). Males migrate to the breeding ponds before females (Twitty 1941; Shaffer et al. 1993; Loredo and Van Vuren 1996; Trenham 1998b) and usually remain there for approximately six to eight weeks, while females stay for approximately one to two weeks. In dry years, both sexes may stay for shorter periods (Loredo and Van Vuren 1996; Trenham 1998b). Most marked salamanders have been recaptured at the pond where they were initially captured. In one study, approximately 80 percent were recaptured at the same pond over the course of three breeding seasons (Trenham 1998b). A CTS breeding site is defined as a location where CTS are able to successfully breed in years of normal rainfall and persist during the dry months of the year. Therefore, suitable habitat includes both suitable wetlands and surrounding uplands.

Historically, vernal pools and other natural seasonal ponds and surrounding uplands constituted primary breeding sites utilized by CTS (Storer 1925; Feaver 1971; Zeiner et al. 1988; Trenham et al. 2000). Vernal pools typically form in topographic depressions underlain by an impervious layer such as claypan, hardpan, or volcanic strata that prevents the downward percolation of water. Vernal pool hydrology is characterized by inundation of water during the late fall, winter, and spring, followed by complete desiccation during the summer dry season (Holland and Jain 1988). Vernal pools support a diverse and highly evolved biota that has adapted to the ever-changing water regime and benefits from the lack of predation by non-native fish. Twenty-nine other federally or State-listed species within the range of CTS are vernal pool specialists, including 24 plants, four crustaceans, and one insect (Keeler-Wolf et al. 1998). CTS, like listed vernal pool crustaceans, inhabit these seasonally inundated habitats. However, listed vernal pool crustaceans require a relatively short period of inundation to complete their life cycle (USFWS 2004b). Therefore, many pools that support crustaceans may not hold water long enough to allow successful metamorphosis of CTS. In a study of amphibians located in eastern Merced County, CTS larvae were only observed in the largest vernal pools (Laabs et al. 2001). Unlike vernal pool crustaceans, CTS can breed and metamorphose in perennial ponds.

Stock ponds for cattle, sheep, horses, and other livestock have been, and continue to be, built to supply local water needs, especially in rural grazing lands in coastal and Sierra Nevada foothill areas (Bennett 1970) and in the absence of historical breeding ponds, have become important aquatic habitats for the CTS throughout its range (USFWS 2004a). These artificial water bodies have become especially important to CTS breeding success in the Bay Area and Coast Range regions where vernal pool complexes have been largely extirpated (Stebbins 1985; Zeiner et al. 1988; Shaffer et al. 1993; CDFG 2004). Of the 155 CTS locality records in the East Bay Area (Alameda and Contra Costa Counties) where the wetland type was identified, 85 percent (131 sites) were located in stock ponds (CDFG 2004). However, management of these water bodies ultimately determines their suitability as CTS breeding habitat (USFWS 2004a). As is true of natural vernal pools, the inundation period of stock ponds can be insufficient in allowing larvae to metamorphose (e.g., when early drawdown of irrigation ponds occurs). Conversely, in contrast to natural vernal pools, stock ponds may be perennial in nature and support predatory fish and bullfrogs, known predators of CTS (Shaffer et al. 1993; Seymour and Westphal 1994). In addition, inappropriate management of ponds can threaten CTS rangewide by increasing sedimentation of breeding ponds and impacts from stock animals (Hamilton and Jepson 1940; Prunuske 1987). In addition, stock ponds may be geographically isolated from other seasonal wetlands occupied by CTS, and newly created ponds may be located beyond the maximum dispersal distances of juvenile or adult salamanders. However, it is possible that during this species' lifetime, individuals from sub-populations could migrate between aquatic and upland habitats, colonizing newly created and geographically isolated ponds provided the intervening habitat could be successfully traversed by dispersing CTS (USFWS 2004a).

14.2.2.2 Upland Habitat and Terrestrial Ecology

The upland component of CTS habitat typically consists of grassland or oak savannah (Shaffer et al. 1993; USFWS 2004a); however, in Santa Barbara and eastern Contra Costa Counties, some CTS breeding ponds occur in grasslands within scrub or chaparral habitats (Shaffer et al. 1993; USFWS 2004a). CTS typically utilize burrows in open grassland or under isolated oaks, and less commonly in woodlands (Shaffer et al. 1993). CTS cannot dig their own burrows and depend on fossorial mammals such as California ground aquirrel (*Spermophilus beecheyi*) and Botta's pocket gopher (*Thomomys bottae*) (Storer 1925; Seymour and Westphal 1994; Loredo and Van Vuren 1996; Petranka 1998; Trenham 1998a) for upland wintering sites.

A key component of CTS habitat, upland wintering sites are where subadult and adult CTS spend the dry summer and fall months of the year aestivating (a state of dormancy or inactivity in response to hot, dry weather). During this time, CTS eat very little (Shaffer et al. 1993). In Sonoma County, occurrence of CTS is significantly associated with occurrence of gophers (USFWS 2004b). The utilization of ground squirrel and gopher burrows by CTS suggests a commensal relationship between these species (Loredo et al. 1996); therefore, active fossorial rodent populations are likely required to sustain CTS as inactive burrow systems become progressively more unsuitable over time. Loredo et al. (1996) found that California Ground Squirrel burrow systems collapsed within 18 months following abandonment by, or loss of, fossorial mammals. CTS use both occupied and unoccupied burrows and movement within and between burrow systems continues for at least several months after CTS return from the breeding ponds (Trenham 2001; Shaffer and Trenham 2004).

Metamorphosed juveniles leave their natal ponds in the late spring or early summer. Before the ponds dry completely, these individuals settle in small mammal burrows, to which they return at the end of nightly movements (Zeiner et al. 1988; Shaffer et al. 1993; Loredo et al. 1996). Similar to the adults, juveniles may emerge from these retreats to feed during nights of high relative humidity (Storer 1925; Shaffer et al. 1993) before settling in their selected upland sites for the dry, hot summer months. While most CTS rely on rodent burrows for shelter, some individuals may utilize soil crevices as temporary shelter during dispersal or migration (Lorendo et al. 1996).

14.2.2.3 *Essential Habitat Elements*

Essential habitat elements are those basic aspects of the environment which are needed for survival and propagation of the species. The essential habitat elements for CTS are identified in Table CTS-1 and have been derived from the USFWS's list of primary constituent elements identified in the Designation of Critical Habitat for the CTS, Central Population: Final Rule (USFWS 2005) as well as input from local species experts.

Table CTS-1
Essential Habitat Elements for California Tiger Salamander

Essential Activities	Land Cover Types	Habitat Elements
Breeding and larval development	Vernal impoundment, vernal pool, and seasonal impoundment.	Provide suitable wetlands (i.e., wetlands must be inundated with winter rain for a minimum of 12 weeks in a year of average rainfall). Seasonal wetlands are preferred, but permanent man-made ponds may be used so long as predatory fish are absent.
Foraging, dispersal, migration, and summer Inactivity	Blue oak savanna, blue oak woodland, and valley grassland.	Provide upland habitat suitable for dispersal, migration, and over-summering. Must also contain small mammal burrows or other underground habitat that CTS depend upon for food, shelter, and protection from the elements and predation.

14.3 Species Distribution and Population Trends

14.3.1 Range-wide Distribution

Genetic studies of the CTS suggest that levels of interchange among populations are very low, and that populations or groups of subpopulations (metapopulations) are genetically isolated from one another (Shaffer et al. 1993; Shaffer and Trenham 2002). Studies of mitochondrial DNA and allozymes (proteins) indicate that there are six populations of *A. californiense*, which are found in the following areas: (1) Santa Rosa area of Sonoma County; (2) Bay Area (central and southern Alameda, Santa Clara, western Stanislaus, western Merced, and the majority of San Benito counties); (3) Central Valley (Yolo, Sacramento, Solano, eastern Contra Costa, northeast Alameda, San Joaquin, Stanislaus, Merced, and northwestern Madera counties); (4) southern San Joaquin Valley (portions of Madera, central Fresno, and northern Tulare and Kings counties); (5) Central Coast Range (southern Santa Cruz, Monterey, northern San Luis Obispo, and portions of western San Benito, Fresno, and Kern counties); and (6) Santa Barbara County (Shaffer and Trenham 2002).

Along the Coast Ranges, the species occurs in the Santa Rosa area of Sonoma County, southern San Mateo County south to San Luis Obispo County, and the vicinity of northern Santa Barbara County (CDFG 2010). In the Central Valley and surrounding Sierra Nevada foothills and Coast

Ranges, the species occurs from northern Yolo County (Dunn 1940) southward to northwestern Kern County and northern Tulare and Kings Counties (CDFG 2010). Other occurrences of CTS from Lake and Mono Counties outside the range of the CTS have been identified as non-native Tiger Salamanders (Shaffer et al. 1993). CTS at Grass Lake in Siskiyou County (Mullen and Stebbins 1978) have been identified as the northwestern tiger salamander (*A. t. melanostictum*) (USFWS 2004b). The USFWS notes several historical occurrences of individual CTS outside its current range. In the northeastern Sacramento Valley, there is a single occurrence located at the Gray Lodge Waterfowl Management Area in southern Butte County and northern Sutter County, and there is also a single occurrence located in Glenn County; both of these records are from the mid 1960s (CDFG 2010). There are two records from 1939 and another, from an unknown date, of CTS recorded from the edge of the range in southwestern San Luis Obispo County (CDFG 2010; Shaffer and Trenham 2002); however, it should be noted that these latter two records have recently been shown to be misidentified specimens (Hunt 2009). There is also a historic record of CTS from outside the species' range in Riverside County that was recorded in the late 1800's (CDFG 2010); however, subsequent surveys have not been able to verify the presence of CTS from this latter location (Stebbins 1989; Shaffer et al. 1993).

Although the area between Butte County and the Cosumnes River contains suitable vernal pools and has been surveyed extensively, the species has only been recorded along the southern edge of Sacramento County, south of the Cosumnes River and in northern Yolo County (CDFG 2010). It is likely that the species is uncommon or absent in much of the southernmost San Joaquin Valley because of unsuitable habitat. This includes areas to the south of Los Banos in Merced County, and the foothills of the Sierra Nevada south of Visalia in Tulare County (Shaffer et al. 1993). The factors that restrict the CTS in the northern and southern extent of its range are not fully understood, but may include low rainfall in the southern San Joaquin Valley and a greater abundance of non-native predatory fish in the northern Sacramento Valley (Hayes 1977). Studies suggest that the present patchy distribution pattern was caused by a combination of the extreme anthropogenic changes in and around the Central Valley, and the restrictive breeding requirements of the species (Dahl 1990; Fisher and Shaffer 1996; Frayer et al. 1989; Holland 1978, 1998; Jones and Stokes 1987; Shaffer et al. 1993; Trenham et al. 2000). Because there are only a few historic collections of the species from the 1800's, and the majority of collections have occurred in the last 25 years (CDFG 2010) subsequent to significant changes in historic habitat-types (Shaffer et al. 1993), documentation of the historic distribution of the CTS does not exist. The USFWS based the analysis associated with listing on estimated current distribution and habitat availability and then assumed the available habitat was populated (USFWS 2004a).

14.3.2 Range within Plan Area

The California Natural Diversity Database (CNNDB) has 22 occurrence records of CTS in Sacramento County (CDFG 2010). An additional four occurrences, not reported in the CNDDB, have been recorded at Gill Ranch (Gill Ranch Survey 2003). Figure CTS-1 shows the recorded occurrences of CTS in Sacramento County. Twenty-one occurrences of CTS are outside the Urban Development Area (UDA) within the Plan Area; all of which are located south of the Cosumnes River and east of Interstate 5. Although the eastern edge of the Sacramento Valley between Butte County and the Cosumnes River contains suitable vernal pools and associated upland, and has been surveyed extensively, the species has only been recorded in the southeastern-most portion of Sacramento County in this part of the valley (USFWS 2004a).

The range of CTS in the Plan Area includes suitable wetland habitats and the grasslands and blue oak savannah south of the Consumes River in the following watersheds: South of Cosumnes River-Badger Creek, North Fork Badger Creek, Middle Laguna, Upper Laguna, Willow Creek, Town of Wilton–Cosumnes River, Arkansas Creek–Cosumnes River, Liberty Cemetery–Dry Creek, Lower Laguna, Loch Lane–Dry Creek, Grizzley South–Cosumnes River and Hadselville Creek. CTS have not been recorded north of the Cosumnes River in the Plan Area. No occurrences have been documented in this latter area despite extensive surveys in very large areas with presumably suitable habitat (e.g., Mather, Sacramento Valley Conservancy Vernal Pool Prairie Preserve, Sunrise Douglas Area, Kiefer landfill, and East of Grant Line Road (CDFG 2010).

14.3.3 Population Level and Trends

Population trends for CTS are difficult to assess due to limited data for the species. Data for the species is lacking for several reasons: 1) the species is difficult to detect; 2) CTS spend much of their life underground (Storer 1925; Feaver 1971; Shaffer et al. 1993); and 3) all individuals do not migrate to breeding pools each year (Trenham et al. 2000). Consequently, population estimates for the species are not possible and the USFWS primarily relies on measures of habitat availability as well as current and future habitat status as an indication of the status of the species.

The life history and ecology of CTS make it likely that it has a metapopulation structure (Hanski and Gilpin 1991). A metapopulation is a set of local populations or breeding sites within an area, where typically migration from one local population or breeding site to other areas containing suitable habitat is possible, but not routine. Movement between areas containing suitable habitat (i.e., dispersal) is restricted due to inhospitable conditions around and between areas of suitable habitat. Because many of the areas of suitable CTS habitat may be small, and support small numbers of CTS, local extinction of these small units may be common. A metapopulation's persistence depends on the combined dynamics of these local extinctions and the subsequent recolonization of these areas through dispersal (Hanski and Gilpin 1991, 1997; McCullough 1996; Hanski 1999).

Habitat loss has reduced the size and connectivity of patches of suitable and occupied CTS habitat (USFWS 2003, 2004b). Reduction in the extent and amount of suitable water bodies, grasslands, and other suitable upland habitats likely has eliminated connectivity among most of the known breeding sites, making recolonization of some sites more difficult following local extinction (USFWS 2003, 2004b). Furthermore, the reduction of habitat below a certain size threshold has the effect of reducing the quality of the remaining habitat by reducing the size of habitat boundaries, and making effects of other factors such as amount of food, availability of rodent burrows, pesticide use, mortality from vehicles, and predators more pronounced given the smaller area now exposed to such impacts (Semlitsch and Brodie 1998). Currently, there is not enough data to determine potential impact thresholds regarding CTS, whereby any further reduction in habitat quality or quantity would decrease survivorship or persistence (USFWS 2003, 2004a). Area of suitable habitat is likely dependent upon factors such as land-use adjacent to habitat boundaries (i.e., residential, industrial, community park), number of coterminous roads and number of vehicular trips on those roads, amount of pesticide use within the breeding pool watershed, or whether domestic animals or people have access to the site during periods when CTS are on the move and vulnerable. According to the USFWS (2003, 2004a), there is a size threshold for habitat below which the combination of various impacts will result in the loss of more CTS than the fragmented populations can produce and local extinction will occur.

14.4 Threats to the Species

Although certain factors are known to contribute to CTS decline range-wide, exactly how and to what extent they affect the decline are largely unknown. Activities that directly remove or replace suitable habitat with incompatible land uses are more easily quantified than factors that indirectly affect an area or population. Therefore, to improve conservation planning efforts for CTS in the Plan Area and elsewhere, additional empirical data are needed, specifically when analyzing factors that indirectly affect known populations and their habitats. Without a better understanding of how covered activities affect California Tiger Salamander and other target species, the potential for success in conserving the species is reduced. The following is a summary of factors known or suspected to negatively affect CTS.

14.4.1 Habitat Loss and Alteration

Destruction or modification of CTS habitat is caused by conversion of rangeland to a variety of urban and agricultural land uses. The USFWS (2004b) defines urban impacts as non-agricultural development activities such as building and maintenance of housing, commercial, and industrial developments; construction and widening of roads and highways; golf course construction and maintenance; landfill operation and expansion; operation of gravel mines and quarries; dam building and inundation of habitat by reservoirs; and other infrastructure activities that support urban areas. Agricultural impacts include the conversion of native habitat by disking and deep-ripping; and cultivation, planting, irrigation, and maintenance of row crops, orchards, and vineyards. These impacts threaten suitable breeding and upland habitat for CTS.

14.4.2 Loss of Upland Habitat

Research suggests that even CTS using breeding ponds that are protected from development may not persist as viable populations if upland habitat is unavailable or reduced in the area, or if breeding ponds become fragmented and isolated from other breeding ponds (Marsh and Trenham 2001; Trenham and Shaffer 2005). Earthmoving operations and cultivation in upland habitat can directly or indirectly kill or injure CTS in burrows or on the surface by crushing or trapping them. Such activities render all affected areas unsuitable for CTS breeding, feeding, and sheltering. Earth disturbing practices can also expose CTS to adverse environmental conditions (increased predation, high temperatures, low humidity), destroy food sources, and alter surface hydrology (potentially affecting breeding ponds). Disking, deep-ripping, or grading of upland habitat also destroys California ground squirrel burrows and crevices utilized by CTS, making suitable subterranean refugia unavailable and likely reducing long-term adult survival of CTS (Loredo et al. 1996). Stebbins (2003) maintains that extensive control of California ground squirrels and Botta's pocket gophers is considered a serious threat to the species.

14.4.3 Loss of Wetland Habitat

Filling, disking, or excavating wetland habitat can directly kill or injure CTS larvae, eggs, or breeding adults, and prevent future use of the wetland for reproduction. Additionally, surviving adults may be unable to locate alternative breeding sites in subsequent years if habitat is present, but has become highly fragmented by roads, housing, agriculture, and other non-habitat elements. Changes in vernal pool or pond inundation duration and depth caused by urban and agricultural land use (e.g., digging of drainage/irrigation ditches, construction of permanent ponds or reservoirs, deepening or terming of seasonal wetlands, and redirection of runoff from developments) can reduce reproductive success for CTS by: 1) prematurely drying wetlands and desiccating larvae; 2) extending the inundation period and facilitating invasion of non-native predators; 3) creating conditions that are more conducive for hybridization with non-native Tiger Salamanders; and 4) increasing vulnerability to disease by increasing isolation and fragmentation (USFWS 2004a).

14.4.4 Rangewide Habitat Trends

Although the CTS still occurs throughout the majority of its historic range, the overall area of the species' natural habitat has been substantially reduced and the species has become increasingly rare (Shaffer et al. 1993; Barry and Shaffer 1994; Fisher and Shaffer 1996). Some researchers estimate that as much as 75 percent of CTS historic habitat has been lost (Shaffer et al. 1993).

Historically, approximately 3.7 million hectares (9.1 million acres) of valley and coastal grasslands existed within the range of the Central Valley CTS population (Central CTS) (Kuchler 1988). An additional 2.6 million hectares (6.5 million acres) of blue oak/foothill pine, valley oak, or mixed hardwoods (Kuchler 1988) also existed, of which some portion was likely used by the species; however, urbanization and intensive agriculture have eliminated virtually all valley grassland and oak savanna habitat from the Central Valley floor. Loss of grasslands has exceeded the loss of all other habitats in California (Ewing et al. 1988) and it has been estimated that less than 10 percent of California's Central Valley grasslands remain (USFWS 2003). Consequently, valley grasslands and the Central CTS are now distributed primarily in a ring around the Central Valley (Heady 1977; Holland 1978).

The relative loss of habitat has also been significant with respect to vernal pool grasslands, the historic breeding habitat of the CTS (Trenham et al. 2000). Approximately 1.68 million hectares (4.15 million acres) of grasslands in 20 Central Valley counties are estimated to have supported vernal pools at the time of European settlement (Holland 1978, 1998; Holland and Jain 1988; CDFG 2010) although there is no historical data to substantiate this estimate. Most of this area, except the northern Sacramento Valley, was within the CTS assumed historic range (Shaffer et al. 1993). The remaining vernal pool complexes in California are now fragmented and significantly reduced in area (USFWS 2004b). Where vernal pools exist, the habitat is often disturbed and degraded and the natural regime has been affected by drainage modification, off-road vehicle use, gravel mining, non-native plant invasion, road construction, and urban development (Jones and Stokes Associates 1987; USFWS 2004b; Keeler-Wolf et al. 1998). Vernal pools in California are now recognized as threatened resources, and many of the species that inhabit them are listed as threatened or endangered species (Jones and Stokes Associates 1987; Wright 1991; USFWS 2004b). Estimates of vernal pool habitat loss through the 1980s were at two to three percent annually and this rate is compounded continually (Holland 1988). During the 1980s and 1990s, vernal pool grasslands continued to be lost at an estimated rate of 1.5 percent per year (Holland 1998). As of 1997, 377,165 hectares (931,991 acres) of vernal pool grasslands remained in the Central Valley, representing a loss of approximately 78 percent (Holland 1998). Along the southeastern edge of the Central Valley, from San Joaquin to Fresno counties, at least 25 percent of the 259–hectare (640–acre) sections that had contained vernal pools in 1970 (Holland 1978) were wholly converted to agriculture or urban uses by 1994 (Seymour and Westphal 1994). This conversion estimate is probably conservative because it does not include partially converted sections where vernal pool habitat may also have been lost (Seymour and Westphal 1994). Holland (1998) estimated that at a continued 1.5 percent annual loss of vernal pools in California, 50 percent of the vernal pool habitat present in 1997 would be lost by 2043 (46 years), representing a cumulative loss of 88 percent of vernal pool grasslands.

As part of an evaluation of CTS status throughout its range, Shaffer et al. (1993) detected CTS in only 36 of 86 localities (42 percent) that had been previously recorded, and ponds currently occupied by CTS were significantly higher in elevation than those that were unoccupied or had been previously occupied; although it should be noted that these decreases may also be the result of low sampling frequency. Some researchers (Shaffer et al. 1993; Seymour and Westphal 1994; Fisher and Shaffer 1996; Davidson et al. 2002) believe these and other data suggest that many of the low-elevation breeding sites on the valley floor have been eliminated in recent years, restricting habitat used by this species to higher elevations on the margin of its ecological requirements. These higher elevation breeding sites are likely human-created stock ponds or bermed ponds that have benefited the species by offsetting the loss of CTS natural, historic vernal pool breeding habitat; however, these artificial breeding ponds have a shorter life span than natural vernal pools if not maintained. Additionally, some of these artificial breeding ponds can place CTS at risk of predation by holding water for a greater period than vernal pools.

Using information from 632 CTS records identified in the CNDDB, of which 589 records were considered extant by the CDFG, as well as 79 CTS breeding sites from Carnegie Off-Road Vehicular Park and the Los Vaqueros watershed, the USFWS (2004b) analyzed threats to the Central CTS throughout the remaining portions of its range in 20 counties. Their results suggested that there were approximately 378,882 hectares (936,204 acres) of Central CTS upland and aquatic habitat remaining in 2003 (USFWS 2004b). Of the 378,882 hectares (936,204 acres) of Central CTS habitat, 28,526 hectares (70,489 acres, 8 percent) fell within areas delineated by general plans or other planned development (high-density residential, medium-density residential, industrial, and commercial development) (USFWS 2004b). Because they are within areas that were to be developed, the USFWS considered these areas to be threatened by development. These development projects may destroy and fragment upland or aquatic breeding habitat and reduce the likelihood of long-term persistence and viability at the affected localities.

The USFWS determined that an additional 24,240 hectares (59,897 acres, 6 percent) of the estimated 378,882 hectares (936,204 acres) of Central CTS habitat is threatened by low-density residential development (2- to 20-acre parcels). Furthermore, 45,880 hectares (113,371 acres, 12 percent) of CTS habitat is threatened by very-low-density residential development (20- to 160-acre parcels) (USFWS 2004b). The land use data the USFWS used to evaluate the threat of low-density and very-low-density development is based on a minimum delineation of these areas in 2000 (USFWS 2004b). These areas will likely be further developed resulting in a greater number of houses per area in the future, and in some cases, low-density areas are regions that will become incorporated into high-density urban areas (USFWS 2004b).

Low-density residential development is a greater threat to the Central CTS than very-low-density residential development due to the greater number of houses per acre. These low-density housing developments may result in the extirpation of CTS at some locations due to the direct effects of construction that destroy breeding sites or indirect effects that alter hydrology and increase sedimentation. Structures, roads, and highways fragment habitat and prevent CTS from reaching their breeding sites by eliminating or disrupting their upland habitat or migratory corridors (Marsh and Trenham 2001). Reduced availability of upland habitat decreases the long-term population viability of CTS breeding sites (Trenham and Shaffer 2005). In the eastern United States, 25 percent of the upland habitat within 300 meters (984 feet) of a spotted salamander (*A. maculatum*) vernal pool breeding site was destroyed, resulting in a 53 percent decline in the abundance of the species at the site (Calhoun and Klemens 2002).

Low-density housing would also further fragment CTS habitats within the Sierra Nevada and Coast Range foothill counties, which are among the fastest growing counties in California (CGCDD 2003). These areas provide the last strongholds of remaining CTS (USFWS 2004b). CTS are known to have a high rate of interpond dispersal between breeding ponds, but only when the ponds are relatively close together (i.e., less than 670 meters [2,200 feet]) (Trenham et al. 2001). Therefore, the loss of breeding localities, or their isolation due to habitat fragmentation, may result in the extirpation of other breeding locations (Marsh and Trenham 2001). Furthermore, decreased landscape connectivity and increased habitat fragmentation has had negative effects on other amphibian assemblages including the eastern tiger salamander (*A. tigrinum*) (Lehtinen et al. 1999). Increased numbers of residents living in low-density residential developments and rural houses may also result in increased introduction of non-native predators, increased applications of pesticides or agricultural contaminants, and rodent control that may reduce the long-term viability of CTS inhabiting these areas. The CTS may also be threatened by the construction of new roads or increased mortality due to increased vehicle traffic (USFWS 2004b).

Estimates of the location and amount of habitat threatened by conversion and fragmentation from urban uses described above does not consider all of the projected human population growth, urbanization, and subsequent habitat loss that will occur in the counties inhabited by the Central CTS because most city and county general plans have variable planning horizons that do not extend beyond 20 years (USFWS 2004b). California developers and builders constructed 2.8 million new housing units between 1980 and 1997, and an additional 220,000 units will be required each year for the next 20 years with the human population of the State almost doubling in less than 40 years (CGCDD 2003). New housing is currently being constructed in low-density developments on the edge of urban areas or beyond such areas (CGCDD 2003). Most of the future growth of California will be outside of the current metropolitan areas (San Francisco, Los Angeles, and San Diego), occurring in the Sacramento, San Joaquin, and Imperial valleys (CGCDD 2003). Two of these valleys are inhabited by CTS.

Rangeland areas contain vernal pool grassland are being lost as a result of rural residential development (CGCDD 2003). Privately owned rangeland in California decreased by 252,524 hectares (624,000 acres) from 1982 to 1997, an average loss of 16,997 hectares (42,000 acres) per year (USFWS 2004a), and from 1998 to 2000, the State lost an additional 21,555 hectares (53,263 acres) of rangeland (CGCDD 2003). The decline in farm rancher income, the aging of ranchers, tax implications of intergenerational transfers of ranches, and the difficulty of beginning a ranching operation (e.g., in terms of cost and knowledge of ranching) are all reasons California is experiencing the loss of rangeland (CGCDD 2003).

Projecting the future loss of Central CTS habitat from conversion of rangeland to intensive agriculture is difficult because conversion to this land use is largely unregulated by cities and counties. Conversion to intensive agriculture largely depends upon the individual landowner and is based on numerous factors that are difficult to predict, such as economic considerations, markets, and water availability. The loss of rangelands and vernal pool grasslands has been well documented in counties within the range of the Central CTS and annual rates of loss have been estimated (CDC 1994, 1998, 2000; Holland 1978, 1998, 2003; Jones and Stokes Associates 1987; Keeler-Wolf et al. 1998; CDFG 2003; CDWR 1998). The cumulative loss of vernal pool grassland was estimated at 78 percent by the late 1990s, and annual rates of loss have been between 1 and 3 percent during the 1980s and 1990s. Some of the loss of Central CTS habitat has resulted from conversion to intensive agriculture, and some is attributable to urbanization and other non-agricultural activities. The USFWS (2004b) believes that the continued loss of Central CTS habitat due to intensive agriculture represents an important threat to the species.

The USFWS anticipates that this conversion of land use will continue to adversely affect CTS if human population growth continues to increase as projected (75 percent increase from 2000 to 2040) in the range of the Central CTS (CDF 1998). If these projections are correct, this population growth will continue to spur the conversion of irrigated agriculture conversion to urban use, and the subsequent displacement of intensive agriculture on to rangeland in the foothill areas of the Central Coast or east side of the San Joaquin Valley (CDWR 1998; CDC 2002). However, the rate of displacement and subsequent conversion to intensive agriculture is expected to continue at lower rates than in the past as areas with suitable soils and water availability necessary for intensive agriculture become increasingly scarce. Additionally, there can be a financial incentive for landowners to convert existing rangeland and grasslands areas to irrigated crops, as rangeland is generally valued much less per acre than irrigated agricultural (ASFMRA 2003). Conversion of Central CTS habitat to intensive agriculture, in addition to the loss of habitat to rural residential housing, further fragments CTS habitat. Fragmentation of habitat may not only be directly impacting breeding sites, but may also be creating barriers to interpond dispersal and seasonal movements between breeding sites and upland refugia (Marsh and Trenham 2001; Trenham and Shaffer 2005; Calhoun and Klemens 2002).

14.4.5 Urban and Population Growth

As the human population of the State of California continues to increase, there is a concomitant increase in urban and suburban development. According to the 2000 census, the number of people in California has increased by 13.8 percent since 1990 (CDF 2002). The average growth in human population within the counties in the range of the Central CTS during this period has been 19.5 percent (CDF 1998). Counties in the East Bay Area region and State Highway 99 corridor in the San Joaquin Valley are also undergoing increases in urbanization related to population growth (CDF 1998, 2002). From 1995 to 2020, the human population in the Central Valley, Bay Area, and Central Coast counties is projected to grow by 49 percent (from 12.8 million to 19.1 million people) (CDWR 1998). According to the California Department of Finance (CDF), the human population in the counties inhabited by the Central CTS is expected to grow by 75 percent from 2000 to 2040 (from 11.2 million to 19.6 million people) (CDF 1998). Therefore, impacts to the CTS due to conversion of its habitat resulting from urban development are expected to continue (USFWS 2004b).

14.4.6 Disease, Parasitism and Non-Native Species

The specific effects of disease on the CTS are not known and there is presently no information indicating disease is prevalent in existing populations in California (USFWS 2004a). Chytrid Fungus infections (chytridiomycosis) have been detected specifically in Central CTS and pathogens (fungi, bacteria, and viruses) have been known to adversely affect other amphibians including other tiger salamander species (USFWS 2004b). Ranaviruses are another potential threat to CTS because they have been found to adversely affect other amphibians including other Tiger Salamander species, and it is carried by non-native species that occur within the range of CTS, including bullfrogs and non-native tiger salamander species. Nowhere are pathogens indicated as an imminent threat.

Bullfrogs prey on CTS (Anderson 1968; Lawler et al. 1999), which has resulted in an overall pattern of the decline in areas where bullfrogs and other exotic species are present (Fisher and Shaffer 1996). The bullfrog, native to North America east of the Great Plains, was introduced into California in the late1800s and early-1900s, and has rapidly spread throughout the State (Storer 1925; Hayes and Jennings 1986). Morey and Guinn (1992) documented a shift in amphibian community composition at a vernal pool complex, with CTS becoming proportionally less abundant as bullfrogs increased in number. Bullfrogs are unable to establish permanent breeding populations in unaltered vernal pools and seasonal ponds because they require more than one year to complete their aquatic larval stage. Dispersing immature bullfrogs take up residence in such water bodies during the winter and spring where they prey on native amphibians, including larval CTS (Laabs et al. 2001; Morey and Guinn 1992; Seymour and Westphal 1994).

Bullfrogs are known to travel at least 2.6 kilometers (1.6 miles) between ponds (Bury and Whelan 1984), and have the potential to naturally colonize new areas where they do not currently exist, including areas where Central CTS occur. In one study of the eastern San Joaquin Valley, 22 of 23 ponds (96 percent) with CTS were within the bullfrogs' potential dispersal range (Seymour and Westphal 1994). In addition, because bullfrogs are still sought within California for sport and as food, and may be taken without limit under a fishing license (USFWS 2004b), the threat of transport for intentional establishment in new habitat already occupied by CTS is significant.

Western mosquitofish (*Gambusia affinis*), first introduced in California in 1922, are native to central North America (watersheds tributary to the Gulf of Mexico) and have been introduced throughout the world for mosquito control. The species occurs throughout California wherever the water does not get too cold for extended periods and they are still widely planted throughout the State (Boyce 1994; Moyle 2002) by about 50 local mosquito abatement districts. Mosquitofish are ubiquitous because of their tolerance of poor water quality and wide temperature ranges (Boyce 1994). Larval CTS may be especially vulnerable to mosquitofish predation due to their fluttering external gills, which may attract these visual predators (Graf and Allen-Diaz 1993). Loredo-Prendeville et al. (1994) found no CTS inhabiting ponds containing mosquitofish. Leyse and Lawler et al. (2000) found that the survival of CTS in experimental ponds stocked with mosquitofish, at densities similar to those found in many stock ponds, was significantly reduced. Larvae that survived in ponds with mosquitofish were smaller, took longer to reach metamorphosis, and had injuries such as shortened tails. However, a recent experiment that replicated conditions in vernal pool environments and permanent ponds determined that, at low densities, mosquitofish did not have a significant effect on larval CTS growth and survival, but that growth and size at metamorphosis was significantly reduced at high fish densities (USFWS 2004b).

Other non-native fish have either been directly implicated in predation of CTS or appear to have the potential to prey upon them (Fisher and Shaffer 1996; Shaffer et al. 1993). For example, introductions of sunfish species (e.g., largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), catfish (*Ictalurus* spp.), and fathead minnows (*Pimephales promelas*) are believed to have eliminated CTS from several breeding sites in Santa Barbara County (USFWS 2000). In eastern Merced County, CTS were absent in stock ponds where non-native fish were present, whereas stock ponds absent of non-native fish had CTS present (Laabs et al. 2001). Non-native sunfish, catfish, and bullheads (*Ameiurus* spp.) have been, and still are, widely planted in ponds in California to provide for sportfishing. By 1984, the California fish fauna included about 50 such transplanted and exotic species, mostly of eastern North American origin (Hayes and Jennings 1986). The alien species have been introduced for a variety of reasons including ornamental, sport, bait, insect control and food uses. Thus, the USFWS considers introductions of such nonnative fish species into Central CTS breeding habitat a threat to the persistence of the species in these locations (USFWS 2004a).

14.4.7 Other Natural or Manmade Factors Affecting California Tiger Salamander Continued Existence

Several other factors may threaten CTS including exposure to various contaminants, rodent population control efforts, chemical mosquito control, direct mortality while crossing roads, hybridization with non-native tiger salamanders, and certain practices associated with livestock grazing.

14.4.7.1 Contaminants

Little research has been done on the effects of contaminants to the CTS, especially with respect to agricultural pesticides. Most toxicological studies to date have been conducted on other amphibian species, specifically anuran species (frogs and toads). Although not specifically on CTS, these latter studies provide insight to the potential risks of contaminants to the CTS. Like most amphibians, CTS inhabit both aquatic and terrestrial habitats during different stages of their life cycle and may be exposed to a variety of pesticides and other chemicals throughout their range. Due to their permeable skin, amphibians may be particularly vulnerable to environmental stressors such as pesticides (Blaustein and Wake 1990). It is important to note that toxicants do not have to be present at lethal levels to be harmful. Toxicants at sub-lethal levels may still cause adverse effects such as developmental abnormalities in larvae and behavioral anomalies in adults (Hall and Henry 1992; Blaustein and Johnson 2003). Sources of chemical pollution which may adversely affect CTS include pesticides used in agricultural, landscaping, roadside maintenance, and rodent and vector control activities, as well as hydrocarbons and other pollutants that enter stormwater runoff from residential areas and industrial facilities (USFWS 2004a).

14.4.7.2 Rodent Control

As CTS spend the majority of their lives aestivating underground, typically in ground squirrel, pocket gopher, and other burrowing mammal burrows (Loredo et al. 1996; Trenham 1998a), widespread burrowing mammal control likely poses a significant threat to CTS. Beginning in the early 1900’s (Marsh 1987), burrowing mammal control methods have included trapping, shooting, fumigation of burrows, use of toxic (e.g., anticoagulant) baits, and deep ripping of burrow areas (USFWS 2004a). Burrowing mammal control programs are widely conducted (frequently via bait stations placed at specific sites) on and around various commercial agricultural operations, including grazing/range lands, various row crop areas, and vineyards (Thompson *in litt*. 1998). In addition, flood control agencies and levee districts, routinely conduct extensive California Ground Squirrel control programs around levees, canals, and other facilities under their management (USFWS 2004b). Pocket gopher control is common around golf courses, residential homes, and gardens. Two of the most commonly used rodenticides, chlorophacinone and diphacinone, are anticoagulants that cause animals to bleed to death. These chemicals can be absorbed through the skin and are considered toxic to fish and wildlife (USFWS 2004a). These latter two chemicals, along with strychnine, are used to control rodents (Thompson *in litt.* 1998). Although the effects of these poisons on CTS have not been assessed, any use in close proximity to occupied Central CTS habitat may have various direct and indirect toxic effects. Gases, including aluminum phosphide, carbon monoxide, and methyl bromide, are used in rodent fumigation operations and are introduced into burrows by either using cartridges or by pumping. When such fumigants are used, most or all animals inhabiting the fumigated burrow are non-selectively killed (Salmon and Schmidt 1984).

In addition to possible direct adverse effects of rodent control chemicals and gasses, California ground squirrel and Botta's pocket gopher control operations may also indirectly affect CTS by reducing the number of upland burrows available to them (Loredo-Prendeville et al. 1994). Because the burrow density required by CTS is unknown, the impacts of less than total burrow loss are also unknown. It is currently thought that active California Ground Squirrel colonies are probably needed to sustain CTS because inactive burrow systems become progressively unsuitable over time (USFWS 2004a). For example, Loredo et al. (1996) found that burrow systems usually collapsed within 18 months following cessation of California ground squirrel use and that CTS did not utilize collapsed burrows.

14.4.7.3 Mosquito Control

In addition to the use of western mosquitofish, a common chemical method of mosquito control in California involves the use of methoprene, an insect hormone mimic that increases the level of juvenile hormone in insect larvae and disrupts the molting process. Lawrenz (1984, 1985) found that methoprene (Altosoid SR–10) retarded the development of selected crustacea that had the same molting hormones (i.e., juvenile hormone) as insects, and anticipated that the same hormone may control metamorphosis in other arthropods. Because the success of many aquatic vertebrates relies on an abundance of invertebrates in temporary wetlands, any delay in insect growth could reduce the numbers and density of available prey (Lawrenz 1984, 1985). Therefore, the use of methoprene could have an indirect adverse effect on CTS by reducing the availability of prey.

14.4.7.4 Road-Crossing Mortality

Although no systematic studies of road mortality of the CTS have been conducted, traffic related mortality on CTS is well documented (Hansen and Tremper 1993; USFWS 2004a). For example, during one 15-day period in 2001 at a Sonoma County location, 26 road-killed CTS were found

(USFWS 2004a). Loss of CTS to vehicular-caused mortality in the vicinity of breeding sites can range from 25 to 72 percent of the observed CTS crossing roads (Twitty 1941; Launer and Fee 1996). Additionally, mortality is likely exacerbated by associated roadway curbs and berms as low as 9 to 12 centimeters (3 to 5 inches) that allow CTS access to roadways, but prevent their exit (Launer and Fee 1996; S. Sweet *in litt.* 1998).

Vehicular usage on California roads is increasing proportional to human population growth and urban expansion. During November 2002, California's estimated total vehicular travel on State highway system roads alone was 23 billion kilometers (14.27 billion miles) (Caltrans 2003). From 1972 to 2001, the State highway system total vehicular usage rose steadily from 108.6 billion to 270 billion kilometers (67.1 to 167.8 billion miles) annually. For the California counties in which the Central CTS may occur, State highway system total annual vehicular usage in 1999, 2000, and 2001 was 86.0, 90.0, and 92.1 billion kilometers (53.3, 55.9, and 57.2 billion miles) respectively. Moreover, in those areas of the State where the Central CTS occurs, road densities from past urbanization are already high. Overall, these areas have 5,860.2 kilometers (3,641.5 miles) of roads (and rail tracks) of all types. The range of current road (and rail) density is from 1.01 kilometer per 100 hectares (0.25 mile per 100 acres) in the southern San Joaquin Valley, to 1.64 kilometers per 100 hectares (0.41 mile per 100 acres) in the Bay Area counties. The USFWS (2004a) believes that these high road-use and road-density values and subsequent associated road-kill mortality are a threat to the species, a threat that will continue growing in concert with the State's rapid growth of human population and urbanization.

14.4.7.5 Hybridization

Hybridization has been defined by Rhymer and Simberloff (1996) as ''interbreeding of individuals from what are believed to be genetically distinct populations, regardless of taxonomic status.'' Hybridization between species may lead to introgression, which occurs when hybrid individuals repeatedly backcross to one or both parental types so that genetic material is transferred between the two species. Natural hybridization can be an important component of evolutionary processes; however, hybridization and introgression can be cause for concern, particularly if they are the result of human activities such as the introduction of non-native taxa. In the extreme, hybridization between native and non-native taxa can lead to loss of the native taxon through ''genetic assimilation'' (Rhymer and Simberloff 1996; Allendorf et al. 2001). Hybridization has been implicated in the extinction of populations and species of many animal and plant taxa (Rhymer and Simberloff 1996; Allendorf et al. 2001), including Tecopa pupfish (*Cyprinodon nevadensis calidae*), Amistad gambusia (*Gambusia amistadensis*), and longjaw cisco (*Coregonus alpenae*) (Rhymer and Simberloff 1996).

Of particular concern is the threat of genetic contamination and assimilation of CTS by non--native barred tiger salamanders (*A. mavortium*), which were introduced into central California as bass bait in the mid-1900s (Riley et al. 2003). Riley et al. (2003) studied hybridization between these two species relative to habitat-types commonly used by the species and identified diagnostic genetic markers from mtDNA and nuclear DNA. They found clear evidence that the two species are interbreeding in the wild and producing viable and fertile hybrid offspring. Furthermore, they determined that the extent of genetic mixing depends on the breeding habitat, with non-hybrid CTS more likely to occur in natural habitats than in artificial or disturbed wetlands. Vernal pools contained significantly fewer larvae with hybrid genotypes and significantly more non-hybrid parental genotypes than expected. Fitzpatrick and Shaffer (2004) further analyzed the frequencies of hybrid genotypes in breeding habitats, focusing on natural vernal pools, ephemeral man-made cattle pools and perennial man-made ponds. They found that perennial ponds contained a high percentage of non-native alleles (alternative forms of a gene). They suggested that this may be because *A. mavortium* has 1) a more flexible breeding phenology than CTS and can therefore take advantage of perennial ponds by breeding earlier in the fall, and 2) exhibits facultative paedomorphosis (i.e., retention of larval characteristics as an adult). These two characteristics of *A. mavortium* may increase the relative ability of non-native alleles to persist in perennial ponds. Riley et al. (2003) and Fitzpatrick and Shaffer (2004) show that the extent of hybridization between *A. mavortium* and CTS may depend on the breeding habitat used (i.e., artificial and highly modified habitats may facilitate hybridization) and that, in at least some circumstances (e.g., where there are perennial ponds), non-native genes may be more likely to persist than native genes.

CTS hybridization has been found to varying degrees in the Central Coast, Bay Area, and Central Valley portions of the CTS range (Shaffer and Trenham 2002; H.B. Shaffer *in litt.* 2003; USFWS 2004a). Of particular concern is the widespread hybridization within the Central Coast population where introduced genes have been found from southern Santa Clara County throughout most of Monterey County down to Fort Hunter Liggett on the San Luis Obispo County line, and east across all of San Benito County (H.B. Shaffer *in litt.* 2003). Within this region, virtually all Monterey County populations of the CTS have been compromised by non-native genes, and every population of the CTS at Fort Hunter Liggett is either introduced or a hybrid mixture (H.B. Shaffer *in litt.* 2003).

Using Geographic Information System (GIS), the USFWS estimated the number of Central CTS records (presumably CTS without non-native genes present) that were threatened by hybridization (USFWS 2004b). A CTS record was considered threatened by hybridization if the record was within 2.1 kilometers (1.3 miles) of a hybridized or non-native tiger salamander observation. Dr. H. Bradley Shaffer of University of California at Davis provided locations of hybridized or non-native tiger salamander locations. Other records also were considered threatened if they were part of a larger polygon that consisted of multiple records located within 2.1 kilometers (1.3 miles) of a hybridized or non-native Tiger Salamander observation. The

USFWS's assumptions were that if a non-native or hybridized tiger salamander was within 2.1 kilometers (1.3 miles) (based on the maximum observed migration distance of a tiger salamander, Sweet *in litt.* 1998) of a CTS record, then the non-native or hybridized tiger salamander would be able to migrate to the native CTS breeding site and breed with the individuals at that location. Additionally, if the non-native or hybrid was located within 2.1 kilometers (1.3 miles) of a polygon consisting of multiple records, then there would be sufficient intervening breeding habitat located within the polygon to allow for the nonnative or hybrid tiger salamanders to migrate to and breed with the CTS records within the polygon (USFWS 2004b).

Using this analysis, the USFWS determined that 48 records (22 percent) in the Bay Area region, 56 records (78 percent) in the Central Coast region, and 27 records (8 percent) in the Central Valley region were threatened by hybridization because of their close proximity to non-native and hybridized tiger salamanders (USFWS 2004b). Non-native tiger salamanders are not known to occur within the range of the CTS in Sonoma County. In Santa Barbara County, nonnative tiger salamanders are known from the Lompoc Federal Penitentiary. The closest known CTS breeding pond is approximately 12.9 kilometers (8 miles) from the Penitentiary.

14.4.7.6 Livestock Grazing

Rangeland, suitably managed for livestock (cattle, sheep, and horses), is generally thought to be compatible in many cases with CTS habitat requirements (Shaffer et al. 1993; Loredo et al. 1996; USFWS 2004a). By maintaining shorter vegetation, grazing may make areas more suitable for California Ground Squirrels whose burrows are essential to CTS survival. The long-term effects of ranching on the species is thought to have been either neutral or beneficial where burrowing rodents were not completely eradicated, because the CTS would have likely been extirpated from many areas if stock ponds had not been built and maintained for livestock production (USFWS 2004b).

14.5 Data Gaps and Conservation Implications

In recent years, the ecology, status, and management of CTS have received increased attention; however, there are several sources of uncertainty regarding CTS and its requirements in the Plan Area. The primary data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

14.5.1 Population and Habitat Distribution within the Plan Area

CTS occur in suitable habitat within the Plan Area; however, the species' overall distribution, abundance, and population structure are incompletely known. Land cover-types used by CTS, such as vernal impoundment, vernal pool, and seasonal impoundment, and adjacent uplands (blue oak woodland, blue oak savanna, and valley grassland), occur throughout Sacramento County. Nonetheless, almost all records of CTS are from the southeastern portion of the area.

Though comprehensive surveys for CTS have been conducted in much of the Plan Area, the population size and distribution of the species throughout the Plan Area are still incompletely known. In addition, though the distribution of different habitat-types is mapped and quantifiable, the quality of habitat (particularly as it relates to certain essential habitat components) for CTS within many areas is unknown. These information gaps limit our ability to identify the best lands available for preserving CTS habitat and accurately estimate the impacts resulting from covered activities.

Until this data gap is remedied, the conservation value for CTS will be considered relatively high in lands that support (or recently supported) known occurrences, are large in extent, have multiple breeding sites that may function as a metapopulation, or are adjacent to these areas.

14.5.2 Determining Threat Severity

Certain factors are known to contribute to CTS decline rangewide; however, exactly how and to what extent these factors contribute are largely unknown. Activities that directly remove or replace suitable habitat with incompatible land uses are more easily quantifiable than factors that indirectly affect an area or population (e.g., habitat fragmentation, changes in hydroperiod of potential breeding sites, etc.). Therefore, to improve conservation planning efforts for CTS in the Plan Area and elsewhere, additional empirical data are needed, specifically when analyzing factors that indirectly affect known populations and their habitats.

14.5.2.1 Effectiveness of Habitat Enhancement and Restoration Techniques in Creating Suitable Habitat for California Tiger Salamander

Achieving the conservation goals and objectives for CTS will require successful enhancement and restoration of suitable habitat. The function of habitat (e.g., connectivity, hydroperiod, biodiversity) is an important factor for suitability for CTS. Whether created, restored or enhanced habitats can retain the functional attributes suitable for CTS is unknown.

If habitat creation, restoration and enhancement techniques cannot eventually result in habitats with functional characteristics suitable for CTS, then those lands would not support sustainable populations.

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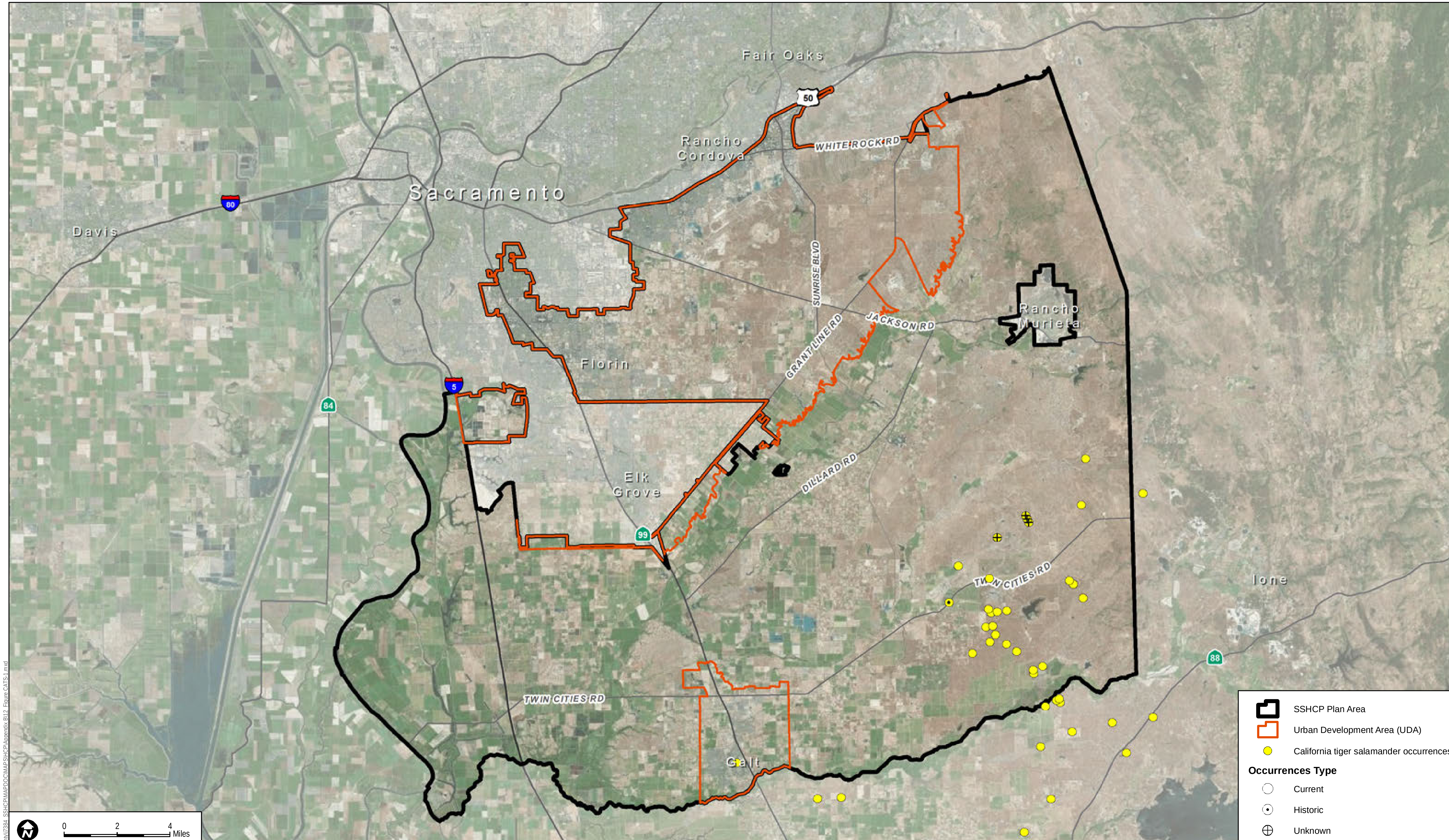

SOURCE: Bing Maps, County of Sacramento 2014, CDFG 2012

FIGURE CTS-1

California Tiger Salamander Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

Path: Z:\Projects\Sacramento_County\I7384_SSHCP\MAPDOC\MAPS\HCP\Appendix B\12_Figure CTS-1.mxd

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15 WESTERN SPADEFOOT (WST)

Prepared by May Consulting (Jamison Watts)

Western Spadefoot (WST)
(Spea hammondii)
Status USFWS: None
Status CDFG: Species of Special Concern

15.1 Legal Status

The western spadefoot (*Spea hammondii*) was a Category 2 candidate for listing in 1994 (USFWS 1994). This species currently has no federal listing status. The western spadefoot was designated a species of special concern by the State of California in 1994 (Jennings and Hayes 1994; CDFG 1998).

15.2 Life History and Ecology

15.2.1 Species Description and Life History

15.2.1.1 Taxonomy

Spadefoots are members of the Family Pelobatidae. Two closely related genera of spadefoots have been recognized within this Family: *Scaphiopus* and *Spea* (Cannatella 1985; Weins and Titus 1991). Western spadefoots are officially recognized within the genus *Spea* (Weins and Titus 1991) although many literature sources reference *Scaphiopus* as the genus. Species relationships within *Spea* have been difficult to define due to morphological homogeneity among species. At least four species currently are recognized (Weins and Titus 1991). Named by Baird in 1859, *Spea hammondii* was believed to have a broad geographic range from California to western Texas and Oklahoma with a distributional gap in the Mojave Desert of California (Storer 1925; Stebbins 1966). Brown (1976) identified morphological, vocalization, and reproductive differences between eastern (Arizona eastward) and western (California) populations, justifying species recognition for each. The California populations retained the name *Spea hammondii* while the eastern populations were designated as *Spea multiplicata*. This distinction was further supported by electrophoretic analyses conducted by Sattler (1980) and by allozymic and morphological analyses conducted by Weins and Titus (1991). Genetic variation across the range of *Spea hammondii* has not been studied to date.

15.2.1.2 Species Description

Western spadefoots are dusky green or gray above and often have four irregular light-colored stripes on their back, with the central pair of stripes sometimes distinguished by a dark, hourglass-shaped area. The skin tubercles (small, rounded protuberances) are sometimes tipped with orange or are reddish in color, particularly among young individuals (Storer 1925; Stebbins 1985). The iris of the eye is usually a pale gold. The abdomen is whitish without any markings. Spadefoots have a wedge-shaped, glossy black "spade" on each hind foot. The call of the western spadefoot is hoarse and snore-like, and lasts between 0.5 and 1.0 second (Stebbins 1985). Snout-vent length ranges in size from 3.7 to 6.2 centimeters (1.5 to 2.5 inches) (Stebbins 1985).

Spadefoots are distinguished from the true toads (genus *Bufo*) by their cat-like eyes (their pupils are vertically elliptical in bright light, but are round at night), the single black sharp-edged "spade" on each hind foot, teeth in the upper jaw, and rather smooth skin (Stebbins 1985). The parotid glands (large swellings on the side of the head and behind the eye) are absent or indistinct on spadefoots. Adult males may have a dusky throat and dark nuptial pads on the innermost front toes (i.e., thumb). Western spadefoots and southern spadefoots (*Spea multiplicata*) lack a cranial boss (a ridge between the eyes). This trait distinguishes these species from the Plains spadefoot (*S. bombifrons)* and Great Basin spadefoot (*S. intermontanus*), which each have a cranial boss. Compared to western spadefoots, southern spadefoots have a more elongate spade, are brownish above, and have a copper-colored iris.

The eggs of western spadefoots are pigmented and are found in irregular cylindrical clusters of about 10 to 42 eggs attached to plant stems and other submerged objects in temporary pools (Stebbins 1985). Spadefoot larvae (tadpoles) can reach seven centimeters (2.5 inches) in length. They have oral papillae (small nipple-like projections that encircle the mouth), and their eyes are set close together at the top of the head. Their body is broadest just behind the eyes (Storer 1925).

Western spadefoot larvae are similar in appearance to other spadefoot larvae. The larvae have oral papillae, and their eyes are set close together and situated well inside the outline of the head as viewed from above. Western spadefoot larvae resemble those of the Plains spadefoot in that their body is broadest just behind the eyes and they are light to medium gray or brown above. In addition, western spadefoot larvae have an upper mandible that is beaked and a lower mandible that is notched. These larvae grow to around seven centimeters (2.8 inches) (Storer 1925).

15.2.1.3 Reproduction

Western spadefoots breed from January to May in temporary pools and drainages that form following winter or spring rains. Water temperatures in these pools must be between nine (9) degrees Celsius (48 degrees Fahrenheit) and 30 degrees Celsius (86 degrees Fahrenheit) for western spadefoots to reproduce (Brown 1966, 1967). Oviposition (egg-laying) does not occur until water temperatures reach the required minimum of nine (9) degrees Celsius (48 degrees Fahrenheit) (Jennings and Hayes 1994). Depending on the water temperature and annual rainfall, oviposition may occur between late February and late May (Storer 1925; Burgess 1950; Feaver 1971; Stebbins 1985). During breeding, highly vocal aggregations of more than 1,000 individuals may form (Jennings and Hayes 1994). Breeding calls are audible at great distances and are thought to bring individuals together at suitable breeding sites (Stebbins 1985). Females deposit their eggs in numerous small irregularly cylindrical clusters of 10 to 42 eggs (average is 24) (Storer 1925), and may lay more than 500 eggs in one season (Stebbins 1951). Eggs are deposited on plant stems or pieces of detritus in temporary rain pools, or sometimes pools in ephemeral stream courses (Storer 1925; Stebbins 1985).

Eggs hatch in 0.6 to sic (6) days depending on water temperature (Brown 1967). At relatively high water temperatures (e.g., 21 degrees Celsius [70 degrees Fahrenheit]), Storer (1925) noted that approximately half of the Western spadefoot eggs failed to develop, possibly due to a fungus that thrives in warmer water and invades the eggs. Larval development can be completed in 3 to 11 weeks (Burgess 1950; Feaver 1971) depending on food resources and water temperature, but must be completed before pools dry. In eight vernal pools examined by Morey (1998), the average duration to complete larval development (hatching to metamorphosis) was 58 days (range 30 to 79 days). Further, pools that persisted for longer periods permitted longer larval development resulting in larger juveniles with greater fat reserves at metamorphosis. Morey (1998) concluded that longer periods of larval development are associated with larger body size at metamorphosis, which is correlated to greater fitness and survivorship (Pfennig 1992).

Annual reproductive success probably varies with precipitation levels with success being lower in drier years (Fisher and Shaffer 1996). Recently metamorphosed juveniles emerge from water and seek refuge in the immediate vicinity of natal ponds where they spend several hours to several days near ponds before dispersing. Weintraub (1979) reported that toadlets of Plains spadefoot seek refuge in drying mud cracks, under boards, and under other surface objects including decomposing cow manure. Age of sexual maturity in western spadefoot is unknown, but considering the relatively long period of subterranean dormancy (eight to nine months), individuals may require at least two years to mature (Jennings and Hayes 1994).

15.2.1.4 Demography

Virtually no data are available on demographic values such as long-term population dynamics, survival rates, reproductive success, and dispersal rates for western spadefoot. However, it is assumed that protecting connectivity corridors between metapopulations is essential for conservation of the species. Morey and Guinn (1992) reported that western spadefoot abundance appeared to remain stable from 1982 to 1986 at a vernal pool complex in Stanislaus County, California. Based on systematic collections of road-killed western spadefoots, proportions of adults and juveniles were 70 percent and 30 percent, respectively, and the proportions of adult males and females were about equal (USFWS 2005).

In a study of amphibian reproduction in 30 vernal pools in Madera County, Feaver (1971) reported a mortality rate of 81 percent for larval spadefoots , 10 percent of which he attributed to predation from California tiger salamander (*Ambystoma californiense*) larvae, while the remainder was due to desiccation from pools drying before metamorphosis was complete. In some years, all reproductive potential is lost when pools dry before any spadefoot larvae are able to metamorphose (Baldwin 1988; Morey 1998). Morey (1998) reported that Western spadefoot larvae that occurred in pools lasting less than five weeks experienced nearly 100 percent mortality. Denver et al. (1998) reported that the Western spadefoot showed the ability to "accelerate metamorphosis in response to water volume reduction" triggered by the reduced opportunity or inability to feed in combination with reduced water volume.

15.2.1.5 Diet and Foraging

Adult western spadefoots forage on a variety of insects, worms, and other invertebrates. Morey and Guinn (1992) examined the stomach contents of 14 Western spadefoots and found 11 different food items including grasshoppers (Order Orthoptera: Family Gryllacrididae), true bugs (Order Hemiptera), moths (Order Lepidoptera: Family Noctuidae and unidentified moths), ground beetles (Order Coleoptera: Family Carabidae), predaceous diving beetles (Order Coleoptera: Family Dytiscidae), ladybird beetles (Order Coleoptera: Family Coccinellidae), click beetles (Order Coleoptera: Family Elateridae), flies (Order Diptera: Family Heleomyzidae), ants (Order Hymenoptera: Family Formicidae), and earthworms (Order Haplotaxida). Adult spadefoots can consume 11 percent of their body mass during a single outing, and Dimmit and Ruibal (1980) speculated that adult southern spadefoots may be able to acquire sufficient energy for their long dormancy period (eight to nine months) in only a few weeks. The specific food habits of western spadefoot larvae are unknown; however, the larvae of southern spadefoot and Plains spadefoot consume planktonic organisms and algae, and also will scavenge dead organisms, including other spadefoot larvae (Bragg 1964). In addition, larvae of Plains spadefoots reportedly will prey on fairy shrimp (e.g., *Branchinecta* spp.) (Bragg 1962).

15.2.2 Habitat Requirements and Ecology

Western spadefoots primarily occur in lowland habitats generally below 900 meters (3,000 feet) within or adjacent to washes, floodplains of rivers, alluvial fans, playas, and alkali flats. They also occur in the foothills and mountains (Stebbins 1985) up to 1,363 meters (4,500 feet) (Morey 1988). Associated vegetative communities include valley-foothill grassland, open chaparral, pine-oak woodland and lower montane conifer and mixed conifer forest within open areas comprised of short grasses and sandy or gravelly soil. Western spadefoots have two distinct habitat requirements including quiet streams (Stebbins 2003) or seasonal pools for breeding and uplands for foraging and dry-season aestivation. Western spadefoot eggs and larvae have been observed in a variety of permanent and temporary wetlands including rivers, creeks, pools in intermittent streams, vernal pools, and temporary rain pools (CDFG 2010). They have also been found in altered wetlands including vernal pools that have been disturbed by activities such as earthmoving, disking, intensive livestock use, and off-road vehicle use, and man-made wetlands such as artificial ponds, livestock ponds, sedimentation and flood control ponds, irrigation and roadside ditches, roadside puddles, tire ruts, and borrow pits (Fisher and Shaffer 1996; CDFG 2010). Although western spadefoots have been observed inhabiting and breeding in wetlands altered or created by humans, survival and reproductive success in these pools have not been compared to unaltered natural pools and research suggests that vernal pools and other temporary wetlands may be optimal for breeding due to the absence or reduced abundance of both native and nonnative predators, many of which require more permanent wetlands.

Often undervalued in conservation planning, terrestrial habitats surrounding aquatic breeding sites are critical to the survival of many semiaquatic species that depend on mesic ecotones to complete their life cycles (Semlitsch and Bodie 2003). Several studies have shown the close dependence of semiaquatic species, such as reptiles and amphibians, on terrestrial habitats for critical life history functions. During periods of drought, aquatic habitats may not be available to semiaquatic species for extended periods of their lives. In such cases, terrestrial habitats act as population reservoirs or sources for adults until breeding and reproduction can again occur (Semlitsch and Bodie 2003). In addition, adult frogs, salamanders and turtles are generally philopatric to individual wetlands and migrate annually between aquatic and terrestrial habitats to forage, reproduce and overwinter or aestivate (Burk and Gibbons 1995; Semlitsch 1998). The amount of terrestrial habitats used during migrations to and from wetlands and for foraging defines the terrestrial core habitat of a population. This aggregation of adults constitutes a local population centered on a single wetland or wetland complex (Semlitsch and Bodie 2003). Local populations are connected by dispersal and are part of a larger metapopulation, which extends across the landscape (Pulliam 1988; Marsh and Trenham 2001).

Annual natal migrations centered on a single wetland or wetland complex are biologically different than dispersal to new breeding sites. It is generally thought that dispersal among populations is achieved primarily by juveniles for amphibians (Gill 1978; Breden 1987; Berven and Grudzien 1990) or by males for turtles (Morreale *et a*l. 1984). Dispersal by juvenile amphibians tends to be unidirectional and longer in distance than the annual migratory movements of breeding adults (Breden 1987; Seburn et al. 1997). Thus, habitats adjacent to wetlands can serve as stopping points and travel corridors for dispersal to other nearby wetlands (Semlitsch and Bodie 2003). In any given western spadefoot population, we expect that some subpopulations will disappear, but the habitat they occupied will eventually be recolonized if it remains suitable.

Little is currently known regarding western spadefoot dispersal distances and overland movement patterns from aquatic breeding sites to upland aestivation sites. Semlitsch and Bodie (2003) summarized data from the literature on the use of terrestrial habitats by 19 frog and 13 salamander species representing 1363 individuals that are otherwise typically associated with wetlands. In general, plethodontid stream salamanders (e.g., *Desmognathus fuscus*, *Eurycea bislineata*, *Eurycea longicauda*), although migratory at some stage of their life cycle, remain close to the edges of ponds and streams and seldom move more than 20-30 m from aquatic habitats. Alternatively, some species of frogs, toads and newts are highly mobile and move 1,000 to 1,600 meters (e.g., *Bufo bufo*, *Rana catesbbeiana*, *Notophthalmus viridescens*). The majority of the remaining species occur at intermediate distances, where they emigrate to find suitable terrestrial habitat. The overall core terrestrial habitat ranged from 159 to 290 meters (522 to 951 feet) from the edge of aquatic breeding sites.

15.2.2.1 Behavior

Western spadefoots are almost completely terrestrial and enter water only to breed (Dimmitt and Ruibal 1980); however, typical of amphibians, Western spadefoots require a certain level of moisture to avoid desiccation, which can be a challenge in the arid habitats occupied by the species. Consequently, spadefoots have adapted behaviorally and physiologically to better facilitate moisture retention.

During dry periods for example, spadefoots construct and occupy burrows that may be up to 0.9 meters (3 feet) in depth (Ruibal et al. 1969) where they may remain for 9 to 10 months aestivating. Like all amphibians, Western spadefoots have very permeable skin, which allows them to absorb moisture from the surrounding soil. Ruibal et al. (1969) found that spadefoots may select soils that are relatively sandy and friable when constructing burrows as these attributes facilitate both digging and water absorption. Research also suggests that spadefoots may retain urea to increase the osmotic pressure within their bodies preventing water loss to, and facilitating water absorption from, surrounding soil with relatively high moisture tensions (Ruibal et al. 1969; Shoemaker et al. 1969).

Spadefoots emerge from burrows to forage and breed following rains in the winter and spring; however, the factors that stimulate emergence are not well understood. In Arizona, spadefoots emerged after as little as 0.25 centimeters (0.1 inch) of precipitation, which barely wet the soil surface and obviously did not soak down to burrows (Ruibal et al. 1969). Sound or vibration from rain striking the ground appears to be the primary emergence cue used by spadefoots, and even the vibrations of a motor can cause them to emerge (Dimmitt and Ruibal 1980). Spadefoots may move closer to the surface prior to precipitation and may even emerge to forage on nights with adequate humidity. Most surface activity is nocturnal. Morey and Guinn (1992) report that surface activity is related to both moisture and cooler temperatures that occur following storms. Surface activity has been observed in all months from October to May (Morey 1988; Morey and Guinn 1992). Above-ground activity is primarily nocturnal, presumably to reduce water loss. Even when exposed to artificial light, spadefoots will immediately move away or begin burrowing underground (Storer 1925; Ruibal et al. 1969). During the day, spadefoots dig and occupy relatively shallow burrows two to five centimeters (0.5 to 2 inches) in depth (Ruibal et al. 1969), and may even use small mammal burrows. In addition to breeding during periods of above-ground activity, spadefoots must acquire sufficient energy resources prior to reentering dormancy (Seymour 1973).

15.2.2.2 Interspecific Interactions

The role of predation on the population dynamics of western spadefoots is unclear. The extended dormancy period of adult and juvenile spadefoots reduces their exposure to predators. Also, toxic secretions from dermal glands provide a significant deterrent to predators. Predators pose a much greater threat to larval western spadefoots than to adults. Spadefoot larvae are preyed upon by a variety of native predators including wading birds, garter snakes (*Thamnophis* spp.), and Raccoons (*Procyon lotor*) (Childs 1953; Feaver 1971). Feaver (1971) found Western spadefoot larvae were preyed upon by California tiger salamander larvae when the two species co-existed in the same pools and the California tiger salamander larvae matured first; however, if western spadefoot and California tiger salamander larvae are the same size, no predation may occur (Anderson 1968).

Nonnative predators introduced within the range of western spadefoots include crayfish (*Procambarus clarkii*), various fishes, and bullfrogs (*Rana catesbeiana*) (Hayes and Warner 1985; Hayes and Jennings 1986; Morey and Guinn 1992; Jennings and Hayes 1994; Fisher and Shaffer 1996). Nonnative fish, many of which are predatory, negatively affect native amphibians by preying upon eggs and larvae (Jennings 1988). In some locations, mosquitofish (*Gambusia affinis*), purposely introduced to control mosquitoes, also prey on Western spadefoot eggs and larvae (Grubb 1972; Jennings and Hayes 1994; Fisher and Shaffer 1996). Introduced bullfrogs have been implicated in the declines of native amphibians (Moyle 1973; Hayes and Jennings 1986), but may not be significant predators of adult western spadefoots, although western spadefoots have been found in the stomachs of bullfrogs on at least two occasions (Hayes and Warner 1985; Morey and Guinn 1992). Bullfrogs may present more of a threat to larval western spadefoots than adults. During dispersal between permanent water sources, juvenile bullfrogs will use temporary water sources (e.g., vernal pools) as resting and feeding areas, increasing the potential for predation on spadefoot larvae (Morey and Guinn 1992).

Although, bullfrogs are of concern regarding the conservation of western spadefoots, some significant ecological differences exist that may minimize interactions between the species. For example, spatial segregation may exist due to bullfrogs occurring less frequently in the temporary wetlands (e.g., vernal pools) used by western spadefoots. Also, western spadefoots increase activity in response to moisture and low temperatures following storms whereas bullfrogs increase activity in response to warmer temperatures prior to storms (Morey and Guinn 1992). Thus, some temporal segregation may occur as well; however, some studies indicate that declining population trends may be associated with introduced predators including bullfrogs (USFWS 2005). At a site in Stanislaus County, California, western spadefoot abundance remained stable during 1982 to 1986 despite dramatic increases in bullfrog abundance during this same period (Morey and Guinn 1992).

Western spadefoots have been recorded in 11 of the 17 vernal pool regions described by Keeler-Wolf et al. (1998). The species has been documented to co-occur with several other rare species, some of which are federally protected. Among the 406 locations for western spadefoots in the CNDDB (CDFG 2010), the following special status animals have been documented to co-occur: California tiger salamander, California red-legged frog (*Rana draytonii*), vernal pool tadpole shrimp (*Lepidurus packardi*), vernal pool fairy shrimp (*Branchinecta lynchi*), and California fairy shrimp (*Linderiella occidentalis*). Rare plants have also been observed in association with western spadefoot and include San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*), hairy Orcutt grass (*O. pilosa*), fleshy owl's clover (*Castilleja campestris* ssp. *succulenta*), Colusa grass (*Neostapfia colusana*), and Hoover's spurge (*Chamaesyce hooveri*). In addition, both adult and larval western spadefoots consume food items that also are used by other co-occurring amphibians including pacific tree frog (*Hyla regilla*), California tiger salamander, and western toad (*Bufo boreas*) (Morey and Guinn 1992). Thus, some degree of resource competition may unnecessarily occur, depending upon the abundance of food resources.

15.2.2.3 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for western spadefoot are identified in Table WST-1 and have been derived from input from local species experts.

Table WST-1
Essential Habitat Elements for Western Spadefoot

Essential Activities	Land Cover Types	Habitat Elements
Breeding and larval development	Vernal impoundment, vernal pool, vernal swale, seasonal wetlands, seasonal impoundment, swale, open water, and streams/creeks.	Temporary pools, drainages, and quiet streams that form following winter or spring rains. Water temperatures in these pools must be between 9 degrees Celsius (48 degrees Fahrenheit) and 30 degrees Celsius (86 degrees Fahrenheit) for western spadefoots to reproduce.
Foraging, dispersal, migration, and summer inactivity	Blue oak savanna, blue oak woodland, and valley grassland.	Require uplands to create burrows and some degree of moisture. In particularly dry areas spadefoots may select soils that are relatively sandy and friable.

15.3 Species Distribution and Population Trends

15.3.1 Central California Distribution

The western spadefoot is nearly endemic to California, and historically ranged from Redding in Shasta County southward to Mesa de San Carlos in northwestern Baja California, Mexico (Stebbins 1985) occurring throughout the Central Valley, Coast Ranges and coastal lowlands (Jennings and Hayes 1994). However, in recent decades the western spadefoot has been extirpated throughout most of the lowlands of southern California (Stebbins 1985) and from many historic locations within the Central Valley (Jennings and Hayes 1994; Fisher and Shaffer 1996). According to Fisher and Shaffer (1996), the western spadefoot has suffered a severe decline with virtually complete extirpation from the Sacramento Valley, a reduced density of populations in the eastern San Joaquin Valley and modest declines in the Coast Ranges. The average elevation of sites where the species still occurs is significantly higher than the average elevation for historical sites suggesting that declines have been more pronounced in lowlands (USFWS 2005).

15.3.2 Population Levels and Trend

Three relatively recent sources of data have presented information regarding the current status and distribution of the western spadefoot. Jennings and Hayes (1994) examined 832 museum and sighting records from 346 locations and concluded that western spadefoots still occurred in 18 California counties, but had been extirpated from six counties. Fisher and Shaffer (1996) conducted field surveys of 315 sites in the Sacramento Valley, San Joaquin Valley, and Coast Ranges from 1990 to 1992 that confirmed the presence of western spadefoots in 13 counties. The CNDDB (CDFG 2010) lists 406 records of western spadefoots from 26 counties. These records range from 1978 to 2006 and do not represent a systematic survey. Additionally, the status of most of the sites where western spadefoots were observed is unknown and many sites may no longer exist due to subsequent development. Some of the records were submitted by biological consultants who conducted surveys on sites that were about to be developed (USFWS 2005).

15.4 Threats to the Species

Although certain factors are known to contribute to western spadefoot decline rangewide, exactly how and to what extent they affect the decline are largely unknown. Activities that directly remove or replace suitable habitat with incompatible land uses are more easily quantifiable than factors that indirectly affect an area or population. Therefore, to improve conservation planning efforts for western spadefoot in the Plan Area and elsewhere, additional empirical data are needed, specifically when analyzing factors that indirectly affect known populations and their habitats. Without a better understanding of how covered activities affect western spadefoot and other target species, the potential for success in conserving the species is reduced. The following is a summary of known and suspected threats to western spadefoot in the Plan Area.

Habitat loss and fragmentation are currently the most significant threats to the survival and recovery of western spadefoot (USFWS 2005). Although determining the degree of severity among contributing factors is difficult without additional information, habitat loss generally is a result of urbanization and agricultural conversion, but can also occur in the form of habitat alteration and degradation resulting from the following: changes to natural hydrology; introduction of invasive species; incompatible grazing regimes, including insufficient grazing for prolonged periods; infrastructure projects (e.g., roads, water storage and conveyance, utilities); recreational activities (e.g., off-highway vehicles and hiking); erosion; contamination; and poor rangeland management and/or lack of monitoring. Habitat fragmentation generally is a result of activities associated with habitat loss (e.g., roads and other infrastructure projects that contribute to the isolation and fragmentation of suitable habitats).

Most western spadefoot habitat is not protected and those areas that are protected are relatively small and therefore highly subject to external threats. It is likely that western spadefoots suffered dramatic reductions in the mid to late 1900's when urban and agricultural development were rapidly destroying natural habitats in the Central Valley and southern California (Jennings and Hayes 1994). Jennings and Hayes (1994) estimated that over 80 percent of the habitat once known to be occupied by the western spadefoot in southern California (from the Santa Clara River Valley in Los Angeles and Ventura Counties southward) has been developed or converted to uses that are incompatible with successful reproduction and recruitment of the species. In northern and central California, loss of habitat has been less severe, but nevertheless significant. It is estimated that over 30 percent of the habitat once occupied by western spadefoots has been developed or converted (Jennings and Hayes 1994). Regions that have been severely affected include the lower two-thirds of the Salinas River system, and much of the areas east of Sacramento, Fresno, and Bakersfield. In addition, many of the suitable seasonal wetlands and vernal habitats concentrated on valley terraces above the Central Valley floor, have begun disappearing or been fragmented (Jennings and Hayes 1994).

California has both the highest absolute and relative human population growth in the United States. California's population is predicted to grow by almost 18 million by the year 2025, an increase of over 50 percent, the highest of any state in the nation (US Census Bureau 1996). Approximately 73 percent of the land within the Central Valley is privately owned, and in areas containing vernal pool habitats, only six percent of the land area is in public ownership (USFWS 2005). According to the 1997 National Resources Inventory (USDA 2000), California ranked sixth in the nation in amount of non-federal land developed between 1992 and 1997, at over 221,200 hectares (546,700 acres). If current population trends continue, seasonal wetland habitats in California, especially those on private land, will be increasingly threatened and possibly extirpated.

In more recent years, vernal pool habitats have been lost primarily as a result of widespread urbanization. Between 1994 and 2003, the Sacramento Field Office of the USFWS conducted section seven consultations on impacts to almost 20,250 hectares (50,000 acres) of vernal pool habitats across California (USFWS 2005). Over half of this loss of habitat, 10,125 hectares (25,000 acres), was the result of residential, commercial, and industrial development projects. The construction of infrastructure associated with urbanization including the construction of highways, wastewater treatment plants, sewer lines, water supply projects, and other utility projects has also contributed greatly to the loss and fragmentation of vernal pools and seasonal wetlands in California (USFWS 2005).

In addition to urbanization, conversion of California's Central Valley to intensive agricultural uses continues to contribute to the decline of vernal pool habitat. From 1992 to 1998, 50,825 hectares (125,591 acres) of grazing land were converted to other agricultural uses in the Central Valley of California. It is likely that much of this land supported vernal pools. Holland (1998) estimated that more than 12,950 hectares (32,000 acres) of vernal pool habitats were lost in the San Joaquin Valley vernal pool region from the late 1980's through 1997, mostly as a result of agricultural conversion. Since 1994, the Sacramento USFWS office has reviewed projects converting more than 6,070 hectares (15,000 acres) of vernal pool habitats to intensive agricultural uses via section 7 of the Endangered Species Act (USFWS 2005).

15.4.1 Altered Hydrology

In addition to direct habitat loss, changes to vernal pool hydrology may also adversely affect spadefoot populations. For example, physical barriers, such as roads and canals can dam or block hydrologically linked systems and alter wetland hydrology both upstream and downstream of the barrier by truncating connectivity and flow. Wetland hydrology also may be altered by changes to patterns of surface and subsurface flow, depending on topography, precipitation, and soil types (Hanes et al. 1990; Hanes and Stromberg 1998). In addition, increased runoff and nuisance flows associated with urban development and impervious surfaces can result in altered hydrology of seasonal wetlands on and off-site. For example, stormwater drains, or the coverage of land surfaces with concrete, asphalt, or irrigated lawns, can alter the duration, volume discharge and frequency of surface flows through increased flooding and runoff (USFWS 2005).

As the timing, frequency, and duration of vernal pool inundation are critical to the survival of vernal pool species including the western spadefoot, alterations to hydrology can be particularly harmful due to premature pool dry-down before the life cycle of the species is completed, preventing reproduction and disrupting gene flow. Similarly, flowing water that artificially removes plants and animals, including cysts, eggs or seeds, from the pool complexes can also prevent successful reproduction and disrupt gene flow. Water flow into vernal pools during the summer can significantly alter vernal pool species composition (Clark et al. 1998). In addition, longer periods of inundation and/or changes in water depth can effectively change seasonal wetland functions (e.g., change from vernal pool to perennial/permanent wetlands), which could potentially provide suitable habitat for introduced bullfrogs and fish.

Excluding livestock and/or changing the grazing intensity and/or season of use can also alter vernal pool hydrology. Historically, native herbivores helped maintain appropriate inundation periods of seasonal wetlands by limiting vegetation accumulation and by sustaining soil conditions that create favorable vernal pool habitat (Barry 1995). The removal of cattle grazing from historically grazed grasslands has been found to dramatically decrease the inundation period of vernal pools (Marty 2004). In a study conducted in pools inhabited by spadefoots, Marty (2004) found that the removal of grazing led to a reduction in pool inundation below the period of time necessary for successfully metamorphose by western spadefoot. Standing dry or dead vegetation may reduce overland flows during precipitation events via interception and direct evaporation. In addition, changes in vernal pool hydrology resulting from livestock exclusion are interrelated with the invasion of nonnative annual species (USFWS 2005). Bauder (1987) found a direct correlation between nonnative vegetation and length of inundation in vernal pools.

In some areas, the alteration of hydrology, often in combination with specific land use practices, has caused downcutting of sloughs and swales, thus threatening the stability and functions of adjacent vernal pools. Any ground-disturbing activities, such as plowing, trenching, grading, deep-ripping, scraping, off-road vehicles, inappropriate levels of livestock grazing, or other activities, adjacent to or within the watersheds of vernal pools can result in siltation when pools fill during the following wet season. Siltation is particularly likely in areas where high, disturbed slopes rise above the level of the vernal pools. Poorly designed trail and road systems near vernal pools may also cause erosion and result in siltation of vernal pools. Larval western spadefoots may suffocate in pools with high levels of siltation and turbidity and siltation may also result in the burial and/or asphyxiation of eggs. Runoff from irrigated agricultural lands can also alter the hydrology of adjacent vernal pools and also can contribute to erosion, siltation, and contaminant loads (USFWS 2005).

15.4.2 Contaminants

Amphibians typically have complex life cycles and thus more opportunities for and routes of exposure than other vertebrates. The western spadefoot is exposed to a variety of toxins throughout its range, but the sensitivity of this species to pesticides, heavy metals, air pollutants, and other contaminants is largely unknown. Each year, millions of kilograms (millions of pounds) of fertilizer, insecticides, herbicides, and fungicides are used on crops, forests, rights of way, and landscape plants in California. Some of these chemicals are extremely toxic to aquatic organisms such as amphibians and their prey. Industrial facilities and motor vehicles also release contaminants that may harm the western spadefoot. Contaminants from road materials, leaks, and spills also could adversely affect western spadefoots by contaminating the water in wetlands.

15.4.3 Human Waste, Recreational Use, and Vandalism

As vernal pool habitats become increasingly rare and urban development expands, threats from disposal of waste, off-road vehicle use, and vandalism increase. People often dump unwanted items such as trash, tires, and appliances in vernal pool areas. Not only can these items release toxic substances into the environment and contaminate water and soil (Ripley et al. 2004), but they can directly affect species by crushing them and restricting photosynthesis in plants by shielding the sun. Waste material also may disrupt the natural hydrologic flow.

Certain recreational activities threaten vernal pool ecosystems and western spadefoots may be adversely affected by off-road vehicle use, hiking, and bicycling. When off-road vehicles and bicycles cut through vernal pool complexes, they may impair hydrological functions by displacing soil and causing erosion or truncating swale connectivity, thus resulting in hydrological changes. Similarly, some off-road enthusiasts (e.g., bicyclists may create dirt jump ramps, which also could result in the aforementioned effects. Western spadefoots may be crushed and killed as a result of careless site users. Trampling also may reduce the reproductive output of western spadefoots using the area.

15.4.4 Inappropriate Livestock Grazing

Considering the historic grazing of native ungulates and other herbivores in vernal pool ecosystems, properly managed livestock grazing can play a significant role as a process surrogate in the protection and enhancement of vernal pool ecosystems. Livestock grazing has three primary effects on vernal pools: consumption of vegetation, trampling, and nutrient input from urine and feces (Vollmar 2002). However, inappropriate levels of grazing, from overgrazing, undergrazing, or inappropriately timed grazing, can result in significant adverse effects to vernal pool ecosystems on which western spadefoots depend.

Although experts maintain that the relationship between grazing livestock and vernal pool habitat condition is difficult to quantify, the prevailing belief is that livestock grazing can play an important role as a management tool in vernal pool habitat (USFWS 2005). The perceived need for some amount of ecosystem disturbance should not be interpreted as an invitation to indiscriminately graze vernal pool landscapes. Because vernal pool species exhibit a variety of life history strategies, grazing regimes must take these needs into consideration.

15.4.5 Random, Naturally Occurring Events

Western spadefoots occurring in small habitat patches are vulnerable to random environmental fluctuations or variation (stochasticity) due to annual weather patterns and availability of food and other environmental factors. As with most vernal pool species, western spadefoot populations are unevenly distributed within fragmented vernal habitats and are predominantly isolated from other. As a result, these populations are more vulnerable to stochastic extinction and genetic problems, particularly in the expression of deleterious genes (known as inbreeding depression). Individuals and populations possessing deleterious genetic material are less likely able to withstand environmental change and survivorship is decreased.

15.4.6 Disease

Chytrid fungus (*Batrachochytrium dendrobatidis*) is known to contribute to amphibian declines, and could be spread via infected organisms or contaminated equipment (USFWS 2005). Diseases and parasitic threats may range from benign to fatal. The vectors and biochemical pathways associated with spread and infection should be considered in order to adequately minimize the threats posed by diseases and pathogens.

15.4.7 Non-Native Species

Another reason for the population decline of the western spadefoot is the introduction of nonnative predators, specifically bullfrogs, crayfishes and fishes (e.g., mosquitofish) (Hayes and Warner 1985; Hayes and Jennings 1986; Fisher and Shaffer 1996). All of these species were introduced into California in the late 1800's and early 1900's, and through range expansions, additional introductions, and transplants, these exotics have become established throughout most of California (USFWS 2005). Fisher and Shaffer (1996) reported an inverse relationship between the presence of western spadefoots and nonnative predators. Additionally, nonnative predators may have displaced western spadefoots at lower elevations, resulting in the species being found primarily at higher elevation sites where these predators apparently are less abundant (Fisher and Shaffer 1996). Fisher and Shaffer (1996) assessed native amphibian populations in the Coast Ranges, Sierra Nevada foothills, and Central Valley. They predicted that widespread declines of western spadefoots would occur if nonnative species continued to spread into low-elevation Coast Range habitats. In the San Joaquin Valley they found that relatively few nonnative predators were present, but native amphibians still had declined significantly. The San Joaquin Valley was the most intensively farmed and most modified of the three regions examined. It has been subject to extensive habitat loss, degradation, and fragmentation (USFWS 1998). Adverse impacts from these activities as well as isolation from other western spadefoot populations may have caused the observed declines. In addition, disking the soil as a part of row-cropping and other forms of intensive agriculture are likely to cause mortality of western spadefoots in their underground burrows.

15.4.8 Roads

Roads represent an additional threat to the western spadefoot. Road construction can result in direct mortality of the western spadefoot and can cause direct loss and fragmentation of habitat. Roads can also cause indirect loss of habitat by facilitating additional road construction and urban development (a major cause of habitat loss for the western spadefoot) (USFWS 2005). Mortality of western spadefoots from motor vehicle strikes has been observed by multiple researchers (Morey and Guinn 1992; CDFG 2010), and appears to be both widespread and frequent. For instance, Jennings (1998) reported road mortality at all seven sites that he surveyed in Kings and Alameda Counties. The impact of motor vehicle-caused mortality on populations of western spadefoots is unknown. Roads can also be a barrier to movements and effectively isolate populations. In Germany, roads are significant barriers to gene flow among common frog (*Rana temporaria*) populations and has resulted in genetic differentiation (Reh and Seitz 1990). Similarly, Kuhn (1987, in Reh and Seitz 1990) determined that approximately 24 to 40 cars per hour on a given road resulted in mortality of 50 percent of common toads (*Bufo bufo*) as individuals attempted to migrate across the road. Heine (1987, *in* Reh and Seitz 1990) identified that 26 cars per hour effectively reduced toad survival at road crossings to zero.

15.4.9 Noise and Vibration

Activities that produce low frequency noise and vibration, such as grading for development and seismic exploration for natural gas in or near habitat for western spadefoots, may be detrimental to the species. Dimmitt and Ruibal (1980) determined that southern spadefoots were extremely sensitive to such stimuli and would break dormancy and emerge from their burrows in response to these disturbances. Disturbances that cause spadefoots to emerge at inappropriate times could result in detrimental effects such as mortality or reduced fitness.

15.5 Data Gaps and Conservation Implications

In recent years, the ecology, status, and management of the western spadefoot have received increased attention. There are several sources of uncertainty regarding western spadefoot and its requirements in the Plan Area. The primary data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

15.5.1 Population and Habitat Distribution within the Plan Area

Western spadefoots occur in suitable habitat within the Plan Area. The species' overall distribution, abundance, and population structure are incompletely known. Habitat-types used by western spadefoot, such as drainages, vernal pools, other seasonal wetlands, some perennial wetlands, and adjacent uplands, occur throughout Sacramento County.

No comprehensive surveys for western spadefoot have been conducted in the Plan Area. Therefore, the population size and distribution of the species throughout the Plan Area are still incompletely known. In addition, though the distribution of suitable habitat-types is mapped and quantifiable, the quality of habitat (particularly as it relates to certain essential habitat components) for California tiger salamander within many areas is unknown. These information gaps limit our ability to identify the best lands available for preserving western spadefoot habitat and accurately estimate the impacts resulting from covered activities.

Until this data gap is remedied, the conservation value for western spadefoot will be considered relatively high in lands that support (or recently supported) known occurrences, are large in extent, have multiple breeding sites that may function as a metapopulation, or are adjacent to these areas.

15.5.2 Determining Threat Severity

Certain factors are known to contribute to western spadefoot decline rangewide. Exactly how and to what extent these factors contribute are largely unknown. Activities that directly remove or replace suitable habitat with incompatible land uses are more easily quantifiable than factors that indirectly affect an area or population (e.g., habitat fragmentation, changes in hydroperiod of potential breeding sites, etc.). Therefore, to improve conservation planning efforts for western spadefoot in the Plan Area and elsewhere, additional empirical data are needed, specifically when analyzing factors that indirectly affect known populations and their habitats.

15.5.3 Effectiveness of Habitat Enhancement and Restoration Techniques in Creating Suitable Habitat for Western Spadefoot

Achieving the conservation goals and objectives for western spadefoot will require successful enhancement and restoration of suitable habitat. The function of habitat (e.g., connectivity, hydroperiod, biodiversity) is an important factor for suitability for western spadefoot. Whether created, restored or enhanced habitats can retain the functional attributes suitable for western spadefoot is unknown.

If habitat creation, restoration and enhancement techniques cannot eventually result in habitats with functional characteristics suitable for western spadefoot, then those lands would not support sustainable populations.

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16 WESTERN POND TURTLE (WPT)

Prepared by May Consulting (Jamison Watts)

Western Pond Turtle (WPT)

(Actinemys marmorata)

Status USFWS: None

Status CDFG: Species of Concern

16.1 Legal Status

The western pond turtle (*Actinemys marmorata*), including the northwestern sub-species (*A. m. marmorata*) and the southwestern sub-species (*A. m. pallida*), is a California species of concern.

16.2 Life History and Ecology

16.2.1 Species Description and Life History

16.2.1.1 Taxonomy

The phylogenetic relationships of the western pond turtle are in a state of flux. Recent evidence suggests that the species is distinct from the other three species of the former group *Clemmys and Emys* in eastern North America (Bickham et al. 1996; Feldman and Parham 2001; Holman and Fritz 2001). Feldman and Parham (2002) and Parham and Feldman (2002) presented evidence that the western pond turtle should be placed in the genus *Emys*, along with the European pond turtle (*Emys orbicularis*) and Blanding's turtle (*Emys* [=*Emydoidea*] *blandingii*), and this view has been adopted by others (Spinks et al. 2003; Spinks and Shaffer 2005). In contrast, Holman and Fritz (2001) and Stephens and Wiens (2003) believed that the western pond turtle is not closely related to any extant species and should be placed in its own genus, *Actinemys*. The Turtle Taxonomy Working Group (2007) recorded it as "*Emys* or *Actinemys marmorata* Baird and Girard 1852 [formerly in *Clemmys*]." The genus *Actinemys* is used in both of the most recent standardized names of North American herpetofauna (Collins and Taggart 2002; Iverson et al. 2008) and globally (Fritz and Havas 2007).

The first specimens of *A. marmorata* were collected in 1841 in the vicinity of Puget Sound, Washington and described by Baird and Girard (1852) as *Emys marmorata*. Seeliger (1945) described two subspecies: northern pacific pond turtle (*Clemmys* [=*Actinemys*] *marmorata marmorata*) and southern pacific pond turtle (*Clemmys* [=*Actinemys*] *m. pallida*). A broad range of intergradations occurs from the American River south through the San Joaquin Valley (Seeliger 1945; Stebbins 2003).

Recently, Spinks and Shaffer (2005) reported genetic differences indicating four un-named clades within *A. marmorata*, with the following distributions: 1) from the Transverse Mountains of southern California south into Baja California Norte; 2) San Joaquin Valley and adjacent foothills; 3) Ventura and Santa Barbara counties in central coastal California; and 4) all of the remaining populations. These data suggest considerable genetic fragmentation within the species, especially in the southern half of the range. The new groups do not follow the pattern of the earlier described subspecies (i.e., *A. m. marmorata* and *A. m. pallida*).

16.2.1.2 Species Description

The western pond turtle is the only native box turtle widely distributed in the western United States (Stebbins 1985). The painted turtle (*Chrysemys picta*), which is found primarily in the Midwestern United States, ranges into the Pacific Northwest. The painted turtle can be distinguished from the western pond turtle by the presence of yellow lines on the head and limbs, and red markings on the shell (Stebbins 1985). The pond slider or red-eared slider (*Trachemys scripta elegans*), has been introduced in the west. The pond slider can be distinguished from the western pond turtle by the presence of lengthwise wrinkles and streaks on the shell, absence of spotting on the head and neck, and a broad red, yellow, or orange stripe or blotch behind the eye (Stebbins 1985).

The western pond turtle is a small (9 to 19 centimeters, 3.5 to 7.5 inches) aquatic turtle characterized by an olive, dark brown, or black shell with a spotted head and neck (Stebbins 1985) and is often observed basking on logs, rocks, or floating on the surface of calm water bodies. The northwestern subspecies is defined on the basis of mottled head and neck coloration and a relatively high frequency of inguinal shields. The southern subspecies is defined on the basis of light head and neck coloration with more prominent markings in these areas, and a reduced frequency of occurrence of large inguinal shields.

16.2.1.3 Reproduction

The age of first reproduction is typically seven to nine years of age for the southern western pond turtle and 10 to 14 years of age for the northern western pond turtle (Holland 1991a). Most females lay eggs in alternate years; however, Hays *et a*l. (1999) reported that females nested every year. Gist and Jones (1989) suggest that sperm storage within the female may occur. This may allow adults to mate in the fall, when environmental conditions are highly suitable, while fertilization occurs during the next year. Clutch size ranges from one to 13 eggs, with larger females generally laying larger clutches (Holland 1985a, 1991a; Storer 1930; Ernst et al. 1994). From May through August females make many extended movements into upland habitat where they dig shallow nests (Rathburn et al. 1992; Reese and Welsh 1997). Nest locations range from 12 to 402 m (39 to 1,319 ft) from aquatic habitat (Storer 1930; Holland 1991b; Rathbun et al. 1992) and are typically located in open areas dominated by grasses and forbs. Soils are dry and generally well drained with significant clay/silt content and low slope. Nests on sloping terrain often have a southern or southwestern exposure. Females excavate their nests in the ground, deposit the eggs, and cover the nest by scraping soil and vegetation over the eggs. Females tend to be very wary during overland nesting movements and may abandon nesting attempts if disturbed (Holland 1991a; Rathbun et al. 1992). Some level of nest site philopatry has been reported in the western pond turtle (Holland 1994). This suggests a great need for the protection of upland habitats that may be used by nesting turtles.

Incubation requires from 96 to 104 days in the wild (Holland 1991a). In captivity, Feldman (1982) noted an incubation period of 73 to 80 days. Normal hatching success is approximately 70 percent (Feldman 1982; Holland 1994). In southern California, juveniles may emerge from the nest in early fall; however, most hatchlings overwinter in the nest and move to water in during March to April (Holland 1994; Reese and Welsh 1997). Feldman (1982) suggested that the eggs of the western pond turtle must normally be laid in soils that are relatively dry. He noted that eggs placed in a wet environment exploded when internal pressure exceeded the limits of the eggs. He further noted that hatchlings did not leave the eggs when temperatures exceeded 27 degrees Celsius, "but once moved to a cooler environment, they broke free from the eggs within two to three hours." This response, he concluded, may reduce the potential for dehydration when hatchlings leave the nest to seek aquatic habitat.

16.2.1.4 Diet and Foraging

Western pond turtles are opportunistic predators and occasionally scavengers (Bury 1986; Ashton et al. 1998). The majority of their diet consists of crustaceans, arthropods (i.e., insect larvae and crayfish), but western pond turtles also feed opportunistically on carrion. Western pond turtles will eat plant matter and have been observed foraging on submergent vegetation mats, as well as willow, alder, and other plant types (Bury 1986; Holland 1994). Herbivory in adults may provide an important source of nutrients and some proteins when animal food is unavailable. Adults, particularly females, consume a greater percentage of plant material than do juveniles (Bury 1986). Young turtles feed on mosquito larvae and other aquatic invertebrates, and nekton (Holland 1994). Western pond turtles commonly forage from early morning to early evening. It has been reported that the western pond turtle must swallow its food underwater (Holland 1994).

16.2.1.5 Dispersal and Migration

In the majority of its range, western pond turtles are active from approximately March through October with the peak of activity in May and June (USFWS 1999). Western pond turtles are generally inactive during the winter months (December to February) within most of their range; however, western pond turtles in southern California are active throughout the year. During this time, turtles either bury into the bottom mud of ponds, creeks, or other watercourses, or they move upland, well away from water, to find suitable habitat to wait out periods of unsuitable weather (Holland 1994; Reese and Welsh 1997). During the winter months, some western pond turtles may become active for short periods (Holland 1994). After their winter inactive period, western pond turtles have been reported to congregate in vernal pools before returning to riverine systems. This may allow them to utilize a warm water habitat while high seasonal water flows in rivers still exist (Ashton et al. 1998). In the fall and spring, hatchling turtles may move as far as 400 m from their nest locations to aquatic sites nearby (Holland 1994).

During their active season, western pond turtles engage in movements along the watercourses in which they live seeking suitable foraging and basking habitat (USFWS 1999). Active season home ranges are typically represented by several hundred meters of the same creek bank (Holland 1994), as they rarely move between drainages (Holland 1991a). Bury (1972a) found active season home ranges of western pond turtles to average one hectare (2.5 acre) for males, 0.3 hectare (0.7 acre) for females, and 0.4 hectare (one acre) for juveniles. Within the northern California stream system studied by Bury (1972a), males moved greater distances than females or juveniles. More extensive movement occurs seasonally when females move upland to find suitable nesting locations. When studying the terrestrial movements of western pond turtle within the Trinity River system of northern California, Reese (1996) found a mean terrestrial migration distance from aquatic sites of 118 meters (range = 39-423 meters).

Western pond turtles exhibit a high degree of site fidelity in both aquatic and terrestrial environments (Ashton et al. 1998; Holland 1994). Western pond turtles trapped and moved at the Los Vaqueros watershed for example, moved 3.2 to 6.4 kilometers (2 to 4 miles) to return to the original trapping site (USFWS 1999). Other long-distance movements may occur in response to drying of local water bodies, or other unknown factors (Ashton et al. 1998). This species is capable of moving distances of 1.6 to 12.8 kilometers (1 to 8 miles) over upland habitat to find water (Ernst et al. 1994; Holland 1994).

16.2.1.6 Survivorship

Survivorship in western pond turtles is apparently dependent on age and sex (USFWS 1999). Hatchlings and first-year juveniles average only eight to 12 percent survivorship and this rate may not increase significantly until turtles are 4–5 years old (USFWS 1999). Once the turtles reach adulthood, survivorship increases dramatically, with an average adult turnover rate of only three to five percent (Holland *in* Hays et al. 1999). On average, adult males have a higher probability of surviving than adult females, with skewed sex ratios observed as high as 4:1 (Holland 1991a). The most plausible explanation for these observed sex ratios is that females suffer higher rates of predation during overland nesting attempts (Holland 1991a). The maximum-recorded age for western pond turtle is 39 to 40 years, but the expected longevity for this species is likely 50 to 70 years (Ashton et al. 1998; USFWS 1999).

The western pond turtle is preyed upon by a wide variety of native and introduced predators including large and small mammals, raptors, herons, corvids, snakes, frogs, and fish. Of the native predators, the raccoon (*Procyon lotor*) is a ubiquitous and effective predator, taking animals of all sizes, including eggs and hatchlings. The spotted skunk (*Spilogale putorius*) is also a suspected predator of nests. In Oregon, over 90 percent of the 100 nests examined in 1991-1992 were destroyed by predators, most likely raccoons or skunks (Holland 1992). Raccoon populations, in particular, respond favorably to urban environments, where human refuse may support larger populations than normal. Larger populations of raccoons and other predators combined with reduced nesting habitat for western pond turtles adjacent to aquatic habitat results in concentrations of nests, which are more easily detected by predators. Other native predators observed to have locally significant effects on western pond turtles are the black bear (*Ursus americanus*), river otter (*Lutra canadensis*), and mink (*Mustela vison*) (Holland 1991a). Two introduced predators of particular concern are the bullfrog (*Rana catesbeiana*) and the largemouth bass (*Micropterus salmoides*). Both species have been observed feeding on juvenile western pond turtles (Moyle 1973; Holland 1991a).

16.2.2 Habitat Requirements and Ecology

Western pond turtles inhabit a variety of aquatic habitats from sea level to elevations of 1,980 meters (6,500 feet). They are found in fresh to brackish aquatic habitats including marshes, rivers, ponds and streams. Western pond turtles also may occur in man-made habitats, such as irrigation ditches, reservoirs, and sewage and millponds. Western pond turtles have been found in waters with temperatures as low as one degree Celsius (34 degrees Fahrenheit), and rarely in water with temperatures exceeding 39 to 40 degrees Celsius (102 to 104 degrees Fahrenheit) (Boyer 1965; Holland 1994; Jennings and Hayes 1994), but seem to become more active in water that consistently reaches 15 degrees Celsius (60 degrees Fahrenheit) (Jennings and Hayes 1994). Preferred aquatic habitat is characterized by slow moving or quiet water, emergent aquatic vegetation, deep pools with undercut banks for refugia, partially submerged rocks and logs, open mud banks and matted floating vegetation for thermoregulatory basking. Western pond turtles use aquatic habitats primarily for foraging, thermoregulation, and avoidance of predators (Boyer 1965; Holland 1994, Reese and Welsh 1998a). Basking is done intermittently throughout the day and is primarily conducted to maintain a body temperature of

24 to 32 degrees Celsius (75 to 90 degrees Fahrenheit) (Boyer 1965; Bury 1986). Hatchling and young turtles (one year) require shallow water areas (less than 30 centimeters [11.8 inches] deep) dominated primarily by emergent aquatic reeds (*Juncus* spp.) and sedges (*Carex* spp.) (Holland 1991a) and have been observed to avoid areas of open water lacking these species (Boyer 1965; Holland 1994; Hays et al. 1999; Reese and Welsh 1998a). Highly fluctuating flow rates associated with aquatic habitats may diminish habitat quality for western pond turtles (Reese and Welsh 1998b). Conversely, western pond turtles may leave aquatic habitat as pools dry. Holland (1994) reported overland movements of five kilometers (3.1 miles) possibly resulting in turtles seeking more appropriate aquatic habitat.

Western pond turtles “hibernate” in both aquatic and terrestrial habitats. Aquatic refugia consist of rocks, logs, mud, and undercut areas along banks while terrestrial hibernacula consist of burrows in leaf litter, heavy brush, or soil (Holland 1994). In woodland and sage scrub habitats along coastal streams in central California, most western pond turtles leave the drying creeks in late summer and return after winter floods. These turtles spend an average of 111 days in upland refugia that are an average of 50 meters (164 feet) from the creeks (Rathbun et al. 1992). Upland nesting sites must be dry and often have a high clay or silt component. Typically, western pond turtles dig nests in open sunny areas that are on slopes no steeper than 25 degrees.

16.2.2.1 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for western pond turtle are identified in Table WPT-1 and have been derived from input from local species experts.

Table WPT-1
Essential Habitat Elements for Western Pond Turtle

Essential Activities	Land Cover Types	Habitat Elements
Foraging, breeding and dispersal	Vernal impoundment, vernal pool, vernal swale, seasonal wetlands, seasonal impoundment, swale, freshwater marsh, open water, and streams/creeks.	Fresh to brackish aquatic habitats characterized by slow moving or quiet water, emergent aquatic vegetation, deep pools with undercut banks for refugia, partially submerged rocks and logs, open mud banks and matted floating vegetation for thermoregulatory basking. Highly fluctuating flow rates associated with aquatic habitats may diminish habitat quality.
Nesting and aestivation	Blue oak savanna, blue oak woodland, mine tailing riparian woodland, valley oak riparian woodland, mixed riparian scrub, and valley grassland.	Aquatic aestivation sites consist of rocks, logs, mud, and undercut areas along banks while terrestrial hibernacula consist of burrows in leaf litter, heavy brush, or soil. Upland nesting sites must be dry and often have a high clay or silt component.

16.3 Species Distribution and Population Trends

16.3.1 Range-wide Distribution

The northern western pond turtle historically and currently ranges from Puget Sound, Washington, south through Oregon, generally west of the Sierra-Cascade crest, to the American River drainage in central California. The southwestern subspecies ranges from the vicinity of Monterey Bay, California, south through the Coast Ranges to Baja California, Mexico. The area of the Central Valley of California between the American River drainage and the Transverse Ranges is considered to be a zone of introgression between the two subspecies (Seeliger 1945). Historically, the western pond turtle inhabited the vast permanent and seasonal wetlands on the Central Valley, with the Tulare Lake Basin being a stronghold for the species. Today, the western pond turtle remains in 90 percent of its historic range, but at greatly reduced numbers (Holland 1991a). Records of the species from Grant County, Oregon, and British Columbia, Canada, are believed to represent introduced animals (Nussbaum et al. 1983; Storer 1937). Outlying populations of the species occur in Nevada primarily in the Carson River drainage. Whether or not these populations are native or represent introduced animals is debated by the experts (Holland 1991a).

16.3.2 Central Valley Distribution

Historically in the Central Valley, western pond turtles inhabited the permanent and seasonal wetlands of the area, with the Tulare Lake Basin as a major population center (Hays et al. 1999; USFWS 1999). Today, western pond turtles occur in 90 percent of their historic range in the Central Valley, but in greatly reduced numbers (Jennings and Hayes 1994).

16.3.3 Range within the Plan Area

The Plan Area falls within the introgression zone for the two subspecies of western pond turtle. Currently there are no records for the southern western pond turtle in the Plan Area. There are 25 known occurrences of western pond turtle in Sacramento County (CDFG 2010). Among these 25 locations, seven are known to occur in the Urban Development Area (UDA). Figure WPT-1 provides the distribution of western pond turtle recorded in Sacramento County. The range of western pond turtle within the Plan Area is therefore considered to be the entire Plan Area.

16.3.4 Population Level and Trends

Western pond turtle were once abundant in California, Oregon, and locally in Washington, but are declining in numbers throughout their range, particularly in Washington, northern Oregon, southern California and Baja California (Lovich 1998; Hays et al. 1999). Although the western pond turtle still exists in about 90 percent of its original range, this species has been completely or ecologically extirpated from a number of areas including the Puget Sound area of Washington, Willamette River drainage in Oregon, Klamath River drainage of Oregon and California, San Francisco metropolitan area, southern San Joaquin Valley, Los Angeles and San Diego metropolitan areas, and Nevada (Holland 1991a). A variety of factors, including habitat loss and modification, commercial exploitation, disease, introduced predators and competitors, and other natural and man-made factors working together have resulted in a significant decline in western pond turtle populations throughout 75 to 80 percent of its range (Holland 1991a; Jennings and Hayes 1994; Hays et al. 1999; USFWS 1999).

The population status and trends of western pond turtle in the HCP Study Area is unknown. The western pond turtle is believed to have been abundant in the area when it supported extensive wetlands (Hays et al. 1999), but conversion of former wetlands to agricultural lands and urban development has likely resulted in local declines of these populations (Jennings and Hayes 1994).

16.4 Threats to the Species

Although certain factors are known to contribute to western pond turtle decline rangewide, exactly how and to what extent they affect the decline are largely unknown. Activities that directly remove or replace suitable habitat with incompatible land uses are more easily quantifiable than factors that indirectly affect an area or population. Therefore, to improve conservation planning efforts for western pond turtle in the Plan area and elsewhere, additional empirical data are needed, specifically when analyzing factors that indirectly affect known populations and their habitats. Without a better understanding of how covered activities affect western pond turtle and other target species, the potential for success in conserving the species is reduced. The following is a summary of factors known or suspected to negatively affect western pond turtle.

16.4.1 Habitat Loss and Alteration

Habitat loss and alteration are most responsible for the historic decline of western pond turtles throughout its range (USFWS 1999). In California, over 90 percent of historic wetlands have been diked, drained, and filled primarily for agricultural development and urban development (Frayer et al. 1989). Urbanization has significantly altered or eliminated western pond turtle habitat, with significant impacts occurring in southern California. Local extirpation of the southwestern subspecies in the Los Angeles Basin has occurred primarily through the channelization and cementing of numerous tributaries comprising the watershed (Brattstrom and Messer 1988; Holland 1991a).

Water diversions for agriculture and urban uses have also negatively affected western pond turtle populations. For example, agricultural, aquatic habitats, such as rice lands, are used to convey and store agricultural water and are consequently subject to changes in the timing and amount of water flow. Many rivers, particularly in more arid regions such as the San Joaquin Valley, have had significant portions of their flows diverted for agriculture resulting in very low flows or no flows for several miles of stream during summer months. In addition, numerous wetlands are channelized and periodically cleaned of aquatic vegetation, rendering them less suitable for western pond turtles. Furthermore, where western pond turtles persist adjacent to agricultural lands, upland nesting opportunities may be limited or nonexistent due to the practice of farming up to the edge of aquatic habitats. Such actions typically result in the elimination of western pond turtles from affected waters and isolation of turtle populations located in other portions of the drainage (Holland 1991a). Because western pond turtles are long-lived, populations may persist in these isolated wetlands long after recruitment of young has ceased (Jennings and Hayes 1994; USFWS 1999) resulting in very small and heavily adult biased populations (Holland 1991a).

Changes in the nature and timing of water releases from reservoirs adversely affects downstream habitat by eliminating or altering basking sites, upland refugia, foraging areas, and particularly, hatchling microhabitat (Reese and Welsh 1998b; Hays et al. 1999). High releases of water in the Trinity River in late May to early June in 1991, for example, scoured out several miles of hatchling turtle habitat (Holland 1991a) and a similar incident occurred in Piru Creek in southern California (Holland 1991a). Reservoirs also are typically stocked with exotic species of fish, which may expand into previously isolated turtle habitat. Reservoirs, in general, provide poor habitat for turtles because of the lack of emergent aquatic vegetation, basking sites, high recreational use, and presence of exotic species. Only small groups of adults are typically seen using reservoir habitats (Holland 1991a).

Another significant source of habitat alteration throughout the range of the western pond turtle is livestock grazing. Livestock have been documented as a major cause of excessive habitat disturbance in riparian areas (Behnke and Raleigh 1978; Kauffman and Krueger 1984). Cattle have a disproportionately greater adverse affect on riparian and other wetland habitats because they tend to concentrate in these areas, particularly during the dry season (Marlow and Pogacnik 1985). Cattle trample and eat emergent vegetation (Platts 1981) that serves as foraging habitat for turtles of all sizes and as critical microhabitat for hatchlings and first-year animals. Stream banks also are trampled by cattle often resulting in the collapse of undercut banks (Platts 1981; Kauffman et al. 1983) that provided refugia for turtles. Cattle grazing results in increased erosion in streams (Winegar 1977), which in turn fills in deep pools, increases stream velocity, and adversely affects aquatic invertebrates (Behnke and Raleigh 1978; Platts 1981). Cattle may also crush turtles (Holland 1991a).

In-stream and streamside mining operations for sand and gravel also unfavorably alter western pond turtle habitat. These operations may directly eliminate or modify aquatic habitats and adjacent riparian habitat, alter the pattern of water flow, increase siltation, which fills in pools and alters the prey base, and disrupt normal behavior patterns or force displacement (Holland 1991a). In addition, removal of basking sites (e.g., logs, snags, and rocks) for aesthetic reasons or to facilitate recreational pursuits has a negative effect on western pond turtles. Loss of basking sites changes thermoregulatory behavior of turtles and reduces available foraging and refuge sites. According to Holland (1992), this activity is a primary factor in the observed decline of western pond turtles in several lakes in Oregon.

Construction of roadways and railways adjacent to western pond turtle habitat may adversely affect western pond turtles in several ways. First, roads often present a partial or complete barrier to turtles traveling overland to nesting or over wintering sites. Western pond turtles have been observed crushed on roadways in California, Oregon and Washington, with the majority of these being gravid (with developing young or eggs) or postpartum females (Holland 1985a, 1992). In addition to hampering access to nesting areas, roadbeds reduce the area of potential nesting. Roads constructed on south-facing slopes adjacent to the Umpqua River in Oregon likely eliminated both existing and potential nesting habitat (Holland 1992). Train tracks may have similar adverse affects on western pond turtles. At two locations in Oregon, western pond turtles were found dead between railroad tracks. In both cases, the railroad tracks paralleled the north side of the watercourse and were located between the watercourse and potential nesting habitat (Holland 1992). Holland (1992) hypothesized that the turtles became trapped between the railroad tracks when unable to find a way to exit under the rail.

16.4.2 Over Utilization for Commercial, Recreational, Scientific, or Educational Purposes

Records of harvesting western pond turtles for food date back to the commercial harvest of this species for the San Francisco market (Lockington 1879). At the time, commercial harvest had already depleted populations of the western pond turtle in the San Francisco area, resulting in commercial operations focusing on populations in the San Joaquin Valley, particularly Tulare Lake (Elliot 1883; Brown 1940). Over 18,000 western pond turtles were offered for sale in San Francisco markets, presumably in one year in the 1890s (Smith 1895). This practice continued at least through the 1920s (Storer 1930).

Collection of western pond turtles for food still exists today with numbers from 20 to over 100 taken in a single outing (Holland 1991a). In addition, a commercial pet market exists for the species despite state prohibitions. Holland (1991a) noted western pond turtles for sale by a Florida dealer in 1991 and in some California pet stores through at least 1985. Bury (1982) noted removal of over 500 turtles from one lake in southern California for the pet trade.

Incidental collection of the species by fisherman may be a significant mortality factor in some areas. Approximately 3.6 percent of turtles captures by Holland (1991a) at an Oregon site had ingested fishhooks. At a California site, about six percent of captured turtles showed evidence of trauma related to removal of hooks, had hooks in place, or were found dead with hooks embedded in the esophagus or stomach (Holland 1991a). A turtle captured by Holland (1991a) in Oregon before and after ingestion of a fishhook had lost a significant amount of weight, suggesting that hooked turtles may eventually starve to death. Hooked turtles are often killed by fishermen, who mistakenly presume that western pond turtles are competitors for fish or consume ducklings (Holland 1991a). Similarly, indiscriminate shooting of western pond turtles can be a significant mortality factor, particularly in areas adjacent to urban development. In southern California for example, a substantial proportion of a western pond turtle population under study was shot by two individuals carrying rifles (Holland 1991a). In Washington, shooting of turtles for sport was reported in the early 1970's (Milner 1986).

16.4.3 Disease, Parasitism and Non-Native Species

The only documented instance of disease outbreak in the western pond turtle occurred in an isolated Klickitat County population in southern Washington in 1990 (Holland 1991b). A significant portion of the population displayed symptoms of upper respiratory disease syndrome, a disease previously observed in desert tortoises (*Gopherus agassizi*). A minimum of 42 to 47 percent of the population died from the disease despite extensive efforts to treat diseased animals in captivity (Holland 1991b). The agent and mechanism responsible for the epidemic are unknown. Given the highly contagious nature of this disease and the high observed rates of mortality, the potential exists for significant population declines should this disease appear in contiguous western pond turtle populations. Evidence of this or a similar disease was found in a turtle from the Willamette River drainage in Oregon (Holland 1991a). Parasites that affect the western pond turtle include trematodes, helminthes, nematodes, lungworms, and leeches (Holland 1994).

Two introduced predators, the bullfrog and largemouth bass have been observed feeding on juvenile western pond turtles (Holland 1991a). Both species were introduced into the western United States in the latter part of the 19th century, and through range expansions, reintroductions, and transplants these species have become established across most of the western United States (Moyle 1973). Bullfrogs forage primarily in shallow water, the microhabitat favored by hatchling and juvenile western pond turtles. Examination of a number of sites in Washington, Oregon, and California by Holland (1991a) indicates a negative correlation between the abundance of bullfrogs and the abundance of small western pond turtles. Their impact on populations of native species is thought to be significant due to the high reproductive potential of the bullfrog (i.e., egg masses may have 20,000 individuals eggs). Although many authors have reported bullfrogs feeding on native reptiles and amphibians, the extent to which bullfrogs can modify or contribute to the decline of their prey populations has been the source of much speculation (Morey and Guinn 1992). High concentrations of bullfrogs within structurally simple habitats (e.g., vernal pools and heavily grazed ponds) may have a significant impact on local populations. Interestingly, recent investigations suggest that Bullfrogs may not contribute to changes in the community composition and structure of native amphibians, particularly in complex habitat types (e.g., heavily vegetated stream courses) (Morey and Guinn 1992). The vulnerability of hatchling turtles remains very high when bullfrogs are sympatric with the western pond turtle. The impact of bullfrogs on the recruitment of western pond turtles is poorly understood and may not be evident until many years have past. This may result in significant gaps in recruitment or the absence of entire cohorts.

Another factor that may adversely affect western pond turtle populations is the introduction of non-native competitors. Numerous species of nonnative aquatic turtles have been observed within the range of the western pond turtle (Jennings 1987). These species include the painted turtle, red-eared slider, common snapping turtle (*Chelydra serpentina*), spiny soft-shelled turtle (*Apalone spinifera*), alligator snapping turtle (*Macroclemys temmincki*), stinkpot (*Sternotherus odoratus*), diamondback terrapin (*Malaclemys terrapin*), and Mississippi map turtle (*Graptemys kohni*). Most of these turtles represent animals imported for the pet or food trade that have been released or escaped captivity. In addition to competition for food, exotic turtles also may carry new pathogens for which western pond turtles exhibit no immunity.

Additional non-native competitors of particular concern are carp (*Cyprinus carpio* and *Carassius auratus*), aunfish (*Lepomis* spp. and *Pomoxis* spp.), and crayfish (*Cambarus*, *Procambarus*, and *Pacifasticus*). Carp alter aquatic habitats by consuming emergent and floating vegetation. Their activities also produce turbid water conditions. These alterations of the aquatic habitat may have a significant impact on hatchling turtle habitat, may reduce the availability of invertebrate prey, and decrease turtle foraging success as turtles rely primarily on vision to capture prey (Holland 1991a). Sunfish, which are capable of reaching large population sizes in aquatic habitats may modify or compete for the available invertebrate prey base (Holland 1991a). Although direct scientific data are unavailable to support this hypothesis, Holland (1991a) noted that several sites lacking native or nonnative fishes support the largest known western pond turtle populations. Crayfish, which also may prey on young western pond turtles, may compete with western pond turtles for both the invertebrate prey base and carrion (Holland 1991a).

16.4.4 Other Natural or Manmade Factors Affecting Its Continued Existence

Off-road vehicle activity poses a threat to western pond turtles both directly and indirectly. Direct impacts include crushing of individual turtles or nests and access to remote populations of the turtle for the purposes of collection or shooting. Off-road vehicle activity indirectly impacts western pond turtles by interfering with normal foraging and basking activities, and by altering or restricting overland or instream movements of turtles. Long-term impacts of off-road vehicle activity include increased soil erosion, soil compaction, vegetation removal, siltation of the watercourse, and alteration or loss of refugia. According to Holland (1991a), western pond turtle populations located in off-road vehicle areas in California tend to be small and disjunct, and occur in very limited habitats. Poor habitat quality combined with a very low probability of maintenance or reestablishment by immigration, renders these populations highly susceptible to extirpation.

Boat traffic also may adversely affect western pond turtles. Observations on the Rogue River in Oregon by Holland (1992) indicate that high levels of boat traffic may detrimentally alter basking and other behavior patterns. In addition, turtles that become acclimated to boat or vehicle traffic are potentially more susceptible to shooting. Holland (1991b) found that flight distances were significantly less in turtle populations acclimated to low or moderate levels of vehicle traffic than for populations in isolated areas. Boat propellers may also injure or kill western pond turtles (Holland 1992).

The exact role that contaminants play in western pond turtle mortality is unknown. Only one documented instance of contaminant-related mortality of western pond turtles was reported by Bury (1972b). Turtle mortality resulted from a spill of diesel fuel. In Oregon, pollution of several tributaries to the Willamette River (i.e., the Tualatin and Clackamas Rivers) in the late 1950's and 1960's may be related to the disappearance of western pond turtles from these rivers (Holland 1991a). The long life span and food habits of the western pond turtle could render this species prone to bioaccumulation of contaminants, such as heavy metals; however, no data are available to support this hypothesis (Holland 1991a).

The most significant natural factor affecting western pond turtle populations is drought. The six-year drought in California (1987 to 1992) had a major effect on western pond turtle populations, particularly in central and southern California within the range of the southern western pond turtle. Surveys of eight sites conducted by Holland (1991a) from 1987 to 1991 in central and southern California indicated that turtle populations had declined from 65 to 100 percent as a result of drought. One population in the Pajaro-Salinas River drainage of central coastal California, which contained the highest recorded density of turtles, suffered an 85 percent population decline (Holland 1991a). Drying of the habitat resulted in 1) concentrating large numbers of turtles in the few remaining pools, 2) major increases in the distance between pools, 3) exhaustion of the prey base, 4) increased exposure to predators, and 5) a general increase in stress suffered by the turtle population (Holland 1991a). Observations of additional sites by Holland (1991a) within the range of the southern western pond turtle indicated that drought related declines in populations of this subspecies were widespread. Where non-native predators and competitors were present, the adverse affects of drought were probably magnified (Holland 1991a).

Fire, which is often associated with drought and the over accumulation of combustible plant material, adversely affects western pond turtles in several ways. Unseasonal fires may kill overwintering turtles or hatchlings in the nest. Sweet (*in* Holland 1991a) reported that the Sespe Creek fire in fall 1991 probably killed any adult or hatchling turtles overwintering in the uplands. Excessive siltation of streams following fires may alter the prey base and eliminate refugial habitat, generally decreasing the suitability of the stream for turtles (Holland 1991a).

16.5 Data Gaps and Conservation Implications

The ecology, status, and management of western pond turtle s have received increased attention in recent years. There are several sources of uncertainty regarding western pond turtle and its requirements in the Plan Area. The primary data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

16.5.1 Population and Habitat Distribution within the Plan Area

Western Pond Turtles occur in suitable habitat within the Plan area; however, their overall distribution, abundance, and population structure are not well known. Habitat-types used by western pond turtles, such as suitable riverine and lacustrine habitats and adjacent uplands, occur throughout much of the Central Valley and are well represented in Sacramento County and the Plan area.

Because comprehensive surveys for western pond turtle in the Plan Area have not been conducted and the existing occurrence data are based primarily on incidental observations (e.g., CNDDB, anecdotal records), the population size and distribution of the species throughout the Plan Area are not known. In addition, though the distribution of different land cover-types is mapped and quantifiable, the quality of habitat for western pond turtle s within most of these areas is unknown. These information gaps limit our ability to identify the best lands available for preserving western pond turtle habitat and accurately estimate the impacts resulting from covered activities.

Until this data gap is remedied, the conservation value for western pond turtle will be considered relatively high in lands that support (or recently supported) known occurrences, are large in extent, or are adjacent to these areas.

16.5.2 Determining Threat Severity

Although certain factors are known to contribute to western pond turtle decline rangewide, exactly how and to what extent these factors contribute are largely unknown. Activities that directly remove or replace suitable habitat with incompatible land uses are more easily quantifiable than factors that indirectly affect an area or population. Therefore, to improve conservation planning efforts for western pond turtle in the Plan Area and elsewhere, additional empirical data are needed, specifically when analyzing factors that indirectly affect known populations and their habitats.

16.5.3 Effectiveness of Habitat Enhancement and Restoration Techniques in Creating Suitable Habitat for Western Pond Turtle

Achieving the conservation goals and objectives for western pond turtle will require successful enhancement and restoration of suitable habitat. The function of habitat (e.g., connectivity, hydroperiod, biodiversity) is an important factor for suitability of western pond turtle. Whether restored or enhanced habitats can retain the structural attributes suitable for western pond turtle is unknown.

If habitat restoration and enhancement techniques cannot eventually create habitats with functional characteristics suitable for western pond turtle, then those lands would not support sustainable populations.

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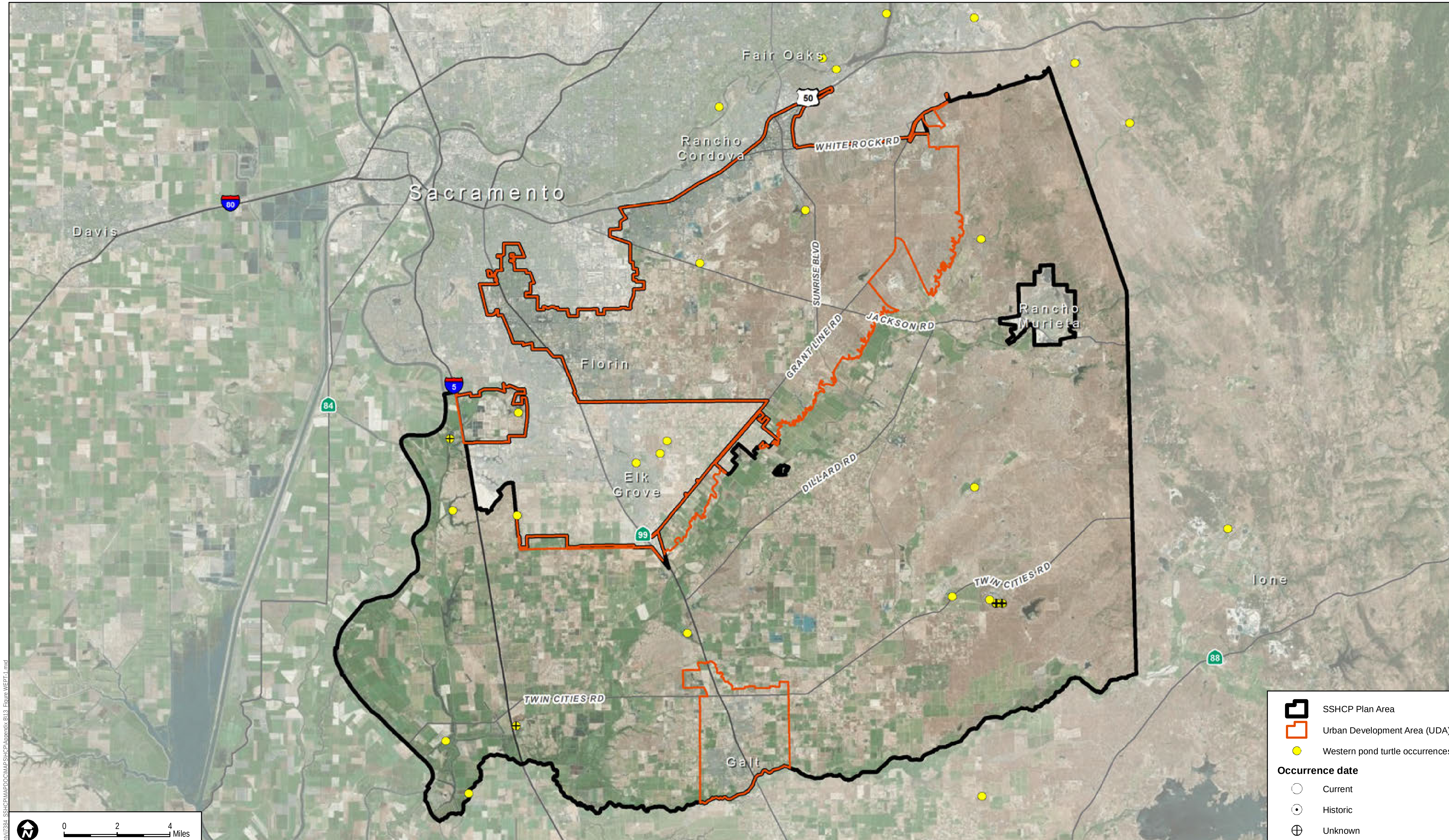

SOURCE: Bing Maps 2015, County of Sacramento 2014, CDFG 2012, CH2MHILL/Garcia & Associates, EIP Associates

FIGURE WPT-1

Western Pond Turtle Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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17 GIANT GARTER SNAKE (GGS)

Prepared by May Consulting (Jamison Watts)

Giant Garter Snake (GGS)

(Thamnophis gigas)

Status USFWS: Threatened

Status CDFG: Threatened

17.1 Legal Status

The giant garter snake (*Thamnophis gigas*) was listed as threatened by the State of California in 1971 and the United States Fish and Wildlife Service (USFWS) in 1993 under the Federal and California Endangered Species Acts respectively (USFWS 1993).

17.2 Life History and Ecology

17.2.1 Species Description and Life History

17.2.1.1 Species Description

The giant garter snake is one of the world's largest garter snakes, reaching a total length of up to 162 centimeters (64 inches). Females are slightly longer and proportionately heavier (typically 500 to 700 grams [1.0 to 1.4 pounds]) than males. The maximum number of dorsal scale rows is 23 or 21; supralabials (scales on upper lip) number eight with the 6th shorter than the 7th; subcaudals (scales on the underside of the tail, counted beginning with the first scale behind the vent) number 73 to 81 inches males and 65 to 73 inches females; and the lateral stripe, when present, is confined to dorsal scale rows two and three (Van Denburgh and Slevin 1918; Fitch 1940; Stebbins 1985; Rossman and Stewart 1987; Rossman et al. 1996).

Dorsal background color varies from brown to olive with a cream, yellow, or orange dorsal stripe and two light colored lateral stripes. Some individuals have a checkered pattern of black spots between the dorsal and lateral stripes. Background coloration, prominence of the checkered pattern, and the three yellow stripes are individually and geographically variable (R. Hansen

1980). Individuals in the northern Sacramento Valley for example, tend to be darker with more pronounced mid-dorsal and lateral stripes (California Department of Fish and Game [CDFG] 1992). The ventral coloration is variable from cream to orange to olive-brown to pale blue with or without ventral markings (R. Hansen 1980; CDFG 1992). Supralabial scales are dull brown and usually lack distinct wedge markings (R. Hansen 1980; CDFG 1992). As giant garter snake nears ecdysis (skin shedding), all pattern characteristics and colors may be obscured.

The giant garter snake can be distinguished from the common garter snake (*T. sirtalis*) and western terrestrial garter snake (*T. elegans*) by its color pattern, scale numbers, and head shape. The giant garter snake lacks the red lateral markings of the common garter snake. The Western terrestrial garter snake has well defined stripes and a black to dark gray ground color. The giant garter snake has a maximum of 23 or 21 scale rows and eight supralabials while the common garter snake has a maximum of 19 scale rows and seven supralabials, and the western terrestrial garter snake has a maximum of 19 or 21 scale rows and eight supralabials. In addition, the giant garter snake's seventh supralabial scale is wider than the sixth (R. Hansen 1980; Stebbins 1985; Rossman et al. 1996). The giant garter snake has an elongated head with a pointed muzzle (Stebbins 1985; Rossman et al. 1996) where the relative width of the muzzle of the giant garter snake averages 75.6 percent in males and 65.1 percent in females (calculated as InR/NR, where InR is the width of contact between the internasal and rostral scales, and NR is the width of contact between the nasal and rostral scales) (Rossman et al. 1996). The common garter snake and western terrestrial garter snake have broad muzzles with the relative muzzle width of the western terrestrial garter snake averaging 99 to 112 percent, and the relative muzzle width of the common garter snake averaging 127.6 percent (Rossman et al. 1996).

Subspecies have not been described for the giant garter snake, but there appears to be some morphological variation, principally with aspects of dorsal coloration and pattern, that conforms to geographic units (i.e., northern and southern groupings) (Boundy 1990). To date, there have been no range-wide studies of genetic variation in the giant garter snake. The only contemporary genetic studies on the giant garter snake have incorporated allozyme variation (Lawson and Dessauer 1979) or mtDNA sequencing (de Queiroz and Lawson 1994) in phylogenetic studies of the Sierra Nevada garter snake complex.

17.2.1.2 Reproduction

The giant garter snake breeding season begins soon after emergence from over-wintering sites and extends from March into May (USFWS 1999). Females brood young internally, and typically give birth to live young from late July through early September (Hansen and Hansen 1990). Brood size is variable, ranging from 10 to 46 young, with a mean of 23 (Hansen and Hansen 1990). At birth, young have an average snout-vent length of approximately 20.6 centimeters (8.1 inches) and weight of three to five grams (0.1 to 0.2 ounces). Following birth, young immediately scatter into dense cover and absorb their yolk sacs, after which they begin feeding on their own. Although growth rates are variable, young typically more than double in size by one year of age (G. Hansen pers. comm.). Sexual maturity averages three years in males and five years for females (USFWS 1999).

During 1989 and 1990, sex ratio data were collected from giant garter snakes captured by hand in the Natomas Basin population near Sacramento County (Hansen and Brode 1993). In a sample of 191 individuals, the ratio of females to males was approximately 1.5:1 (Hansen and Brode 1993). During 1996, sex ratio data were collected for three other populations (Wylie et al. 1997). The ratio of females to males was approximately 1:1 at both Badger Creek Marsh in Sacramento County and Gilsizer Slough in Sutter County. In contrast, the sex ratio was roughly 2:1 at Colusa National Wildlife Refuge in Colusa County.

17.2.1.3 Diet and Foraging

Giant garter snakes feed primarily on aquatic prey such as fish and amphibians. Brode (1988) and G. Hansen (1988) suggest that the giant garter snake specializes in ambushing small fish underwater, and Rossman et al. (1996) suggest the giant garter snake occupies a niche similar to some eastern water snakes (*Nerodia* spp.). They appear to take advantage of pools which trap and concentrate prey items. R. Hansen (1980) and Hansen and Brode (1993) observed giant garter snakes feeding on mosquitofish (*Gambusia affinis*) confined to small pools of water. The predominant food items of giant garter snakes are now introduced species such as carp (*Cyprinus carpio*), mosquitofish, other small fish, and bullfrogs (*Rana catesbeiana*) (Fitch 1941; Fox 1951; R. Hansen 1980; Brode 1988; Hansen and Brode 1993; Rossman et al. 1996; USFWS 1993). Native species preyed upon by giant garter snakes include the Sacramento blackfish (*Orthodox microlepidotus*) and Pacific treefrog (*Hyla regilla*). Cunningham (1959) reported a record of a giant garter snake from Buena Vista Lake, Kern County, swallowing a live Sacramento blackfish, which it had just dragged onto the bank. Historically, giant garter snake food also may have included the extinct thick-tailed chub (*Gila crassicauda*) and the federally threatened California red-legged frog (*Rana draytonii*), which has been extirpated from the Central Valley floor (R. Hansen 1980; Rossman et al. 1996).

17.2.1.4 Dispersal and Migration

Giant garter snakes begin emerging from winter retreats around April 1st. By April 15th, most giant garter snakes are active and beginning to search for food. By May 1st, all giant garter snakes have usually emerged and are actively foraging. Around October 1st, giant garter snakes begin seeking winter retreats. Foraging and other activities are sporadic at this time and dependent upon weather conditions. By November 1st, most snakes are in winter retreats and will remain there until spring (Brode 1990; Hansen and Brode 1993).

Seasonal activity may begin earlier than April 1st (as early as March 1st) in some years. Hansen and Brode (1993) concluded that they may emerge from winter retreats during any month of the year based on captures of giant garter snakes in the Natomas Basin in March and multiple observations of injured snakes. In 1996, captures of giant garter snakes began in March at Gilsizer Slough and at Colusa National Wildlife Refuge (Wylie et al. 1997). Late March was reported as the earliest time of regular seasonal activity at the Mendota Wildlife Area (R. Hansen 1980). Giant garter snake activity peaks during April and May; therefore, they may become less detectable in mid- to late summer (Hansen and Brode 1993). Hansen and Brode (1993) found that the sudden decrease in observations of giant garter snakes along canals in June and July corresponded with the sudden appearance of giant garter snakes within maturing rice fields. Captures at Gilsizer Slough and Colusa National Wildlife Refuge became infrequent after June of 1996 (Wylie et al. 1997). At Badger Creek Marsh, captures in 1996 became infrequent after mid-July, and in August of 1996, giant garter snakes at Badger Creek Marsh used burrows as much as 50 meters (164 feet) away from the marsh edge to escape extreme heat (Wylie et al. 1997).

Giant garter snakes are generally inactive during the winter months although some individuals may bask or move short distances on warmer days. For example, juveniles were occasionally observed at the Mendota Wildlife Area during the winter months when the air temperature was only 15 degrees Celsius (59 degrees Fahrenheit) (R. Hansen 1980). In the Sacramento Valley, 50 percent of the radio-telemetered snakes were observed, at some time, basking or moving short distances during the winter months (Wylie et al. 1997).

Fitch (1940) considered the giant garter snake as a "strictly diurnal snake"; however, observations by R. Hansen (1980) suggest that giant garter snakes are flexible in terms of their activity. Giant garter snakes were observed feeding at night on mosquitofish in small pools of water, and giant garter snakes at the Mendota Wildlife Area exhibited diurnal activity during the spring (March to June), and nocturnal activity during the hot summer months (R. Hansen 1980). Cunningham (1959) observed giant garter snakes feeding at night in September, 2.5 hours after dark at Buena Vista Lake. Hansen and Brode (1993) also observed giant garter snakes after sunset during hot weather. G. Hansen reported observing giant garter snakes active at night at the Mendota Wildlife Area, Gray Lodge Wildlife Area, and within the Natomas Basin during cool spring nights as well as during hot weather (USFWS 1993). The daily activity of giant garter snakes as described by Hansen and Brode (1993) follows a general pattern: 1) emergence from burrows after sunrise; 2) increasing body temperature to activity temperatures by basking, particularly during cool weather or on cold mornings; and 3) foraging or courting activity for the remainder of the day.

During radio-telemetry studies conducted by the USFWS, giant garter snakes typically moved little from day to day; however, total activity varied widely among individuals (USFWS 1993). At the Colusa National Wildlife Refuge, snakes moved up to eight kilometers (five miles) in two days in response to dewatering of habitat during refuge maintenance of water control structures (Wylie et al. 1997). Giant garter snakes usually remain in close proximity to wetland habitats, but can be found as far away as 250 meters (820 feet) from their edge (G. Hansen 1988; Wylie et al. 1997). Hansen and Brode (1993) also documented giant garter snakes moving at least 400 meters (0.25 miles) between small lateral ditches and larger canals within the Natomas Basin. Some marked and recaptured giant garter snakes moved distances greater than 800 meters (0.5 miles) in as little as a day. The average distance between upland, over wintering sites and aquatic breeding sites is thought to be approximately 150 meters, ranging from 50 to 400 meters (G. Wylie and S. Barry pers. comm. 2005)

Derived from telemetry data, the USFWS estimated the home range sizes of giant garter snakes at three study sites (Table GGS-1). The mean home range estimate for individual snakes was 19.0 hectares (47 acres) (range 0.8 hectares [2 acres] to 259.5 hectares [641 acres], N=27) at Gilsizer Slough; 53.2 hectares (131 acres) (range 1.3 to 1,130 hectares [3.2 to 2,792 acres], N=29) at the Colusa National Wildlife Refuge; and 9.2 hectares (23 acres) (range 4.2 to 82.0 hectares [10.3 to 203 acres], N=8) at Badger Creek (USFWS 1993).

Table GGS-1
Population Estimates and Home Range Size Estimates for Three Populations of Giant Garter Snakes

Site (surface area in hectares/acres)	Year	Population Estimate (95% C.I.)*	Median Home Range in hectares/acres (range in hectares)**
Gilsizer Slough (1,430/3,500)	1995	206 (136-349)	19.0/47 (0.8-259.5) N =27
	1996	170 (128-248)	
Colusa NWR (4,500/11,120)	1996	132 (80-254)	53.2/131 (1.3 - 1,130) N =29
	1997	119 (72-239)	
Badger Creek (235/580)	1996	191 (69-674)	9.2/23 (4.2 - 82.0) N =8

* Population estimates for giant garter snakes from the mark-recapture model with time-specific changes in probability of capture, which results in a conservative estimate. Estimates are derived from two-week time intervals. ** Home range estimates (ha/ac) for individual giant garter snakes derived from telemetry using the adaptive kernal method. "N" is the number of snakes in the sample. "C.I." is the Confidence Interval.

17.2.1.5 Ecological Relationships

A number of native mammals and birds are known or likely predators of giant garter snake including raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), opossums *(Didelphis virginiana*), foxes (*Vulpes vulpes*, *Urocyon cinereoargenteus*), hawks (*Bute*o spp.), northern harriers *(Circus cyaneus*), egrets (*Ardea alba*, *Egretta thula*), bitterns (*Botaurus lentiginosus*), and great blue herons (*Ardea herodias*). Many areas supporting garter snakes have been documented to have abundant predators (R. Hansen 1980; Hansen and Brode 1993; Wylie et al.

1997). G. Hansen (1986) observed that nearly all giant garter snakes captured and examined possessed scars or recent injuries, presumably acquired during attacks by predators. R. Hansen (1980) concluded that the abundance and diversity of predators suggested that predation pressure might be severe; however, predation does not seem to be a limiting factor in areas that provide abundant cover, high concentrations of prey items, and connectivity to a permanent water source (Wylie et al. 1997).

The giant garter snake may coexist with two other species of garter snakes. The Valley garter snake (*T. sirtalis fitchi*) was found to coexist with giant garter snakes in all areas that currently support them (R. Hansen 1980; G. Hansen 1986). The western terrestrial garter snake was observed at locations in the Elk Grove and Galt areas of Sacramento County, and Badger Creek Marsh supports all three species of garter snakes (G. Hansen 1986). Differences in foraging behavior may allow these species to co-exist. The Valley garter snake forages among vegetation bordering the water, while the giant garter snake captures its food in the water (R. Hansen 1980). Giant garter snakes may also successfully compete with the Valley garter snake by specializing on small fish as prey (Brode 1988).

17.2.2 Habitat Requirements and Ecology

Endemic to valley floor wetlands in California's Central Valley, the giant garter snake inhabits marshes, sloughs, low gradient streams, and other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields. Giant garter snakes feed on small fishes, tadpoles, and frogs (Fitch 1941; G. Hansen 1980; G. Hansen 1988). Suitable habitat consists of (1) adequate water during the snake's active season (early-spring through mid-fall) to provide food and cover, (2) emergent, herbaceous wetland vegetation, such as *Scirpus* and *Typha* spp. for escape cover and foraging habitat during the active season, (3) grassy banks and openings in waterside vegetation for basking, and (4) higher elevation uplands for cover and refuge from flood waters during the snake's dormant season in the winter (G. Hansen 1988). Giant garter snakes are absent from larger rivers and other water bodies that support introduced populations of large, predatory fish, and from wetlands with sand, gravel, or rock substrates (Hansen 1980; Rossman and Stewart 1987; Brode 1988; G. Hansen 1988). Riparian woodlands do not typically provide suitable habitat because of excessive shade, lack of basking sites, and absence of prey populations (R. Hansen 1980).

The ideal concept of a marsh managed for giant garter snake includes shallow and deep water with variations in topography, including some higher ground resembling ditch banks, or "islands" similar to a rice check. Rice fields contain warm, shallow water with emergent vegetation (i.e., rice plants), which is present during the giant garter snake's active season (spring through early fall). During the late summer when rice fields contain large numbers of mosquitofish and Pacific tree frogs, rice fields may provide important nursery areas for newborn giant garter snakes (Brode and Hansen 1992; Hansen and Brode 1993). In addition, this habitat-type and its associated water conveyance system, if managed properly, provides hydrological connectivity, protection from predators, relatively warm water to aid metabolism, gestation, and digestion, and a reliable source of food (USFWS 1993).

Today, giant garter snakes appear to be most numerous in rice growing regions. The diverse habitat elements of rice lands, rice fields, tail-water marshes, ditch and drain components of water conveyance systems, delivery canals, and associated levees, all contribute structure and complexity to this man-made ecosystem. Giant garter snakes can apparently survive in this artificial ecosystem because the spring and summer flooding and fall dry-down of rice culture roughly coincides with the biological needs of the species (USFWS 1999). Giant garter snakes utilize rice lands extensively and depend on them for habitat (Fuller pers. comm. 2005). Giant garter snake seasonal activity associated with rice cultivation occurs as follows:

- **Spring:** Rice is planted and the fields are flooded with several inches of water. Rice fields that contain prey species such as small fish or frogs attract giant garter snakes.
- **Summer:** While the rice grows, giant garter snake continue to use rice fields as long as prey species are present in sufficient densities.
- **Late Summer/Fall:** Rice fields are drained and rice is harvested. Giant garter snakes move off the fields into adjacent habitats and the females, who have just delivered young, intensively forage to regain their body weight before winter. The dry-down of rice fields during this time is thought to be important because prey species which have been proliferating, become concentrated in the remaining pockets of standing water where snakes can gorge prior to the period of winter inactivity.
- **Winter:** giant garter snakes are predominantly dormant in the winter and rice fields are fallow.

In addition to grassy banks, giant garter snakes will bask in bulrush, cattails, shrubs overhanging the water, patches of waterweed (*Ludwigia peploides*) and other floating vegetation. In the San Joaquin Valley, giant garter snakes also bask in openings within saltbush (*Atriplex* spp.) (Van Denburgh and Slevin 1918; Brode 1988). Riparian vegetation such as saltbush and willows (*Salix* spp.) provide cover from predation. Giant garter snakes also bask in openings in vegetation created by rip-rap placed around water control structures. Giant garter snakes use small mammal burrows and other soil crevices above prevailing flood elevations during the winter (i.e., November to mid-March), typically with sunny exposures along south- and west-facing slopes (USFWS 1999). During the active season, small mammal burrows, crayfish burrows, and soil crevices provide retreats from extreme heat (Hansen and Brode 1993). In one study, wintering site location varied from canal banks and marsh areas to riprap along a railroad grade near the marsh (Wylie et al. 1997). Wintering locations of radio-telemetered snakes tended to be in the vicinity of spring capture sites. In addition, during the active season, giant garter snakes use burrows as far as 50 meters (164 feet) away from the marsh edge, whereas, overwintering snakes use burrows as far as 250 meters (820 feet) from the edge of marsh habitat (Wylie et al. 1997).

Brode and Hansen (1992) and Hansen and Brode (1993), reported that giant garter snakes begin utilizing rice fields as early as June. In agricultural areas where rice fields and agricultural waterways are available, radio-telemetered giant garter snakes were located in rice fields 19 to 20 percent of the time, in marsh habitat 20 to 23 percent, and in canal and agricultural waterway habitats 50 to 56 percent of the time (Wylie et al. 1997). Between 48 and 55 percent of these latter snakes used rice fields at some time. Where marsh habitat and adjacent uplands were the only habitat available, giant garter snakes used the marsh edge most of the time (Wylie et al. 1997).

17.2.2.1 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment which are needed for survival and propagation of the species. The essential habitat elements for giant garter snake are identified in Table GGS-2 and have been derived from the USFWS's list of essential habitat components in the Draft Recovery Plan for the giant garter snake (USFWS 1999) as well as input from local species experts.

Table GGS-2
Essential Habitat Elements for Giant Garter Snake

Essential Activities	Land Cover Types	Habitat Elements
Foraging, breeding and dispersal	Seasonal impoundments, freshwater marsh, open water, and streams/creeks.	Adequate water during the snake's active season (early-spring through mid-fall) to provide food and cover; emergent, herbaceous wetland vegetation for escape cover, dispersal, and foraging habitat during the active season; and grassy banks and openings in waterside vegetation for basking.
Winter and summer inactivity	Mine tailing riparian woodland, valley oak riparian woodland, mixed riparian scrub, cropland, seasonal wetlands, seasonal impoundment, and freshwater marsh.	Uplands for cover and refuge during high summer temperatures. Higher elevation uplands for cover and refuge from flood waters during winter dormancy.

17.3 Species Distribution and Population Trends

17.3.1 Range-wide Distribution

Giant garter snakes are endemic to the valley floors of the Sacramento and San Joaquin Valleys of California (Fitch 1940; Hansen and Brode 1980; R. Hansen 1980; Rossman and Stewart 1987). Although the boundaries of its original distribution are uncertain, records coincide with the historical distribution of the large flood basins, fresh water marshes, and tributary streams of the Central Valley of California (Hansen and Brode 1980). Fitch (1940) described the historical range of giant garter snakes as extending from the vicinity of Sacramento and Contra Costa Counties southward to Buena Vista Lake, near Bakersfield in Kern County. Fox (1951) indicated that intergrades between giant garter snakes and another closely related species (then called *T. elegans aquaticus*) occurred from Butte County near Gridley south to Sacramento. Hansen and Brode (1980) suggested that the intergrades described by Fox (1951) were actually giant garter snakes and described the range of the giant garter snake as extending from Burrel in Fresno County, north to Gridley. Rossman and Stewart (1987) examined additional specimens and concluded that the range of the giant garter snake extended to about 32 kilometers (20 miles) north of Gridley.

The giant garter snake probably occurred historically from Butte County in the north, southward to Buena Vista Lake in Kern County. Giant garter snakes have probably always been absent from the northern portion of the San Joaquin Valley, where the floodplain of the San Joaquin River is restricted to a relatively narrow trough by alluvium from tributary rivers and streams. This 100-kilometer (62 -mile) gap in its distribution separates populations in Merced County from those along the eastern fringes in the Sacramento/San Joaquin River Delta (Delta) in San Joaquin County (Hansen and Brode 1980). Because extensive marshes once occurred throughout the Delta, it is possible that giant garter snakes historically occupied this area (G. Hansen 1986, 1988). The foothills of the Coast Ranges and Sierra Nevada Mountains probably define the eastern and western boundaries of their range. Rossman et al. (1996) described the elevational distribution as ranging from sea level to 122 meters (400 feet) above mean sea level; whereas locality records in the southern Sacramento Valley occurred between three and 12 meters (10 and 40 feet) in elevation (G. Hansen 1986).

R. Hansen (1980) investigated the gap between the distribution of the giant garter snake and Sierra garter snake on the eastern side of San Joaquin Valley and determined that extensive riparian forests along river corridors historically limited the ranges of the two garter snake species. The river corridors lacked rocks or exposed vegetation (e.g., bulrushes, cattails) and areas on shore that might serve as basking sites. Prey items may also have been less abundant in these riparian corridors than in sloughs and marshes of the Central Valley floor (R. Hansen 1980).

17.3.2 Sacramento County Distribution

There are 56 documented occurrences of giant garter snake in Sacramento County in the California Natural Diversity Data Base (CNDDB) (CDFG 2010). Thirty-nine (70 percent) of these occurrences are located in northern Sacramento County (i.e., north of Interstate 80)and constitute the southern portion of the American Basin population, the largest extant population of the giant garter snake (USFWS 1999). Reconnaissance-level surveys of this area conducted by the USFWS prior to 1991 indicated that approximately 570 hectares (1,408 acres) of giant garter snake habitat existed in the form of man-made irrigation channels and drainage ditches, and an undetermined number of acres of suitable habitat within approximately 5,260 hectares (13,000 acres) of adjoining rice fields; however, much of this habitat is now gone. The remaining 17 CNDDB occurrences in Sacramento County (i.e., south of Interstate 80) are in the following general locations: just north of the Antioch Bridge, Horseshoe Bend, Stone Lake, Laguna Creek, Morrison Creek, Snodgrass Slough, Willow Creek, Badger Creek, Hadselville Creek, and Elk Grove Creek. In addition, an unknown number of giant garter snakes are believed to occur along portions of Elder Creek (USFWS 1999) as well as hydrologically connected irrigation canals and tail waters in agricultural areas. Together, these occurrences suggest that Sacramento County supports a substantial proportion of the current rangewide distribution of giant garter snake. Figure GGS-1 displays the previously recorded occurrences of giant garter snake in Sacramento County (CDFG 2010).

17.3.3 Range within Plan Area

There are 15 documented occurrences of giant garter snake within the Plan Area including six within the Urban Development Area (UDA) and nine outside of the UDA (CDFG 2010). The giant garter snake occurrence records within the Plan Area are concentrated within the southern and southwestern portions of the Plan Area (Figure GGS-1). There are no occurrence records east of Clay Station Road in the southern portion of the Plan Area or east of Bradshaw Road in the City of Elk Grove (CDFG 2010). The occurrence record located in the southern part of the City of Elk Grove east of Waterman Road approximately one mile north of Grant Line Road is assumed to be recorded in error. Eric Hansen (pers. comm., January 12, 2006) considers this occurrence questionable given the general lack of essential habitat components for the species at and near this location, the lack of other documented occurrences from the vicinity, and no supporting documentation for the occurrence (e.g., specimen or photograph). The documented occurrence records seem to indicate that the range of the species is west of State Highway 99 and south of the Cosumnes River; however, according to the Draft Recovery Plan for the giant garter snake, the distribution of giant garter snake is defined by the Delta Recovery Area from the Draft Giant Garter Snake Recovery Plan (USFWS 1999). The range was then extended to include streams and creeks that have been visually determined to have a perennial water source and are hydrologically connected to current or past occurrence records according to CNDDB (CDFG 2010).

17.3.4 Population Levels and Trends

Agricultural and flood control activities have extirpated the giant garter snake from the southern one third of its range in the former wetlands associated with the historic Buena Vista, Tulare, and Kern lakebeds (Hansen and Brode 1980; R. Hansen 1980; CDFG 1992; G. Hansen 1986, 1988). As recently as the 1970's, the range of the giant garter snake extended from near Burrel (Hansen and Brode 1980) northward to the vicinity of Chico (Rossman and Stewart 1987). CDFG studies (G. Hansen 1988) indicate that giant garter snake populations are distributed in portions of the rice production zones of Sacramento, Sutter, Butte, Colusa, and Glenn Counties; along the western border of the Yolo Bypass in Yolo and Solano Counties; west to the vicinity of Woodland in Yolo County and the vicinity of Liberty Farms in Solano County; and along the eastern fringes of the Sacramento/San Joaquin River Delta from the Laguna Creek/Elk Grove region of central Sacramento County southward to the Stockton area of San Joaquin County. Giant garter snakes also occur in the central San Joaquin Valley in rice production zones in Fresno and Merced Counties, and at Mendota Wildlife Area in Fresno County (G. Hansen 1996; USFWS 1993). In September 1998, a giant garter snake was positively identified in the western Sacramento/San Joaquin Delta in the vicinity of Decker and Sherman Islands, in Sacramento County (USFWS 1999). The last record of a giant garter snake this far west in the Delta region was a specimen collected in the 1930's to 1940's. It is not known if this snake represents a resident population in the western Delta or was washed into the Delta during high water flows in the winter of 1997-1998 (USFWS 1999).

The San Joaquin Valley populations of giant garter snakes have apparently suffered severe declines and possible extirpations over the last three decades. Prior to 1980, several areas within the San Joaquin Valley supported populations of giant garter snakes. Until recently, there were no post-1980 sightings from Stockton southward despite several survey efforts (G. Hansen 1988). Surveys of historic localities conducted during 1986 did not detect any giant garter snakes (G. Hansen 1988). However, during the 1995 surveys of historic locality records and adjacent waterways, one road-killed giant garter snake was found, and three presumed giant garter snakes were observed, but not captured. These two sightings occurred at the Mendota Wildlife Area, and two occurred several miles south of the city of Los Banos. These data indicated that giant garter snakes are still extant in two localities within the San Joaquin Valley, but are in extremely low to undetectable numbers. giant garter snakes also were observed in the Caldoni Marsh/White Slough Wildlife Area in San Joaquin County during 1995 surveys (G. Hansen 1996).

In 1994, the Biological Resources Division of the US Geological Survey (BRD) (formerly the National Biological Survey) began a study of the life history and habitat requirements of the giant garter snake in response to an interagency submittal for consideration as a National Biological Survey Ecosystem Initiative. Since April of 1995, the BRD has further documented occurrences of giant garter snakes within some of the populations identified in the final rule to list this species (USFWS 1993). The BRD has studied populations of giant garter snakes at the Sacramento and Colusa National Wildlife Refuges within the Colusa Basin; at Gilsizer Slough within the Sutter Basin; and at the Badger Creek area of the approximately 46,000-acre Cosumnes River Preserve, within the Badger Creek/Willow Creek area (Wylie et al. 1997). These populations, along with the American Basin population of giant garter snakes, represent the largest extant populations. During 1997, the BRD also surveyed at Stone Lakes National Wildlife Refuge, where four locality records from 1992 and earlier occur on or within close proximity to the Refuge (CDFG 2010). Although suitable habitat is present at Stone Lakes National Wildlife Refuge, the BRD did not find giant garter snakes during their trapping efforts (USFWS 1999). Surveys over the last two decades have located the giant garter snake as far north as the Butte Basin in the Sacramento Valley.

Currently, the USFWS recognizes 13 separate populations of giant garter snakes, with each population representing a cluster of discrete locality records within contiguous habitat (USFWS 1993). The 13 extant populations largely coincide with historical riverine flood basins and tributary streams throughout the Central Valley (G. Hansen 1980, Brode and Hansen 1992) and include: (1) Butte Basin, (2) Colusa Basin, (3) Sutter Basin, (4) American Basin, (5) Yolo Basin/Willow Slough, (6) Yolo Basin/Liberty Farms, (7) Sacramento Basin, (8) Badger Creek/Willow Creek, (9) Caldoni Marsh, (10) East Stockton -- Diverting Canal and Duck Creek, (11) North and South Grasslands, (12) Mendota, and (13) Burrel/Lanare. These populations are distributed discontinuously in small isolated patches and are vulnerable to extirpation by random, naturally occurring environmental events, population dynamics and genetic processes. All 13 populations are isolated from each other without protected dispersal corridors. These populations span the Central Valley from just southwest of Fresno (i.e., Burrel/Lanare) north to Butte Creek. The 11 counties where the giant garter snake is still presumed to occur are: Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo.

The current distribution and abundance of the giant garter snake is much reduced from former times (USFWS 1999). Agricultural and flood control activities have extirpated the giant garter snake from the southern one third of its range in former wetlands which were associated with the historic Buena Vista, Tulare, and Kern lakebeds (Brode and Hansen 1992; CDFG 1992; G. Hansen 1986; Hansen and Brode 1980; R. Hansen 1980). These lakebeds once supported vast expanses of ideal giant garter snake habitat, consisting of Cattail and Bulrush-dominated marshes. South of Fresno, virtually no suitable freshwater habitat remains (Hansen and Brode 1980). Vast expanses of Bulrush and Cattail floodplain habitat also typified much of the Sacramento Valley historically (Hinds 1952). Prior to reclamation activities beginning in the mid-to late 1800's, about 60% of the Sacramento Valley was subject to seasonal flooding in broad, shallow flood basins that provided expansive areas of giant garter snake habitat (Hinds 1952). However, these valley floor wetlands have since been subjected to the cumulative effects of upstream watershed modifications, water storage and diversion projects, as well as urban and agricultural development resulting in their almost complete elimination; however, a relatively small percentage of semi-natural and artificial wetlands remain, which currently provides suitable habitat for giant garter snake (USFWS 1999). Regardless of the extent of wetlands currently remaining, field studies (Hansen 1986; Hansen 1988) indicate that the species is absent from most areas with seemingly suitable habitat.

17.4 Threats to the Species

Although certain factors are known to contribute to giant garter snake decline range wide, exactly how and to what extent they affect the decline are largely unknown. Activities that directly remove or replace suitable habitat with incompatible land uses are more easily quantifiable than factors that indirectly affect an area or population. Therefore, to improve conservation planning efforts for giant garter snake in the Plan Area and elsewhere, additional empirical data are needed, specifically when analyzing factors that indirectly affect known populations and their habitats. Without a better understanding of how covered activities affect giant garter snake and other target species, the potential for success in conserving the species is reduced. The following is a summary of factors known or suspected to negatively affect giant garter snake.

17.4.1 Habitat Loss and Alteration

Habitat loss and alteration throughout the range of the giant garter snake has resulted in fragmented and isolated habitat remnants supporting small, scattered populations of giant garter snake. Principles of population genetics stipulate that small populations confined to limited habitat areas are more vulnerable to extirpation from stochastic (random) environmental, genetic and demographic events than larger, less fragmented populations (Schonewald-Cox et al. 1983). When an existing, local population becomes extinct, there is virtually no chance of recolonization by other populations unless adequate dispersal corridors are protected and maintained into perpetuity. In addition, the breeding of closely related individuals can cause genetic problems in small populations, particularly the expression of deleterious genes (known as inbreeding depression).

A number of land use practices and other human activities currently threaten the survival of the giant garter snake throughout its remaining range. Although some giant garter snake populations have persisted at low population levels in artificial wetlands associated with agricultural and flood control activities, many of these altered wetlands are now threatened with urban development. Several cities within the current range of the giant garter snake are expanding rapidly within or near the historic range of the giant garter snake and include, but are not limited to, Chico (Butte Basin population), Yuba City (Sutter Basin population), Sacramento (American and Sacramento Basin populations), Galt (Badger/Willow Creek population), Stockton (East Stockton population), and Gustine and Los Banos (North and South Grasslands population). In addition, the North Delta Water Management project proposed by the California Department of Water Resources would facilitate urban development and adversely affect the Sacramento Basin population; the American River Watershed Investigation or local equivalent by the Corps would facilitate urban growth that may adversely affect the American Basin population; and the Sacramento River Flood Control Project, Phase II Marysville/Yuba City Area, and Yuba River Basin project would facilitate urban growth in the vicinity of the Sutter Basin population.

Certain agricultural practices can also destroy habitat that supports the giant garter snake. For example, intensive vegetation control activities along canal banks can fragment and isolate available habitat. In addition, G. Hansen (1982, 1986), and G. Hansen and J. Brode (USFWS 1993) observed livestock grazing threats to four populations of the species. Studies on other garter snake species have established a negative cause and effect relationship between livestock grazing and snake population demographics (Szaro et al. 1985). The giant garter snake requires dense vegetative cover in proximity to waterside foraging and basking habitats in which to seek refuge from predators and other forms of disturbance. Livestock grazing along the edges of water sources degrades habitat quality by reducing vegetative cover. Overall, grazing has eliminated or reduced the quality of available habitat at four known locations (USFWS 1993).

17.4.1.1 Northern Sacramento County

Habitat supporting the giant garter snake in the American Basin is threatened by a number of activities including urbanization. In addition, the United States Corps of Engineers and/or local project sponsors are proposing flood protection for this approximately 22,260-hectare (55,000-acre) agricultural area. The USFWS (USFWS 1991) anticipates that the provision of flood control would result in the conversion of most or all of this area to urban land uses within the next 50 years. Other projects in the American Basin include the North Natomas Community Drainage System and associated urban development. These projects, which are proposed by the City of Sacramento, would affect about 42 kilometers (26 miles) of giant garter snake habitat along existing canals and ditchesas well as additional rice field habitat (Brode and Hansen 1992). In addition, the Sacramento Metropolitan Airport is proposing about 765 hectares (1,890 acres) of development on agricultural and vacant lands that could result in major adverse impacts to the species, including the loss of about 14.5 kilometers (9.0 miles) of canal habitat and 607 hectares (1,500 acres) of rice fields, as well as the disruption of movement corridors (Brode and Hansen 1992). Roadway improvements or construction projects, or the planned extension of the Sacramento Regional Transit system in this area, would likely result in elevated mortality from increased traffic on local roads and highways (Brode and Hansen 1992).

17.4.1.2 Plan Area

Habitat supporting the giant garter snake in the Plan Area is threatened by a number of activities including urbanization. Development within the Urban Development Area (UDA) may adversely affect the species if present. For example, the City of Elk Grove contains natural and man-altered wetland features that may support giant garter snake. These features include areas within the Stone Lakes National Wildlife Refuge, Cosumnes River, Sacramento River and associated tributaries (e.g., Deer Creek, Morrison Creek, and Laguna Creek), and vegetative communities consisting of valley oak woodland, annual grassland, valley foothill riparian, and agricultural lands. Some of the irrigation ditches and open water habitats in the UDA support suitable habitats for this species.

17.4.2 Over Utilization for Commercial, Recreational, Scientific, or Educational Purposes

Although giant garter snakes do not seem to be of great interest to reptile collectors, the species has been found for sale in pet shops (USFWS 1993); however, collection for commercial purposes does not appear to threaten the giant garter snake.

Collection and harassment associated with recreational activities apparently cause a substantial impact in certain areas (USFWS 1993). Recreationists can disturb basking snakes, interfering with thermoregulatory behavior. Fishing pressure at the Mendota population during the 1970's and 1980's resulted in numerous observed instances of road kills and other possible killing and injuring of giant garter snakes (USFWS 1993). In the American Basin, collection of crayfish for human consumption also results in harassment of giant garter snakes and disturbance and harassment associated with fishing pressure also is implicated in the demise of the giant garter snake population at Burrell (USFWS 1993).

17.4.3 Disease and Predation

Little information on diseases that affect the giant garter snake is available. The CDFG ceased mark and recapture studies on the giant garter snake in the American Basin after observing that marked snakes were slow to heal and often became infected (USFWS 1993).

Unidentified parasitic worms have been found in giant garter snakes from the American Basin population (USFWS 1993). Infected snakes exhibited reduced appetites and growth rates compared to uninfected snakes and all infected snakes eventually died after lingering malaise, although some reached 12 to 14 months of age. Upon death, uniformly sized five- to eight-centimeter worms emerged from noticeable lumps at locations along the ventral or dorsal skin surfaces. The degree of threat posed by these worms to the American Basin population or the species throughout its range is not known.

Predation levels on the giant garter snakes have increased due to a number of factors. A number of native mammals and birds are known or likely predators of giant garter snakes, including raccoons, skunks, opossums, foxes, hawks, egrets, and herons. The abundance and diversity of predators and a paucity of escape cover in remaining giant garter snake habitat suggest that predation pressure on this species probably is severe (Hansen 1980). The high fecundity (Hansen and Hansen 1990) and extremely wary behavior (Hansen 1980 and references cited therein) of the species provide additional evidence that the species has developed physiological and behavioral adaptations to help withstand predatory pressure. Hansen (1986) observed that nearly all captured and examined giant garter snakes possessed scars or recent injuries (presumably acquired during attacks by predators).

Domestic cats prey upon the giant garter snake. G. Hansen (USFWS 1993) has observed numerous snake kills by domestic cats in one of his longtime study areas about 3.2 kilometers (2 miles) from the closest urban development in the City of Davis, Yolo County.

Few, if any, native fish species pose a predatory threat to the giant garter snake. However, introduced large mouth bass and catfish are voracious, opportunistic predators of many species of invertebrates, fish, reptiles, amphibians, birds, and small mammals, and have become established in virtually all permanent and semi-permanent waters throughout the Central Valley (USFWS 1993). These introduced predatory fishes have been responsible for eliminating many species of native fishes and aquatic vertebrates in the western United States (Minkley 1973; Moyle 1976).

Bass in the 0.4 to 1.4 kilogram size class can take 30 to 38-centimeter snakes and would prey upon giant garter snakes (USFWS 1993). The instinctive response of giant garter snakes to dive under water upon disturbance (Fitch 1941) would be maladaptive where nonnative predatory fish have become established. Parmley and Mulford (1985) reported an instance of a Largemouth Bass eating a water snake. Introduced predatory fish may explain the absence of garter snakes from large bodies of water (Brode 1988). Brode (1988) believed that the giant garter snake was absent from large bodies of water due to the presence of introduced predatory fishes.

Introduction of the bullfrog to virtually all areas inhabited by the giant garter snake further increases the threat of predation facing the species. The spread of Bullfrogs has contributed to the demise of numerous species of native amphibians and reptiles (Schwalbe and Rosen 1989; Holland 1991). Bury and Whelan (1984) cited 14 cases of bullfrogs eating snakes. These studies documented (1) bullfrog ingestion of garter snakes up to 80 centimeters (31.5 inches) in length, (2) depletion of the <80-centimeter length (snout-vent) age class, and (3) disappearance and resurgence of garter snake populations coincident with the introduction and decline of bullfrog populations. Schwalbe and Rosen (1989) concluded that bullfrogs have a high potential for eliminating garter snake populations. Treanor (1993) found that unidentified garter snakes *(Thamnophis* spp.*)* comprised 6.0 and 6.4 percent volume of bullfrog stomach contents in the months of July and August at Gray Lodge Waterfowl Management Area, a known giant garter snake location.

17.4.4 Other Natural or Manmade Factors Affecting Giant Garter Snake Continued Existence

In rice production areas of the American Basin, the largest remaining population of giant garter snakes inhabits water management facilities adjoining rice fields (in rare instances the snake occurs along other agricultural waterways) (USFWS 1993). The seasonal flooding and draining of rice ponds may provide an adequate forage base and may prevent establishment of populations of large predatory fish (Brode and Hansen 1992).

However, Pacific Environmental Consultants (1992) cites sources that document 250,000-acre swings in rice production over a three-year time span suggesting that these situations do not represent stable conditions for associated giant garter snake populations. Rice production varies depending upon market conditions (e.g., Department of Agriculture price support programs), and water availability for agriculture (e.g., State Water Resources Control Board Draft Interim Water Rights Decision, D—1630) protects estuarine fisheries values by reducing winter and spring exports from the Delta, which could result in reduced acreage of rice production.

Furthermore, intensive control of vegetation along water delivery and drainage facilities eliminates remaining habitat and prevents reestablishment of former habitat (Hansen 1988; Brode and Hansen 1992; USFWS 1993). For example, more intensive maintenance practices have eliminated habitat along water canals in the American Basin along State Route 70/99 (USFWS 1993). Such activities can kill or injure snakes, remove critical escape cover, eliminate prey populations, and destroy small mammal burrows and other soil fissures needed as winter retreat habitat. G. Hansen observed the complete elimination of suitable habitat from maintenance practices along both sides of canals where giant garter snakes were found the previous season (USFWS 1993).

The giant garter snake is vulnerable to changes in water management because it depends on the availability of wetlands. In response to Statewide water shortages associated with drought, water management agencies, including the California Department of Water Resources and US Bureau of Reclamation, announce reductions in delivery of water to certain agricultural regions. In addition, the Department of Water Resources has begun acting as a broker to facilitate transfer of water from users with discretionary supplies to those with critical needs. Water districts from around the State are offering to purchase water from water districts in rice production regions of the Sacramento Valley (USFWS 1993).

Contaminants, such as fertilizers and pesticides, could adversely affect giant garter snake populations by degrading water quality and reducing prey populations. Selenium contamination of agricultural drain water appears to pose a severe threat to any giant garter snake population that still may inhabit the Grasslands region of western Merced County in the San Joaquin Valley (USFWS 1999). High levels of selenium contamination have been documented in biota from at least six major canals and watercourses in the Merced Grasslands (Saiki et al. 1991, 1992a) that have historic giant garter snake records. The bioaccumulative food chain threat of selenium contamination to fish, frogs, and fish-eating birds in the region has been well documented (Ohlendorf et al. 1986, 1988; Saiki and Lowe 1987; Saiki and May 1988; Hothem and Ohlendorf 1989; Saiki et al. 1991, 1992b, 1993). Contaminant studies on aquatic organisms and their habitats in the grasslands and neighboring areas documented elevated levels of waterborne selenium in many representative water bodies in this region that exceeded known toxicity thresholds for giant garter snake prey species (San Joaquin Valley Drainage Program 1990; Central Valley Regional Water Quality Control Board 1992; Hermanutz 1992; Hermanutz et al. 1992; Nakamoto and Hassler 1992). Elevated salinity of waters in the grasslands due to a sodium sulfate-based salt have also been documented at deleterious levels in resident fishes and amphibians (Ohlendorf et al. 1986, 1988; Saiki et al. 1992a), the major food source of giant garter snakes.

According to the USFWS (1993), most or all giant garter snake populations are vulnerable to adverse effects from flooding, and a 100-year flood event has the potential of extirpating all remaining populations of giant garter snake. Many areas, such as in the rice production districts of the Sacramento Valley, flood more frequently, even during winters with normal levels of rainfall. In Glenn and Colusa Counties, Willow Creek, Walker Creek, French Creek, Wilson Creek, Logan Creek, Hunter Creek, Lurline Creek, and the Colusa Drain all flood to heights exceeding the levee tops (USFWS 1993). In eastern Sutter County, many creeks convey water to heights one to two feet above levee tops (USFWS 1993). These flooding events may account, at least in part, for the apparent absence of the giant garter snake in many rice production districts.

Giant garter snakes retreat to habitats at higher elevations during the winter dormancy period. Commercial development, agricultural conversion, and levee channel construction and maintenance along the edges of wetlands have eliminated much of the retreat habitat, forcing giant garter snakes to overwinter in flood-prone (streamside) levee slopes.

17.5 Data Gaps and Conservation Implications

The ecology, status, and management of giant garter snake have received increased attention in recent years; however, there are several sources of uncertainty regarding giant garter snake and its requirements in the Plan Area. The primary data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

17.5.1 Population and Habitat Distribution within the Plan Area

Giant garter snakes occur in suitable habitat within the Plan Area; however, their overall distribution, abundance, and population structure are not well known. Land cover-types used by giant garter snakes, such as suitable seasonal impoundments, freshwater marsh, open water, streams and creeks as well as adjacent uplands, occur throughout much of the Central Valley and are well represented in Sacramento County and the Plan Area.

Because comprehensive surveys for giant garter snake in the Plan Area have not been conducted and the existing occurrence data are based primarily on incidental observations (e.g., CNDDB, anecdotal records), the population size and distribution of the species throughout the Plan Area are not known. In addition, though the distribution of different habitat-types is mapped and quantifiable, the quality of habitat (particularly as it relates to essential habitat components) for giant garter snakes within most of these areas is unknown. These information gaps limit the ability to identify the best lands available for preserving giant garter snake habitat and accurately estimate the impacts resulting from covered activities.

Until this data gap is remedied, the conservation value for giant garter snake will be considered relatively high in lands that support (or recently supported) known occurrences, are large in extent, or are adjacent to these areas.

17.5.1.1 Determining Threat Severity

Although certain factors are known to contribute to giant garter snake decline rangewide, exactly how and to what extent these factors contribute are largely unknown. Activities that directly remove or replace suitable habitat with incompatible land uses are more easily quantifiable than factors that indirectly affect an area or population (e.g., stormwater flooding of occupied winter retreats). Therefore, to improve conservation planning efforts for giant garter snake in the Plan Area and elsewhere, additional empirical data are needed, specifically when analyzing factors that indirectly affect known populations and their habitats.

17.5.1.2 Effectiveness of Habitat Enhancement and Restoration Techniques in Creating Suitable Habitat for Giant Garter Snake

Achieving the conservation goals and objectives for giant garter snake will require successful enhancement and restoration of suitable habitat. The function of habitat (e.g., connectivity, hydroperiod, biodiversity) is an important factor for suitability of giant garter snake. Whether restored or enhanced habitats can retain the structural attributes suitable for giant garter snake is unknown.

If habitat restoration and enhancement techniques cannot eventually create habitats with functional characteristics suitable for giant garter snake, then those lands would not support sustainable populations.

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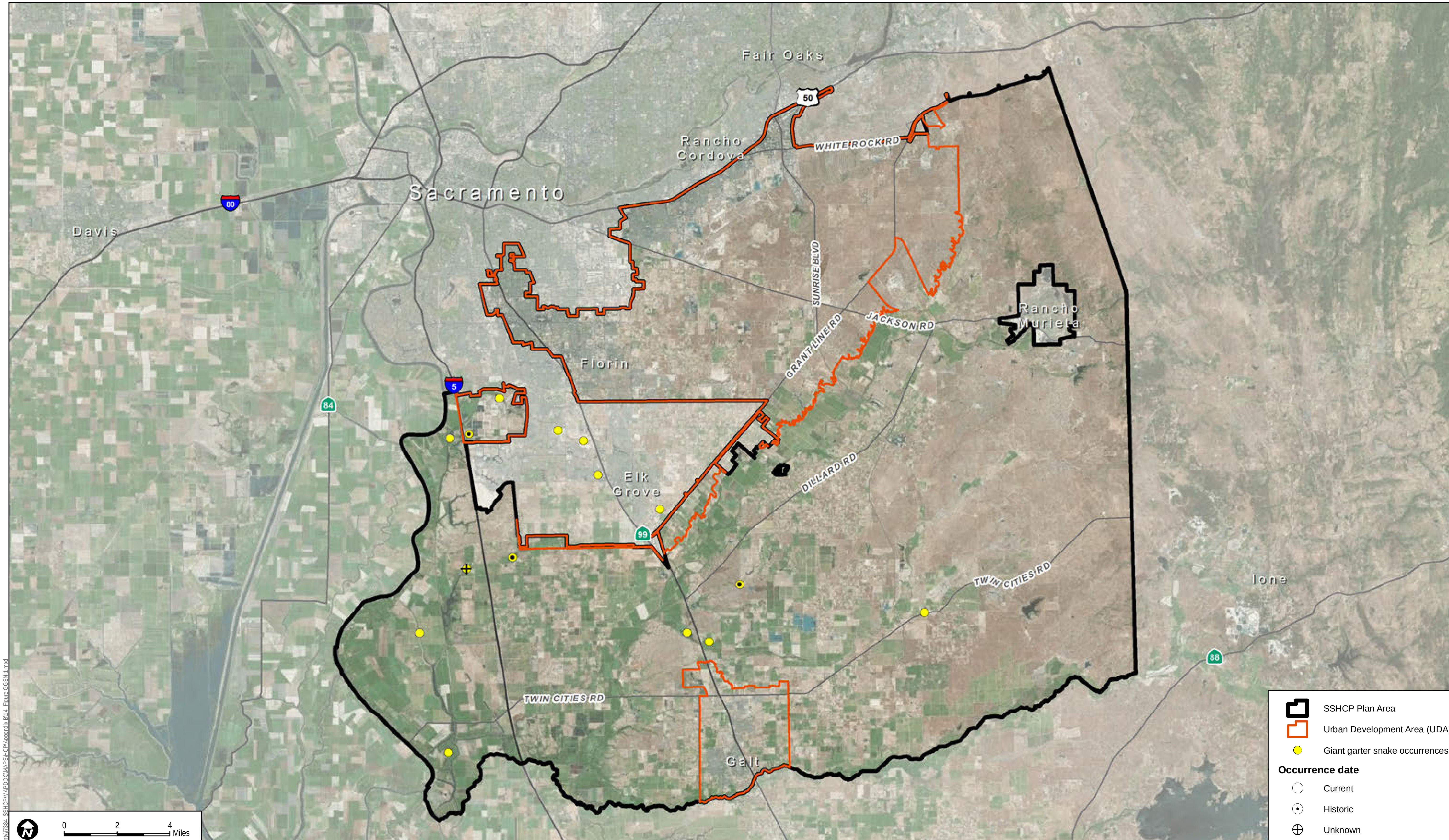

SOURCE: Bing Maps, County of Sacramento 2014, CDFG 2012, CNPS 1999

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

FIGURE GGS-1

Giant Gartersnake Documented Occurrences

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

Path: Z:\Projects\Sacramento_County\I07384_SSHCP\MAPDOC\MAPS\SHCP\Appendix B\14_Figure GGSN-1.mxd

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18 COOPER'S HAWK (COHA)

Prepared by Henderson Ecology and Planning (Steve Henderson)

Cooper's Hawk (COHA)
(Accipiter cooperii)
Status USFWS: None
Status CDFG: Bird Species of Special Concern

18.1 Legal Status

Cooper's hawk (*Accipiter cooperii*) is legally protected under the federal Migratory Bird Treaty Act (16 U.S.C. 703-712) and California Fish and Game Code (Sections 3503.5 and 3800). This species is considered a Special Animal by the California Department of Fish and Game (CDFG).

18.2 Life History and Ecology

18.2.1 Species Description and Life History

18.2.1.1 Physical Description

Cooper's hawk is a medium-sized (e.g., crow-sized) woodland hawk with short, rounded wings and a long tail. Adult birds have yellow legs and orange-red eyes. The back and upper wing coverts are blue-gray, and the breast and underparts are finely barred with rufous or rust coloration. Young and juvenile birds are brown on the back and white on the breast with fine brownish streaks. Female Cooper's hawks are approximately one-third larger than males, and western birds are smaller than eastern birds. Adult mass of western females averages 16.7 and 15.5 ounces (473 and 439 grams) during the breeding season and migration, respectively. Adult mass of western males averages around 9.9 ounces (280 grams) during breeding and migration. Length estimates for western Cooper's hawks have not been summarized; however, eastern females average 17.7 inches (45 centimeters) in length, while males average 15.4 inches (39 centimeters). (Rosenfield and Bielefeldt 1993).

Field identification of Cooper's hawk can be difficult where the species co-occurs with similar species. This species is frequently confused with the smaller sharp-shinned hawk (*A. striatus*) and larger northern goshawk (*A. gentilis*).

18.2.1.2 Taxonomy

Cooper's hawk is one of three North American hawks in the genus *Accipiter*. The other two species are the larger northern goshawk and smaller sharp-shinned hawk. Two subspecies of *A. cooperii*, the western *A. c. mexicanus* and eastern *A. c. cooperii*, are no longer recognized (Rosenfield and Bielefeldt 1993).

18.2.1.3 Reproduction

The breeding season for Cooper's hawk is generally March to July, however breeding is sometimes initiated earlier. Cooper's hawks typically begin breeding after two years of age, although breeding by first-year males (Rosenfield and Wilde 1982) and females (Meng 1951; Hennessy 1978; Reynolds and Wight 1978; Moore and Henny 1984; Asay 1987) have been documented. Cooper's hawks are monogamous and generally breed once per year; however, renesting can occur if a clutch is lost early in the incubation period (Rosenfield and Bielefeldt 1993). Pairs generally return to the same territory each year, but typically build a new (alternate) nest in the vicinity of the existing nest (Reynolds and Wight 1978). In California, the rate of nest area reoccupancy has been found to be 80 percent, and half of nesting attempts occurred in rebuilt nests (Asay 1987). In Southeast Arizona, Boal and Mannan (1999) observed color-banded pairs of Cooper's hawks on their territories during the non-breeding seasons, suggesting that some pairs maintain their pair bonds year-round.

Throughout its range, Cooper's hawk nests in evergreen and deciduous tree species. In California, 75 of 77 (97 percent) Cooper's hawk nests studied by Asay (1987) in three low-elevation study areas (Sacramento, Stockton, and southern California) were in live oaks (*Quercus wislizenii* or *Q. agrifolia*). The other two nests were in a blue oak (*Q. douglasii*) and California sycamore (*Platanus racemosa*). Most of these nests occurred in groves of six or more trees; however, two were in solitary trees 30 to 40 meters from the nearest tree.

Cooper's hawk nests are stick platforms with a cup lined with bark, placed in a crotch or lateral limb against the trunk of a tree. On average, nests are constructed 26 to 49 feet (8 to 15 meters) high, in trees 8.3 to 20 inches (21 to 52 centimeters) diameter-at-breast-height (dbh), and in stands with 64 to 95 percent canopy closure and 600 to 2,863 trees per acre (243 to 1,159 trees per hectare) (Rosenfield and Bielefeldt 1993).

Once the nest is built, Cooper's hawks engage in a month-long prelaying and copulatory period (Rosenfield et al. 1991). During this period, the male leaves the nest area to forage for himself and the female, but spends most of his time near the nest. The male provides nearly all the female's food during the pre-laying and nesting periods (Rosenfield and Bielefeldt 1993). In California, Cooper's hawks typically lay eggs in April and May. Clutch sizes range from one to seven eggs, but clutch sizes of three to five eggs are typical. Immature breeders tend to lay approximately five to 10 days later than adults. Incubation lasts approximately 34 to 36 days, and young remain in the nest an additional 30 to 34 days. Young may remain together in the vicinity of the nest for up to five to six weeks or more prior to dispersal (Rosenfield and Bielefeldt 1993). Boal and Spaulding (2000) recently observed a nesting attempt that involved nest helping by a third Cooper's hawk. Both the parental male and a subadult male delivered food to the nesting female, and all three individuals defended the nest.

18.2.1.4 Survival and Longevity

The maximum reported age of a Cooper's hawk is 12 years, while nine years is the maximum age known for a breeding bird. First year and adult annual survivorship has been estimated at 22 to 28 percent and 63 to 66 percent for first year and adult birds, respectively, using life table methods (Rosenfield and Bielefeldt 1993). Mannan et al. (2004) estimated a survival rate of 67 percent for radio-tagged fledgling Cooper's hawks, through 180 days of age, in an urban setting in Tuscon, Arizona.

18.2.1.5 Dispersal Patterns

The small amount of information on Cooper's hawk natal dispersal is based on band return data and a few localized studies. In Wisconsin, the average distance between the natal site and subsequent breeding site was 7.5 miles (12.0 kilometers) for six males, and 8.9 miles (14.4 kilometers) for a female (Rosenfield and Bielefeldt 1993). A female Cooper's hawk was also documented dispersing 49 miles (79 kilometers) between the natal and subsequent breeding site (Rosenfield and Bielefeldt 1993). Mannan et al. (2004) studied dispersal of 40 radio-tagged fledgling Cooper's hawks in urban Tuscon, Arizona. Dispersal patterns were characterized by relatively sedentary behavior in the natal area, followed by long movements after 11 to 13 weeks of age, then settlement and sedentary behavior in the fall/winter home range. The average distance between natal sites and winter home ranges was 6.8 and 3.7 miles (10.9 and 6.0 kilometers) for females and males, respectively.

There is little empirical information about adult dispersal; however, the available information suggests that adult Cooper's hawks exhibit strong fidelity to nesting areas (Rosenfield and Bielefeldt 1993), and pairs often reuse the same nest sites over consecutive years (Call 1978).

18.2.1.6 Diet and Foraging

Cooper's hawks primarily eat medium-sized birds and mammals; and birds comprise most of the diet (Peterson and Murphy 1992; Rosenfield and Bielefeldt 1993). Important avian prey includes mourning dove (*Zenaida macroura*), American robin (*Turdus migratorius*), northern flicker (*Colaptes auratus*), jays (*Cyanocitta* spp., *Aphelocoma* spp.), and European starling (*Sturnus vulgaris*). Other documented avian prey includes ring-necked pheasant (*Phasianus colchicus*), American crow (*Corvus brachyrhynchos*), rock pigeon (*Columba livia*), house sparrow (*Passer domesticus*), and dark-eyed junco (*Junco hyemalis*). Mammalian prey includes chipmunks (*Tamius* spp., *Eutamius* spp.), hares (*Lepus* spp.), deer mouse (*Peromyscus*), tree squirrels (*Sciurus* spp., *Tamiasciurus*), ground squirrels (*Ammospermophilus* spp., *Spermophilus* spp.). Cooper's hawks also eat reptiles, mammals, insects, and fish.

In an urban environment, Roth and Lima (2003) found that mourning dove, European starling, and rock pigeon comprised 91 percent of the diet of eight Cooper's hawks. In this study, small birds such as house sparrow were abundant, but rarely attacked. Mammals were not taken.

Cooper's hawks are considered aggressive ambush predators, using concealment to catch prey. Surprise attacks are often initiated at close range from behind an obstruction (Roth and Lima 2003). They often use a series of brief perch and scan episodes to locate and capture prey. In open habitats, Cooper's hawks occasionally hunt from the air, scanning the ground and stooping on prey (Rosenfield and Bielefeldt 1993).

18.2.1.7 Movement and Migration Patterns

Cooper's hawks breeding in the northern portions of the species' range are more migratory than those at more southern latitudes (Palmer 1988; Rosenfield and Bielefeldt 1993). Most Cooper's hawks breeding in California are permanent, non-migratory residents; however, Cooper's hawks breeding in montane habitats may exhibit seasonal movements, moving to snow-free lower elevations during winter (Zeiner et al. 1990).

18.2.1.8 Territoriality/Home Range

Cooper's hawk home ranges have been estimated at 988 to 4,446 acres (400 to 1,800 hectares) in New York, Michigan, Oregon, New Mexico, and Wisconsin. Home range size varies through the nesting cycle, and small portions of the home range may be used disproportionately (Rosenfield and Bielefeldt 1993). In urban Tuscon, Arizona, home range size for nine subadult Cooper's hawks during their first fall/winter averaged 1,905 acres (771 hectares) (Mannan et al. 2004). In a study of nesting Cooper's hawks in the Sacramento area, the average distance between adjacent nests was 0.99 mile (1.6 kilometers) (Asay 1987).

In Tuscon, Mannan and Boal (2000) studied the movements of adult male Cooper's hawks in adjacent home ranges during the breeding season. Home range sizes for nine individuals ranged between 32.9 and 322.7 acres (13.3 and 130.6 hectares) and averaged 161.9 acres (65.5 hectares), while only one pair of home ranges overlapped. These home range sizes were considerably smaller than those reported elsewhere. Home range size apparently decreased with the number of years a Cooper's hawk maintained its breeding territory. The authors suggested that these relatively small home ranges may be a function of abundant prey availability, and Cooper's hawks in their study area may not require long foraging distances to meet their energetic requirements. In a study by Estes and Mannan (2003), the proportion of land use types within home ranges varied considerably among territories, and Cooper's hawks did not appear to select their home ranges based on the land use categories recognized by the authors. Also, patterns of habitat use suggested that male Cooper's hawks foraged primarily in areas surrounding their nests.

18.2.2 Habitat Requirements and Ecology

Throughout its range, the Cooper's hawk nests in a wide variety of woodland and forest habitats, including oak woodland, riparian woodland, coniferous, deciduous, and mixed forest, woodlots, and suburban and urban areas. In much of California's lowland valley and foothill landscapes, including those within the Plan Area, this species appears strongly associated with live oak woodland (Asay 1987). At higher elevations in California (e.g., the Sierra Nevada), Cooper's hawks nest in conifer forest (Asay 1987; Zeiner et al. 1990; Henderson pers. obs.).

On average, Cooper's hawk nests are constructed 26 to 49 feet (8 to 15 meters) high, in trees 8.3 to 20 inches (21 to 52 centimeters) diameter-at-breast-height (dbh), and in stands with 64 to 95 percent canopy closure and 600 to 2,863 trees per acre (243 to 1,159 trees per hectare) (Rosenfield and Bielefeldt 1993). Dense canopy closure is a consistent feature of most nest sites, and the tallest tree in the stand is often selected for nesting (Kennedy 1988). Kennedy (1988) suggested that suitability of Cooper's hawk nest sites may be a function of four primary factors: 1) proximity to foraging habitat with dense prey populations; 2) availability of prey during the fledgling period; 3) historic nest success at a site; and 4) the overall vegetation structure of the site.

In a study of 77 Cooper's hawk nests in California, Asay (1987) found that nearly all nests (i.e., 75) were in live oak trees. The other two nests were in a blue oak and California sycamore; and these trees were in stands of live oak. This study focused on three study areas at relatively low elevation including the Sacramento study area (Sacramento, Placer, and El Dorado counties at 98 to 656 feet [30 to 200 meters] elevation), the Stockton study area in the foothills east of Stockton (Calaveras county at 394 to 1,378 feet [120 to 420 meters] elevation), and the southern California study area in the hills east and north of San Diego (Riverside and San Diego Counties at 345 to 3,593 feet [105 to 1,095 meters] elevation). The Sacramento study area, which included

27 nest sites, was dominated by gray pine (*Pinus sabiniana*), Fremont cottonwood (*Populus fremontii*), valley oak (*Quercus lobata*), blue oak, and interior live oak (*Q. wislizenii*). In the vicinity of Folsom Lake, habitat consisted of relatively continuous and dense stands of interior live oak, gray pine, and shrubs. Occupied areas south of Folsom Lake consisted of more patchy stands of interior live oak mixed with valley oak, blue oak, and gray pine in a matrix of rolling grasslands. Although not specified in Asay's study, riparian woodlands also provide important habitat for Cooper's hawks in Sacramento County.

Other key findings of Asay's (1987) study of Cooper's hawk nesting habitat in lowland California were: 1) most nests occurred in groves of six or more trees; 2) stand structure was characterized by the canopies of multiple trees growing together; 3) the understory of these stands was relatively sparse, comprised of larger branches, few small branches and leaves, and sparse ground cover that included short grass and/or poison oak; 4) most nest trees (79 percent) were in flat or bottomland areas, although 21 percent occurred on steep hillsides; 5) nests were typically constructed in one of the most mature trees in the stand, in or just below the canopy; and 6) the heights of 48 nests ranged 18.7 to 46 feet (5.7 to 14 meters) and averaged 33 feet (10.1 meters) above ground.

In typical conifer forest habitats, Cooper's hawks inhabit medium to older aged forests with moderate tree densities, high canopy closure, and high canopy height (Reynolds et al. 1982; Moore and Henny 1983). Forest edge habitats are generally included within the home range (Rosenfield and Bielefeldt 1993). In Oregon, Cooper's hawks nested in stands of intermediate ages (30 to 70 years old) and densities (2,240 trees per acre [907 trees per hectare]). Comparatively, northern goshawks nested in older and more open stands, and sharp-shinned hawks nested in the youngest and densest stands (Reynolds 1983; Moore and Henny 1983).

Cooper's hawks also breed in urban and suburban areas. Several urban populations of Cooper's hawks have been well documented (Beebe 1974; Stahlecker and Beach 1979; Murphy et al. 1988; Rosenfield et al. 1991; Mannan et al 2004). Cooper's hawks appear tolerant of habitat fragmentation and human disturbance near the nest (Beebe 1974; Murphy et al. 1988; Palmer 1988; Rosenfield et al. 1992). Urban nest sites have included isolated trees within 492 feet (150 meters) of commercial and recreational activities, and 66 to 98 feet (20 to 30 meters) of residential houses (Stahlecker and Beach 1979; Rosenfield and Bielefeldt 1993). In urban Tuscon, first-year Cooper's hawks used a variety of habitats before settling on winter home ranges, but occurred most frequently (35 percent of locations) in riparian areas (Mannan et al. 2004). Adult Cooper's hawks in Tuscon nested more frequently in eucalyptus (*Eucalyptus* spp., 70.8 percent), Aleppo pine (*Pinus halepensis*, 25 percent), and cottonwood (4.2 percent) trees than expected based on their availability (Boal and Mannan 1998). Most nest trees were in the yards of single-family residences (48.3 percent) and high-use recreational areas (28.3 percent). Human disturbance levels did not appear to affect nest site selection. Compared to random sites, nest sites were characterized by groves of greater canopy closure and more trees greater than 32.8 feet (10 meters) tall. Furthermore, nest trees were taller and larger (Boal and Mannan 1998).

18.2.2.1 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for Cooper's hawk are identified in Table COHA-1 and have been derived from input from local species experts.

Table COHA-1
Essential Habitat Elements for Cooper's Hawk

Essential Activities	Land Cover Types	Habitat Elements
Foraging	Blue oak woodland, blue oak savanna, mine tailing riparian woodlands, valley oak riparian woodlands, mixed riparian woodland, mixed riparian scrub, and orchards.	Structurally diverse woodland habitats that provide suitable prey abundance and diversity (i.e., medium-sized birds) and large numbers of sites within which to perch, scan, and launch attacks on potential prey.
Nesting	Blue oak woodland, mine tailing riparian woodlands, valley oak riparian woodlands, mixed riparian woodland, and mixed riparian scrub.	Groves of trees; stand structure with the canopies of multiple trees growing together; sparse understory; and mature trees that allow for placement of nests 18 to 46 feet above ground.

18.3 Species Distribution and Population Trends

18.3.1 Species Distribution

Cooper's hawk is the most widely distributed North American Accipiter south of Canada (American Ornithologists' Union 1957; Asay 1987). Populations of Cooper's hawk occur throughout most of the United States as well as southern Canada and northern Mexico. Northern populations are migratory or partially migratory (Palmer 1988; Rosenfield and Bielefeldt 1993), while some southwestern populations migrate as well (Millsap 1981; Kelly and Kennedy 1993). Most Cooper's hawks winter in the coterminous United States, most of Mexico, and south to Costa Rica and possibly Panama (Ridgely and Gwynne 1989; Rosenfield and Bielefeldt 1993).

18.3.2 Central Valley Distribution

Cooper's hawk is a breeding resident throughout most of California, including the Central Valley, in a variety of woodland habitats. Based on its close association with live oak woodlands (Asay 1987), its Central Valley breeding distribution is probably concentrated in the foothill woodlands along the upper margins of the Central Valley.

18.3.3 Range Within the Plan Area

Cooper's hawks occur in suitable habitat within the Plan Area; however, their overall distribution, abundance, and population structure are not well known. Land-cover types used by Cooper's hawks, such as oak and riparian woodland, occur throughout much of the Central Valley and are well-represented in Sacramento County and the Plan Area, particularly in the eastern portion of the Plan Area and outside the Urban Development Area (UDA). At most sites within these land-cover types, the presence of Cooper's hawk is not known, and it is assumed that most of this habitat is not occupied.

Asay (1987) studied breeding habitat characteristics and productivity of Cooper's hawks at 27 nest sites in Sacramento, El Dorado, and Placer Counties collectively; however, the number and locations of sites specifically in Sacramento County were not reported. In the Plan Area, the CNDDB reports three occurrences inside the UDA and no occurrences outside the UDA (CDFG 2010). There are four CNDDB occurrence records of Cooper's hawk in Sacramento County outside, but near the Plan Area (CDFG 2010). Figure COHA-1 shows the known occurrences of Cooper's Hawk inside the Plan Area (CDFG 2010; Henderson unpublished; Asay 1987). The occurrence data from the CNDDB does not allow for an estimate of the distribution or population size of Cooper's hawk in the Plan Area because they are based on a very small number of surveys in a limited area. Local ornithologists C. Conard and J. Trochet provided additional occurrence and habitat distribution information, which is summarized below.

- At the Cosumnes River Preserve, at least three Cooper's hawk nests have been documented in the Lower Preserve over the last 10 years. All of these nests failed before fledging, presumably due to predation by great horned owls (*Bubo virginianus*). Also, an adult Cooper's hawk carrying a towhee was recently observed at the Tall Forest (Trochet pers. comm.). This adult could have been delivering food to a nest.
- In 2003, nesting was documented east of Highway 99 at Bond Drive (Trochet pers. comm.).
- First-year Cooper's hawks are regularly observed at the Bufferlands (Conard pers. comm.).
- Cooper's hawks have historically nested in McKinley Park (Trochet pers. comm.).
- Nesting has not been documented at Howard Ranch (Trochet pers. comm.).
- Habitat identified as suitable for nesting Cooper's hawks in the Plan Area includes dense stands of interior live oak near Scott Road (Conard pers. comm.). Also, riparian woodland along Deer Creek downstream of its crossing with Scott Road, which includes cottonwood trees, has a high potential to support breeding Cooper's hawks (Trochet pers. comm.).

Because comprehensive surveys or monitoring efforts for Cooper's hawk in the Plan Area have not been conducted, and because the known occurrences are based mostly on incidental observations or limited surveys (e.g., CNDDB, anecdotal records, surveys conducted over a limited area), the population size and extent of suitable nesting habitat for this species in the Plan Area are not well known.

SSHCP compliance monitoring (including pre-project surveys for covered activities and pre-acquisition surveys for potential preserve lands) will be used to expand upon and refine Cooper's hawk occurrence and habitat distribution information through implementation of the SSHCP.

18.3.4 Population Levels and Trend

Overall, Cooper's hawk has been considered common in the western portion of its range (Reynolds 1989), and western populations have been considered relatively stable (Snyder et al. 1973; Jones 1979). Grinnell and Miller (1944) once considered Cooper's hawk a common breeder throughout its range in California. Although population declines in the west are less well documented than in the east, Remsen (1978) reported that breeding populations of Cooper's hawk had declined throughout California over the two or three decades prior to 1978. At that time, breeding populations had been extirpated from some areas (e.g., the Colorado River), and severe declines were reported for the Sacramento Valley (Gaines 1974), Santa Cruz and Santa Clara Counties (Chandik and Baldridge 1969), Santa Barbara area, northern San Diego County, and Yosemite National Park (Gaines 1977, Remsen 1978). Also, analysis of Breeding Bird Survey (BBS) data for the 20-year period (1983 to 2003) suggests that Cooper's hawk populations in California may have declined ($P = 0.11$) during that period (Sauer et al. 2004).

18.4 Threats to the Species

The primary threat to Cooper's hawk, particularly in California, is probably habitat loss and degradation as a result of urbanization and development. Direct or indirect human disturbance of nesting activities, particularly in suburban areas, may also threaten populations (Thelander 1973; Olendorff and Kochert 1977; Remsen 1978; Bosakowski et al. 1993; Boal and Mannan 1998).

Declines in eastern Cooper's hawk populations attributed to pesticide contamination have been documented (Henny and Wight 1972; Snyder et al. 1973; Bednarz et al. 1990). In San Diego, one Cooper's hawk in 1968 was found to be highly contaminated with DDT (dichlorodiphenyltrichloroethane) (Risebrough et al. 1968); however, pesticide contamination of Cooper's hawks in California has not been reported elsewhere (Remsen 1978).

Shooting and trapping were important factors in historical population declines, but are no longer considered a threat (Rosenfield and Bielefeldt 1993). Timber harvest is considered a potential threat, but the impacts of logging on this species are poorly understood (Reynolds 1983; Rosenfield and Bielefeldt 1993). The availability of breeding habitat is apparently not a limiting factor for Cooper's hawk populations, at least in some areas, including suburban areas

(Rosenfield and Bielefeldt 1993). More than 100 nest sites for this species have been found during on-going surveys by the Golden Gate Raptor Observatory (GGRO) in the larger East Bay Area (i.e., urban areas from El Cerrito south to Alameda) since 2002 (Fish 2008).

Trichonmoniasis, a digestive tract disease in raptors that originates from infected avian prey (particularly doves), has been reported to be common and an important source of mortality in nestling and fledgling Cooper's hawks in some urban populations (Boal et al. 1998; Boal and Mannan 1999; Rosenfield et al. 2002; Estes and Mannan 2003). However, the prevalence of infection appears to vary widely across the Cooper's hawk's breeding range (Rosenfield et al. 2002). Also, West Nile virus has been isolated from brain tissue of a Cooper's hawk in Connecticut (Wakem et al. 1999).

18.5 Data Gaps and Conservation Implications

The ecology, status, and management of Cooper's hawks have received considerable attention in recent years. However, there are several sources of uncertainty regarding Cooper's hawks and their requirements in the Plan Area. The primary data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

18.5.1 Population and Habitat Distribution within the Plan Area

Cooper's hawks occur in suitable habitat within the Plan Area; however, their overall distribution, abundance, and population structure are not well known. Land-cover types used by Cooper's hawks, such as oak and riparian woodland, occur throughout much of the Central Valley and are well-represented in Sacramento County and the Plan Area, particularly in the eastern portion of the Plan Area and outside the UDA. However, at most sites within these land-cover types, the presence of Cooper's hawk is not known, and it is assumed that most of this habitat is not occupied.

Because comprehensive surveys for Cooper's hawk in the Plan Area have not been conducted and because the existing occurrence data are based primarily on incidental observations (e.g., CNDDB, anecdotal records), the population size and nesting locations of this species throughout the Plan Area are not known. Also, although the distribution of oak and riparian woodlands is mapped and quantifiable, the quality of habitat for Cooper's hawks within most of these areas is unknown. A few areas identified as suitable for nesting Cooper's hawks in the Plan Area include dense stands of interior live oak near Scott Road (Conard pers. comm.). Also, riparian woodland along Deer Creek downstream of its crossing with Scott Road has a high potential to support breeding Cooper's hawks (Trochet pers. comm.).

These information gaps limit our ability to identify the best lands available for preserving Cooper's hawk habitat and accurately estimate the impacts resulting from covered activities.

Until this data gap is remedied, the conservation value of woodland and riparian woodland land-cover types for Cooper's hawk will be considered relatively high in lands that support (or recently supported) known occurrences, are large in extent, or are adjacent to these areas (e.g., near the Cosumnes River Preserve).

18.5.2 Effectiveness of Woodland Enhancement and Restoration Techniques in Creating Suitable Habitat Structure for Cooper's Hawk

Achieving the conservation goals and objectives for Cooper's hawk will require successful enhancement and restoration of oak and riparian woodlands. The structure of woodlands (e.g., dense canopy closure) is an important factor for suitability of Cooper's hawk. Whether restored or enhanced woodlands can retain the structural attributes suitable for Cooper's hawk is unknown. If woodland restoration and enhancement techniques cannot eventually create woodland habitats with structural characteristics suitable for Cooper's hawk, then those lands would not support breeding pairs.

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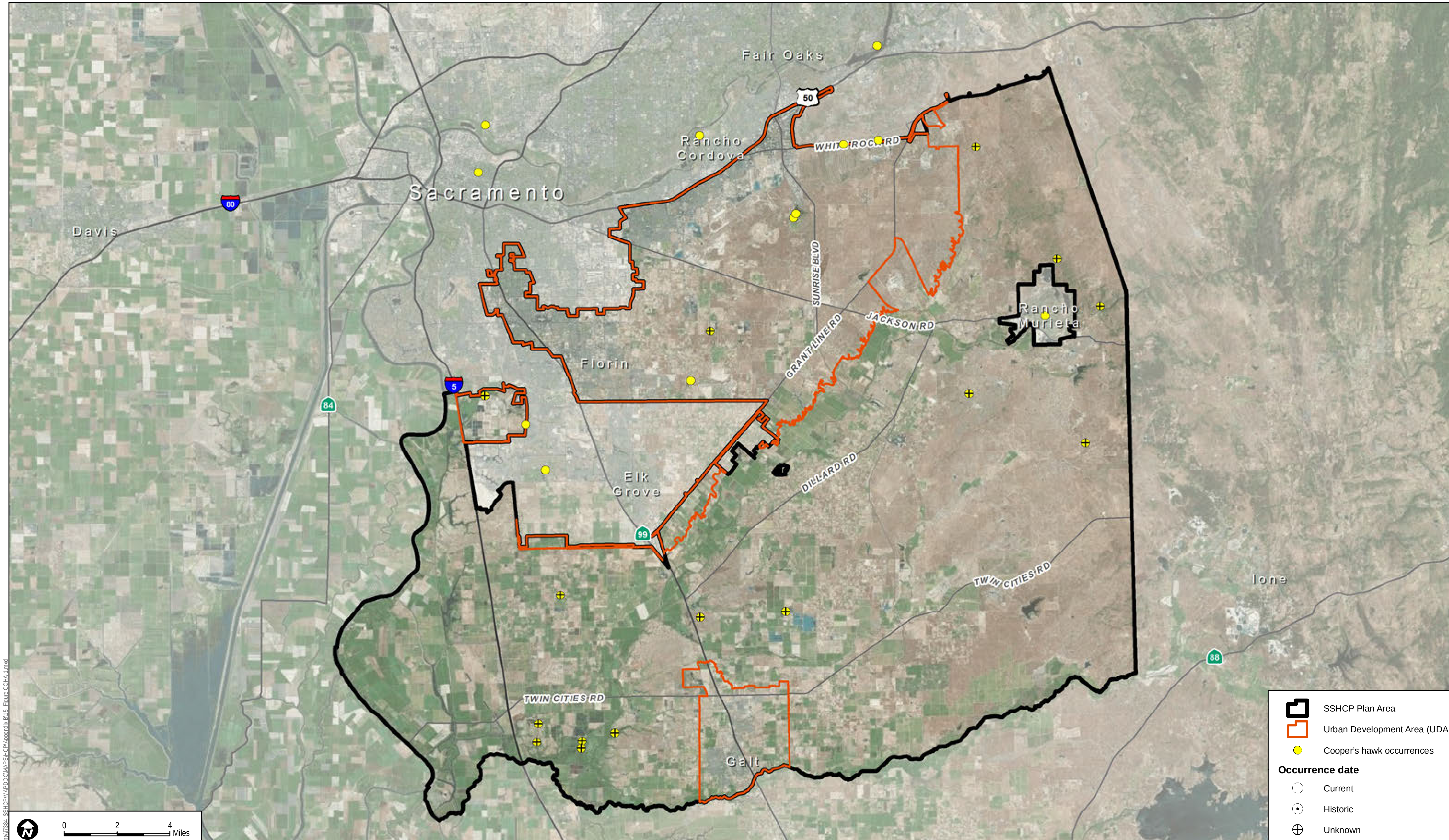

SOURCE: Bing Maps, County of Sacramento 2014, CDFG 2012, ebird.org

FIGURE COHA-1

Cooper's Hawk Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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19 TRICOLORED BLACKBIRD (TRIC)

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Tricolored Blackbird (TRIC)
(Agelaius tricolor)
Status USFWS: Bird of Conservation Concern
Status CDFG: Species of Special Concern

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19.1 Legal Status

The tricolored blackbird (*Agelaius tricolor*) is legally protected under the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-7012) and California Fish and Game Code (Section 3503.5 and 3800). The species is also considered a species of special concern by the California Department of Fish and Game (CDFG) (Shuford and Gardali 2008). The tricolored blackbird was formerly a candidate (category 2) for federal listing as either Threatened or Endangered by the U.S. Fish and Wildlife Service (USFWS) (59 Federal Register [219]: 58990), and was also informally identified as a Species of Concern (USFWS 1995). More recently, the USFWS (2002) designated the tricolored blackbird as a Bird of Conservation Concern (BCC). The Bureau of Land Management (BLM) also designates it as a Sensitive Species (BLM 1999).

19.2 Life History and Ecology

19.2.1 Species Description and Life History

19.2.1.1 Physical Description

The tricolored blackbird is a medium-sized, sexually dimorphic blackbird. Adults range from 18 to 24 centimeters (7 to 9.5 inches) in length (from beak to tail) and weight between 40 to 70 grams (1.4 to 2.5 ounces), depending on the sex and season (Beedy and Hamilton 1999). Adult males are entirely black, glossed bluish (in full sunlight), with bright red lesser wing-coverts forming conspicuous reddish patches on wing shoulders (epaulets). The median-coverts are buffy white (August through February) to pure white (February through July) (Mailliard 1910; DeHaven 1975). Adult females are mostly black, with distinct grayish streaks; relatively whitish chins and throats, rarely with faint pinkish or peach wash; and small but distinct reddish shoulder patches (DeHaven 1975). Juveniles of both sexes (April through August) are similar to adult females but are much paler gray and buff (Pyle 1997).

19.2.2 Demography

19.2.2.1 Reproduction

During the breeding season, tricolored blackbirds typically nest in dense colonies (some estimated as having 200,000+ nests), with males defending small territories and mating with one to four females (Beedy and Hamilton 1999). They are also considered itinerant breeders, sometimes nesting more than once at different locations during the breeding season. Studies by Neff (1937) reported that nesting colonies are often located in seasonal wetlands with tules (*Scirpus* spp.) and cattails (*Typha* spp.) present. More recent studies indicate that nesting colonies are also regularly found in Himalayan blackberries (*Rubus discolor*) (Cook 1999) and grain fields (DeHaven 2000).

Female tricolored blackbirds breed in their first year, but most males apparently defer breeding until they are at least two years old (Payne 1969). Nest construction, done exclusively by females, is usually highly synchronous and may be initiated as soon as the day of arrival at the breeding colony (Neff 1937). Additional birds may be recruited to the colony site and initiate nesting later. These birds may nest in a continuing concentric wave at the margin of the colony (Orians 1961). As colonization of a breeding site proceeds, the area occupied by nests expands (Tyler 1907), engulfing any previously established breeding red-winged blackbird (*Agelaius phoeniceus*) nest sites (Orians 1961).

Tricolored blackbird nests are bound to upright plant stems from a few inches up to about six feet (1.8 meters) above water or ground (Harrison 1978). Nests in the canopies of willows (*Salix* spp.) and ashes (*Fraxinus* spp.), however, may be more than 12 feet (3.6 meters) high (Hamilton pers. comm.). Tricolored blackbird nests are rarely built on the ground (Neff 1937). Deep cup nests are constructed with outer layers of long leavers (e.g., cattail thatch, annual grasses, or forbs) woven tightly around supporting stems. The inner layers are coiled stems of grasses lined with soft plant down, mud, or algal fibers. Nest building takes about four days (Payne 1969).

Egg laying can begin as early as the second day after nest initiation, but ordinarily starts about four days after the arrival of birds at breeding sites (Payne 1969). One egg per day is laid, and clutch size is typically three to four eggs (Payne 1969, Hamilton et al. 1995). Emlen (1941) and Orians (1961) estimated the tricolored blackbirds incubation period at 11 or 12 days, while Payne (1969) estimated this interval at 11 to 14 days. Incubation begins before clutches are completed, and eggs in individual nests hatch asynchronously (Hamilton pers. comm.).

Tricolored blackbird clutches take about nine days from hatching until the oldest nestling is willing to jump from the nest when disturbed. Young require about 15 days from this pre-fledging date until they are independent of their parents. Thus, one successful nesting effort for a reproductive pair takes about 45 days (Hamilton et al. 1995). The persistence of a successful colony takes additional time, depending on the presence of females recruited into the colony after the initial establishment.

A successful tricolored blackbird colony, including some asynchronous nests, takes about 50 days from nest initiation to fledging. Because most first nesting efforts are made before April 25, most nesting attempts observed between April 25 and May 20 are probably second or third attempts by birds that lost earlier nests. A pair beginning nesting after April 25 and before May 20 would not have had sufficient time (i.e., about 45 days) to complete a prior, successful nest (Beedy and Hamilton 1997).

Tricolored blackbird activity during the early stages of colony settlement may give the erroneous impression of high local nesting densities because typically more birds are present at some colonies initially than will actually remain to nest (Hamilton et al. 1995). Flight activity over colonies during the settlement phase is mainly by males that have not established nesting territories. Males gaining breeding territories may remain below the canopy of nesting substrates and, therefore, out of view. The mean number of females per male is estimated to be two (Orians 1961; Payne 1969), but some colonies may have nearly as many males as females (Hamilton pers. comm.). A count of active tricolored blackbird nests per unit area is a better indication of local abundance than numbers of singing males (Neff 1937).

Females on nests are quiet during incubation, and active colonies may appear to be largely deserted. The more synchronous colonies are particularly inconspicuous at this stage and can be easily overlooked. Close approach by an observer, however, usually causes females to leave their nests and fly away (Hamilton pers. comm.).

Banding studies, summarized by Neff (1942) and DeHaven and Neff (1973), indicated life span may extend to at least 13 years (Kennard 1975; Beedy and Hamilton 1999). No annual survivorship studies have been conducted and available banding data is inadequate to determine annual survivorship (Beedy and Hamilton 1999).

Dyer et al. (1977 *in* DeHaven 2000) reported red-winged blackbird's (*Agelaius phoeniceus*), the tricolored blackbird’s closest relative, annual survival between 42 to 62 percent and an average life expectancy of 2.14 years.

19.2.2.2 Dispersal Patterns

A crèche of tricolored blackbirds is a group of fledglings that have left the nest and assembled either at the colony site or at locations between colonies and favorable foraging areas (Payne 1969). These fledglings are conspicuous, both because they are vociferous and because adults are feeding them as rapidly as possible (Hamilton pers. comm.). DeHaven et al. (1975) banded 33,058 nestlings and only 39 percent of band recoveries were re-located within 16 kilometers (10 miles) of natal colonies.

19.2.2.3 Diet and Foraging

Tricolored blackbirds primarily forage by gleaning food parts from the ground and secondarily by gleaning food parts from foliage (Ehrlich et al. 1988). Food items are diverse and change seasonally. During the nesting season, foods delivered by adults to nestlings include beetles and weevils, grasshoppers, caddisfly larvae, and moth and butterfly larvae (Orians 1961; Crase and DeHaven 1977; Skorupa et al. 1980), and, especially in current rice-growing areas, dragonfly larvae (Hamilton pers. comm.). In contrast, breeding season foraging studies in Merced County showed that animal matter makes up about 91 percent of the food volume of nestlings and fledglings, 56 percent of the food volume of adult females, and 28 percent of that of adult males (Skorupa et al. 1980). Studies conducted since the 1980's have documented tricolored blackbirds feeding on dairy cow silage that is stored in large open piles on the ground (Cook pers. comm.). Also, the importance of grasshoppers as a dietary item has been highlighted during the breeding season (Cook pers. comm.; DeHaven 2000).

Adults may continue to consume plant foods through the nesting cycle, but also forage on insects and other animal foods. Immediately before and during nesting, adults are often attracted to dairies, where the birds take high-energy items from livestock feed rations. Adults with access to livestock feed, such as cracked corn, begin providing it to nestlings when they are about 10 days old (Hamilton et al. 1995).

More that 88 percent of all winter food in the Sacramento Valley is plant material, primarily seeds or rice and other grains, but also weed seeds (Crase and DeHaven 1978). In winter, tricolored blackbirds often associate with other blackbirds, but flocks as large as 15,000 individuals (almost all tricolored blackbirds) may aggregate at one location and disperse to foraging sites. Some winter foraging flocks are almost exclusively composed of one sex (Hamilton pers. comm.), which may imply an as-yet unidentified gender difference in foraging preferences.

19.2.2.4 Movement and Migration Patterns

In late March and early April, tricolored blackbirds vacate wintering areas in the Sacramento-San Joaquin River Delta and along coastal central California and arrive at breeding locations in Sacramento County and throughout the San Joaquin Valley (DeHaven et al. 1975). A substantial, but as yet unmeasured, number of tricolored blackbirds also winter in the northern San Joaquin Valley (Hamilton pers. comm.).

During the breeding season, tricolored blackbirds often exhibit itinerant breeding and move to new breeding locations following previous nesting attempts elsewhere (Hamilton 1998). Most probably move from the San Joaquin Valley and Sacramento County to the northern Sacramento Valley for second or third nesting attempts. While this trend was noted in all three years of an intensive study, colonies may form at any time during the breeding season (April through July) throughout the known breeding distribution of this species (Hamilton et al. 1995; Hamilton 2000).

Long-term banding studies by DeHaven et al. (1975) demonstrated a major postbreeding season movement into the Sacramento Valley from other breeding locales. Large postbreeding roosts continue to develop in this area from late summer (August) into fall (Hamilton pers. comm.).

The timing of major movements to wintering areas is unknown. Large foraging flocks can be seen in pasturelands north of Rio Vista, Solano County, by late October (Beedy pers. obs.), and Hamilton (pers. comm.) has seen large flocks in the Sacramento and San Joaquin River Delta by late November. During winter, tricolored blackbirds can be found in large flocks by themselves, or with other blackbird species including red-winged blackbirds and Brewer's blackbirds (*Euphagus cyanocephalus*) (Beedy and Hamilton 1999).

19.2.2.5 Ecological Relationships

Several wildlife species are known to raid tricolored blackbird nests. In addition, great-tailed grackles (*Quisalus mexicanus*), a southern species expanding its range northward, have been reported nesting near and exhibiting aggression toward tricolored blackbird breeding colonies (Hamilton pers. comm. *in* Beedy and Hamilton 1999). Roosting European starlings (*Sturnus vulgaris*) are associated with desertion of tricolored blackbird colonies (Payne 1969 *in* Beedy and Hamilton 1999).

19.2.3 Habitat Requirements and Ecology

Tricolored blackbirds are closely related to red-winged blackbirds, but the two species differ substantially in their breeding ecology. Red-winged blackbird pairs defend individual territories, while tricolored blackbirds are among the most colonial of North American passerines (Bent 1958; Orians 1961, 1980; Orians and Collier 1963; Payne 1969; Beedy and Hamilton 1999). As many as 20,000 or 30,000 tricolored blackbird nests have been recorded in cattail marshes of 9 acres (four hectares) or less (Neff 1937; DeHaven et al. 1975), and individual nests may be built less than 1.5 feet (0.50 meters) from each other (Neff 1937). The tricolored blackbirds highly synchronized and colonial breeding system have adapted to exploit a rapidly changing environment where the locations of secure nesting habitat and rich insect food supplies were ephemeral and likely to change each year (Orians 1961; Orians and Collier 1963; Collier 1968; Payne 1969).

Tricolored blackbirds have three basic requirements for selecting their breeding colony sites: a protected nesting substrate that is either flooded, thorny, spiny, or "visually" but not actually spiny; a suitable foraging space providing adequate insect prey within a few miles of the nesting colony; and open accessible water (Hamilton et al. 1995; Beedy and Hamilton 1997, 1999). DeHaven (2000), however, questioned whether the lack of water constitutes a significant limitation on breeding substrate utilization.

Almost 93 percent of the 252 tricolored blackbird breeding colonies reported by Neff (1937) were in freshwater marshes dominated by tules and cattails. The remaining colonies in Neff's study were in willows, blackberries (*Rubus* spp.), thistles (*Cirsium* and *Centaurea* spp.), or nettles (*Urtica* spp.). In contrast, only 53 percent of the colonies reported during the 1970s were in cattails and tules (DeHaven et al. 1975).

An increasing percentage of tricolored blackbird colonies in the 1980s and 1990s were reported in Himalayan blackberries (Beedy et al. 1991; Cook 1996, 1999), and some of the largest recent colonies are in grain fields (Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000). Other substrates where they have been observed nesting include giant European reed (*Arundo donax*), safflower (*Carthamus tinctorius*) (DeHaven et al. 1975), tamarisk (*Tamarix* spp.), elderberry (*Sambucus* spp.), poison-oak (*Toxicodendron diversilobum*), and riparian scrublands and forests (e.g., *Salix, Populus,* and *Fraxinus* spp.) (American Birds file data).

Tricolored blackbird foraging habitats in all seasons include annual grasslands, wet and dry vernal pools and other seasonal wetlands, agricultural fields (such as large tracts of alfalfa and pastures with continuous haying schedules, and recently tilled fields), cattle feedlots, and dairies. They also forage occasionally in mixed riparian scrub habitats along marsh borders. Weed-free row crops and intensively managed vineyards and other orchards do not serve as regular foraging sites (Beedy and Hamilton 1997, 1999; DeHaven 2000).

Grassland and vernal pool complexes characterize the landscape in much of the tricolored blackbirds breeding range and preferred foraging habitat in southern Sacramento County (Cook 1999). Ungrazed grasslands containing tall grasses (greater than 15 centimeters [six inches] tall) and vernal pools were considered preferred over dry, grazed grasslands containing short grasses (Cook 1999). Foraging birds often congregate at the margins of wet vernal pools and in their interiors once they dry (Cook 1999). Most tricolored blackbirds forage within five kilometers (three miles) of their colony sites (Orians 1961), but commute distances of up to 13 kilometers (eight miles) have been reported (Hamilton pers. comm.). Short-distance foraging (i.e., in sight of the colony) for nestling provisioning also is common. Both sexes are known to provision nestlings (Beedy and Hamilton 1999).

Proximity to suitable foraging habitat appears to be extremely important for the establishment of colony sites, because tricolored blackbirds always forage, at least initially, in the field containing the colony site (Cook 1999). Usually only a minor fraction of the area within the commuting ranges of a colony, however, provides suitable foraging habitat (Beedy and Hamilton 1999; Cook 1999). For example, within a five-kilometer (three-mile) radius there may be low-quality foraging habitats such as cultivated row crops, orchards, and vineyards, along with high-quality foraging areas like irrigated pastures, lightly grazed rangelands, vernal pools, and recently hayed alfalfa fields (Cook 1999).

19.2.3.1 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for tricolored blackbird are identified in Table TRIC-1 and have been derived from input from local species experts.

Table TRIC-1
Essential Habitat Elements for Tricolored Blackbirds

Essential Activities	Land Cover Types	Habitat Elements
Foraging	Blue oak savanna, blue oak woodland, mine tailing riparian woodland, valley oak riparian woodland, cropland, vineyards, orchards, irrigated pasture grassland, valley grassland, seasonal wetlands, freshwater marsh, and open water.	Foraging space providing adequate insect prey within a few miles of the nesting colony; and open accessible water.
Nesting	Mine tailing riparian woodland, valley oak riparian woodland, mixed riparian scrub, cropland, seasonal wetlands, seasonal impoundment, and freshwater marsh.	A protected nesting substrate, including flooded, thorny, spiny, or “visually” spiny vegetation.

19.3 Species Distribution and Population Trends

19.3.1 Species Distribution

Surveys indicate that the Tricolored Blackbirds overall range is little changed since the 1930s (Neff 1937; DeHaven et al. 1975; Beedy et al. 1991; Hamilton 1998). Tricolored blackbirds are largely endemic to California, and more than 99 percent of the global population occurs in the state. In any give year, more than 75 percent of the breeding population occurs in the Central Valley (Hamilton 2000). Small breeding populations also exist at scattered sites in Oregon, Washington, Nevada, and western coastal Baja California (Beedy and Hamilton 1999).

19.3.2 Central Valley Distribution

Tricolored blackbird breeding colonies have been observed in all Central Valley counties (Beedy and Hamilton 1997, 1999; Hamilton 2000). DeHaven et al. (1975) found that tricolored blackbirds were unlikely to nest at the sites where they hatched or where they had nested the year before (N=298 recoveries from 45,660 banded birds). Other studies have demonstrated that breeding colonies often exhibit site fidelity and traditionally use many of the same areas year after year if they continue to provide essential resources, including secure nesting substrates, water, and suitable foraging habitats (Beedy et al. 1991; Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000). Therefore, there may be regional differences in the degree of site fidelity. As discussed earlier, the distribution of tricolored blackbirds in the Central Valley varies according to relatively predictable, seasonal movements.

19.3.3 Range within Plan Area

Observations and field studies of tricolored blackbirds have been ongoing in southern Sacramento County since 1991 (Cook 1999). Colonies occurred primarily in the approximately 1,036 square kilometers (400 square miles) region bordered by U.S. Highway 50 to the north, U.S. Highway 99 to the west, and the county line to the south and east. A total of 46 active tricolored blackbird colony sites had been documented in the Plan Area from surveys conducted until 1999 (Cook 1999). Of the 46 nest sites reported by Cook (1999), 37 colonies were found in Himalayan blackberries surrounded by mostly fallow, annual grasslands. The remaining eight colonies were in cattail marshes or willows. Between 1992 and 1994, an average of 22 active tricolored blackbird colonies were found in the Plan Area. That number declined in 1997, 1998, and 1999 when the counts were 12, 11, and 9, respectively. Six formerly active colony sites have been lost (i.e. nesting habitat), including one of the largest colonies (Bozich Ranch) observed since 1992 (Cook 1999). Figure TRIC-1 provides the distribution of known tricolored blackbird occurrences in Sacramento County. The range of the species in the Plan Area, for the purpose of the SSHCP, encompasses the full extent of those cover types within which various and extensive data collections have documented the species in the Plan Area.

19.3.4 Population Levels and Trend

19.3.4.1 Historical Populations

Published and unpublished accounts of historical tricolored blackbird breeding observations were summarized by Dawson (1923), Neff (1937), Grinnell and Miller (1944), and Beedy et al. (1991). Hamilton et al. (1995) also provided an update of historical tricolored blackbird observations. The first systematic, rangewide surveys of their population status and distribution were conducted by Neff (1937, 1942). He observed as many as 736,500 adults per year (1934) in just eight Central Valley counties. During a five-year interval, he found tricolored blackbirds in 26 California counties. The largest numbers of breeding tricolored blackbirds were in the Central Valley (Neff 1937).

Neff (1937) summarized his observations of 252 California colonies. These surveys were conducted after most Central Valley wetlands were lost (Frayer et al. 1989). Neff (1937) found many large colonies, including one in Glenn County containing more than 200,000 nests (about 300,000 adults) covering almost 24 hectares (60 acres), and several others in Sacramento and Butte Counties that contained more than 100,000 nests (about 150,000 adults). Most large tricolored blackbird colonies observed by Neff (1937) were associated with freshwater emergent wetlands in rice growing areas of California.

Orians (1961) and Payne (1969) made detailed accounts of the ecology and breeding biology of tricolored blackbirds. These workers observed colonies of up to 100,000 nests in Colusa, Yolo, and Yuba Counties, but did not attempt to survey the entire range of the species. DeHaven et al. (1975) conducted population surveys and banding studies of tricolored blackbirds in the Central Valley from 1969 through 1972. They concluded that the tricolored blackbirds geographic range and major breeding areas were unchanged in the 35 years since Neff's (1937) study. They observed an average of about 133,000 individuals per year and estimated that the overall population size had declined by more than 50 percent since the 1930s. It is possible, however, that DeHaven et al. (1975) underestimated the tricolored blackbird total population size because they did not survey large portions of the southern San Joaquin Valley (Beedy and Hamilton 1999). Table TRIC-2 shows the tricolored blackbird colonies in Sacramento County from 1991 to 1999 (Cook 1999).

Table TRIC-2
Tricolored Blackbird Colonies in Sacramento County from 1991 through 1999[1].

No.	Name	Habitat	1991	1992	1993	1994a	1994b	1997	1998	1999
1	Rancho Seco	HB	K's	20000	5000	20000	7000	4000	N	2400
2	Latrobe	HB	K's	4000	N	4000		N	Y	3500
3	Folsom	HB	K's	3000	3500	6000	5000	N	N	&
4	Calvine	HB	H's	250	1000	250		X	Y	X
5	Calvine @ Hwy 99	HB	H's	X	X	X	X	X	X	X
6	Slough-house [1]	HB	2000	N	N	N	N	N	?	N
7	Slough-house [2]	HB	1600	N	N	N	N	N	?	N
8	Clay @ Dillard	HB	400	Y	N		400	N	?	N
9	Marengo [1]	HB	600	X	X	X	X	X	X	X
10	Borden & West	HB	Y	?	?	600	?	?	?	?
11	Alabama	Cattail	?	5000	N	N	N	N	N	N
12	Alabama [2]	HB	?	5000	?	?	?	110	?	N
13	Campbell	HB	?	5000	7000	4000		N	N	N
14	Cherokee	HB	?	1500	15000	N	N	15000	1500	N
15	Cherokee [2]	HB	?	500	N	N	N	N	N	N
16	Moore	Cattail	Y*	3000	7500	?	?	?	?	?
17	Green Rd	Cattail	?	3000	N	N	N	N	N	?
18	Colony Rd	HB	Y	3000	550	400	400	X	X	X
19	Knox	HB	?	4000	2400	15000		1000	3500	4500
20	Sheldon	HB	?	500	Y*	500		N	N	&
21	Van Vleck [1]	Cattail	?	1950	3000	4000		?	?	?
22	Van Vleck [2]	Willows	?	500	?	?	?	?	?	?
23	Van Vleck [3]	Willows	?	1500	?	?	?	?	?	?
24	Elder Ck	HB	?	5000	30	7000		N	N	52
25	Bozich Ranch	HB	Y*	20000	N	N	N	N	N	X
26	Bradshaw	HB	?	350	350	350		N	Y	N
27	Grant Line @ Mosher	HB	?	1500	?	?	?	?	Y	N
28	Hwy99 @ Twin Cities	HB	?	100	?	?	?	?	?	?
29	Walmort	HB	?	Y						
30	Alta Mesa	HB	?	?	3500	3000		N	?	Y
31	Brad/Elder	HB	?	?	3500	4500		N	N	N
32	Horse	HB	Y*	Y*	2000	N	N	N	?	#
33	Davis Rd	HB	?	?	1600	1000		500	900	1200
34	Bull	HB	?	?	320	N	N	N	X	X
35	Ivie	HB	?	?	260	N	N	N	N	N
36	Betts Ranch	HB	?	?	7500	?	?	?	?	?
37	Koessler	HB	?	?	?	4000		3000	?	20
38	Scott Marsh	Cattail	?	?	500	5000	5750	300	Y	3000
39	Eagles Nest	HB	?	?	?	1000		250	Y	Y
40	Grant Line @ Bradshaw	HB	?	?	Y	6750	2500	?	?	N

Table TRIC-2
Tricolored Blackbird Colonies in Sacramento County from 1991 through 1999[1].

No.	Name	Habitat	1991	1992	1993	1994a	1994b	1997	1998	1999
41	Slough-house [3]	HB	N	N	N		40	30	?	N
42	Excelsior-Jackson Hwy	HB	?	N	N	15		N	?	N
43	Mather	HB	?	?	?	9000		200	?	?
44	Dillard-Cosumnes	unknown	?	?	?	?	?	Y	Y	?
45	Marengo Marsh	Cattails	N	N	?	?	?	3000	4000	N
46	Tavenor & Apricot	HB	?	?	?	?	?	3000	?	
Total number of colonies			**13**	**24**	**21**	**22**		**12**	**9**	
Total number of birds				**86142**	**64510****	**96365**	**21090**	**32387**	**NA**	**16671**

[1] Data from Cook (1999)
Y = Nesting occurred, but colony size estimate not available
Y* = Observation reported by landowner
N = The site was visited, but no colony was observed
X = No breeding due to nesting habitat loss
? = Breeding unverified. The site may or may not have been used that year.
= Birds observed, but the site was not used for breeding
& = Settlement attempted, but was unsuccessful
** = Probably an underestimate. An intensive survey
K's = Thousands; H's= Hundreds
HB = Himalayan blackberry

Notes: This table includes only observed colonies. Because not all colonies may have been observed, the total population sizes may have been larger. In 1991, the colony size estimating skills were under development. Therefore, relatively reliable estimates are not available. In 1993, the total estimated number of breeding birds is probably less than the actual number because survey efforts were focused on obtaining data about reproductive success at a sample of colonies, such that survey effort was not comparable to other years. The 1994a and 1994b surveys represent an early and later (second) breeding attempt following the first. The total estimate for the number of breeding tricolored blackbirds in Sacramento County in 1994 would therefore be the combined total, or, 111,855. In 1998, survey effort was not comparable to other years. The total number for the year is, therefore, an underestimate.

19.3.4.2 Recent Populations

The USFWS, CDFG, and California Audubon cosponsored intensive, volunteer tricolored blackbird surveys (Volunteer Surveys) in suitable habitats throughout California in 1994, 1997, 1999, and 2000 (Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000). Results of late April surveys for Sacramento County, Sacramento Valley, and the statewide totals for these four years are presented in Table TRIC-3. In 2001, Point Reyes Bird Observatory (PRBO) coordinated the Volunteer Surveys with the help of Bill Hamilton and developed a web based data sheet and submittal process for volunteers. A statewide estimate of 142,045 adults was reported, but PRBO believed data from priority sites was not submitted (PRBO 2002). Therefore, some researchers do not consider the 2001 effort comparable to previous years such as those in 1994, 1997, 1999, and 2000 (Cook pers. comm.)

Local, regional, and statewide tricolored blackbird populations have experienced major declines since 1994. These declines are especially alarming because approximately 99 percent of the global population of this species occurs in California (Beedy and Hamilton 1999).

Table TRIC-3
Total Adult Tricolored Blackbirds (breeding and nonbreeding) in Statewide Surveys.[1]

Region	1994	1997	1999	2000	% Decline (1994-2000)
Sacramento County	94,028	31,508	12,859	16,383	-82.6%
Sacramento Valley	98,362	37,426	24,748	30,979	-68.7%
Statewide Total	369,359	237,928	104,786	162,508	-56%

1 Data from Hamilton (2000)

The Volunteer Survey results (summarized by Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000) have identified several important distribution and population trends for tricolored blackbirds that should be emphasized for the SSHCP: 1) local, regional, and statewide populations and distributions vary from year to year; 2) 60 percent of all Tricolored Blackbirds located in all years were found in the ten largest colonies; 3) 70 percent of all tricolored blackbird nests and 86 percent of all foraging by nesting birds were on private agricultural lands; 4) in some portions of their range, tricolored blackbirds have definitely declined or been eliminated, including local extirpation in most of Yolo County and portions of southern Sacramento County.

A decline in the number of breeding tricolored blackbirds in Sacramento County has mirrored the species' overall population decline since 1994. In the four years when accurate population censuses were made, Sacramento County supported 50 to 95 percent of the Sacramento Valley breeding population, and between 10 and 25 percent of the statewide population. In each census year since 1992, one or more of the state's 10 largest colonies has been in southern Sacramento County, and this area has consistently supported some of the largest and most successful colonies observed anywhere in the species' range (Cook 1996, 1999; Beedy and Hamilton 1997).

Declines in the tricolored blackbird population is northern Sacramento County corresponded with a reduction in the percentage of the statewide population nesting in Himalayan blackberries, which averaged from 22 to 34 percent in 1992 and 1994, but declined to about 12 percent and 17 percent in 1997 and 1999, respectively (Cook 1999). Most Himalayan blackberry nesting colonies in the Plan Area are situated in areas where the extent of suitable foraging and nesting habitat has been substantially reduced since 1992 because of extensive conversion of grasslands and vernal pools to vineyards. Declines in the number of breeding tricolored blackbirds in southern Sacramento County is probably related to this documented habitat loss (Cook 1999) (**Table 3**).

Reproductive success of tricolored blackbird colonies in southern Sacramento County has consistently been the highest of any region in the state since studies began in 1992 (Cook 1999). On average, the reproductive success of colonies in Himalayan blackberries was substantially higher than in other habitats, such as cattails, which approached zero in most years. The high reproductive success of tricolored blackbirds in Himalayan blackberry habitats was attributed to a marked reduction in predation rates compared to marsh habitats (Cook 1999).

19.4 Threats to the Species

19.4.1 Habitat Loss and Alteration

At one time virtually all alluvial soils in the Central Valley supported riparian woodlands, marshlands, or perennial grasslands, but these lands were converted to agricultural and urbanization uses (Frayer et al. 1989). Many formerly agricultural areas within the historical range of the tricolored blackbird are now being urbanized. Tricolored blackbirds in Sacramento County forage in the extensive, lightly to moderately grazed annual grasslands associated with ranches and rural subdivisions (Cook pers. comm.). These land uses currently provide suitable habitat for tricolored blackbirds, habitat that will be largely eliminated if current development patterns and land use conversions continue.

In some places, most historical tricolored blackbird breeding and foraging habitats have been eliminated, and there is little or no breeding effort where once there were large colonies (Orians 1961; Beedy et al. 1991). Elsewhere, tricolored blackbirds have shifted from cattails as a primary nesting substrate (Neff 1937) to Himalayan blackberries (DeHaven 1975) and more recently to cereal crops and barley silage (Hamilton et al. 1995). Nests and nest contents in cereal crops and silage are often destroyed by agricultural operations (Hamilton et al. 1995). Harvesting silage and plowing weedy fields are currently the most common reasons tricolored blackbird colonies are destroyed on agricultural lands.

Agricultural cropping patterns have also affected tricolored blackbird habitat. DeHaven (2000) quantified changes in California cropping patterns and found that tricolored blackbird “friendly” habitats such as rangelands, grassland, and pastures have decreased. These habitats are often replaced by other crops that do not provide habitat (e.g., fruit and nuts, vegetables and melons, cotton, tomatoes, beans, potatoes, sugar beets, and vineyards). Clearly, irrigated and non-irrigated pastures (alfalfa, various hay crops, etc.) and grasslands of various kinds, dry seasonally wet areas, dairies, livestock feedlots, and harvested grain fields continue to be important crops and areas to tricolored blackbirds during breeding and non-breeding periods (DeHaven 2000).

In addition to the increase in tricolored blackbird non-habitat crops, changes in management of habitat friendly crops such as rice and hay have affected foraging. Tricolored blackbirds were observed in huge flocks during the fall and winter months in the 1970s in rice fields after they were harvested and burned (DeHaven 2000). Recent crop harvesting and management changes (i.e., flooding during fall) preclude significant foraging by tricolored blackbirds (DeHaven 2000). More intensive pest control management practices in hay and pastures is hypothesized to substantially reduce insect-foraging opportunities, although no confirming studies have been conducted (DeHaven 2000).

In recent years and possibly also in the past, more than half of all observed nesting efforts by tricolored blackbirds occurred in a few, large colonies (Hamilton et al. 1995; Beedy and Hamilton 1997). Concentration of a high proportion of the known population in a few breeding colonies increases their risk of major reproductive failures, especially if they are situated in vulnerable habitats such as active agricultural fields.

19.4.1.1 Predation

Predation is at present a major cause of complete nesting failure at some tricolored blackbird colonies (Hamilton et al. 1995; Beedy and Hayworth 1992). Historical accounts documented the destruction of nesting colonies by a diversity of predators, including wolves (*Canis lupus*) and gray foxes (*Urocyon cinereoargenteus*) (Hermann 1853), skunks (*Mephitis* sp.) and opossums (*Didelphis virginiana*) (Evermann 1919), Swainson's hawks (*Buteo swainsoni*) (Mailliard 1914), Cooper's hawks (*Accipiter cooperii*), burrowing owls (*Athene cunicularia*), American crows (*Corvus brachyrhynchos*), raccoons (*Procyon lotor*), and mink (*Mustela vison*) (Neff 1937).

More recently, Payne (1969) reported predation of tricolored blackbird nests by feral domestic cats (*Felis catus*), northern harriers (*Circus cyaneus*), barn owls (*Tyto alba*), short-eared owls (*Asio flammeus*), and yellow-billed magpies (*Pica nuttallii*). Merlins (*Falco columbarius*) may associate with flocks of wintering tricolored blackbirds and have been observed preying on adults (Manolis pers. comm.).

At some colonies, especially those in permanent freshwater marshes, black-crowned night herons (*Nycticorax nycticorax*) devastate nesting efforts and eliminate all or most nests (Hamilton et al. 1995). At foothill locations and in the southern San Joaquin Valley, common ravens (*Corvus corax*) may assemble and destroy all or almost all nests within colonies. In the Central Valley, coyotes (*Canis latrans*) are a major predator of tricolored blackbird colonies, especially in silage field colonies, and cattail colonies when water is withdrawn (Hamilton pers. comm.).

19.4.1.2 Poisoning, Hunting, Contaminants, and Pollution

Tricolored blackbirds were commercially hunted in the early 1900's (DeHaven 2000) and were regularly shot during hazing programs in an effort to limit crop damage in rice. Neff (1937) reported that greater than 300,000 tricolored blackbirds and red-winged blackbirds were killed and marketed during one five-year period in the 1930's. As agriculture expanded, the use of poisons was adopted to also control blackbirds from rice crop depredations (DeHaven 2000).

McCabe (1932) described the strychnine poisoning of 30,000 breeding tricolored blackbirds as part of an agricultural experiment. Poisoning to regulate numbers of blackbirds preying on crops in California, especially rice, was considered a major source of adult mortality by Neff (1942). This practice continued until the 1960s, and thousands of tricolored blackbirds and other blackbirds were exterminated to control damage to rice crops in the Central Valley. However, improved harvesting methods, earlier ripening rice varieties, and fewer blackbirds have resulted in few recent reports of blackbird crop depredation, and no control programs are currently operating (Gorenzel pers comm.).

During 1986, Beedy and Hayworth (1992) observed a complete nesting failure of a large (about 47,000 breeding adults) tricolored blackbird colony at Kesterson Reservoir, Merced County. External examinations of dead nestlings collected from roads surrounding the reservoir revealed that two of the 10 specimens had club feet (Grau pers. comm. *in* Beedy and Hayworth 1992). Similar deformities were found for shorebirds and other water birds that were also collected at Kesterson Reservoir (Ohlendorf et al. 1986). Pathological examinations of the tricolored blackbird nestlings revealed some evidence of heart muscle degeneration. Selenium toxicosis was suspected as the cause of the deaths (Beedy pers. comm.).

Hamilton (pers. comm.) observed a colony sprayed by mosquito abatement operators in Kern County. All sprayed eggs failed to hatch. Hosea (1986) attributed the loss of at least two tricolored blackbird colonies to aerial herbicide applications.

19.4.1.3 Human Disturbance

Tricolored blackbirds are sensitive to human disturbance at active nesting colonies. Entry into colonies may be required for management purposes or for scientific study; however, to avoid unnecessary disturbance of the nesting birds, colonies should not be entered by casual observers (Beedy and Hamilton 1999).

19.5 Data Gaps and Conservation Implications

Several researchers have documented the life history, habitat requirements, species distribution, population trends, and threats to the species throughout California and the Plan Area. This information is critical for the development of the tricolored blackbird Conservation Strategy. Equally important is the acknowledgment of information considered to be data gaps, along with their implications for conservation. These topics are discussed below.

19.5.1 Wintering Habitat

Most of the tricolored blackbird population within the SSHCP is assumed to winter along the Delta and central coast area; however, it is unclear if important wintering habitat is necessary within the Plan Area. Wintering habitat requirements, if not met, can potentially aid to the further decline of the species rangewide and in the Plan Area.

19.5.2 Locations of Important yet Unknown Tricolored Blackbird Colonies

Undescribed tricolored blackbird breeding colonies may be located within portions of the Plan Area that have not been surveyed. In the Plan Area, discovery of new populations of tricolored blackbirds may occur anywhere that vernal pool/grassland complexes, emergent marshes, natural drainages, artificial irrigation/drainage conveyances, reservoirs and lake margins and stockponds, and silage fields are present.

Tricolored blackbirds do not currently occupy habitat that appears suitable (Cook pers. comm). Although specific habitat elements are present (i.e., Himalayan blackberry), and general habitats such as irrigated pasture and rangelands occur nearby, no active colonies have been identified. Decisions regarding which areas to include as tricolored blackbird preserves would benefit from discovering if there are any relationships between amount of suitable habitat and food abundance to support specific population sizes of nesting tricolored blackbirds.

No studies have been conducted that can make predictions regarding the potential size of a tricolored blackbird colony based on the quality of nearby foraging habitat or other operating factors (e.g., predation). Tricolored blackbird colony sizes vary tremendously (e.g., 50 to 20,000 individuals) within the Plan Area, and no data is available to conclude why some colonies are larger than others.

19.5.3 Predators and Nest Destruction

Several predators have been documented to cause complete reproductive failure of large tricolored blackbird colonies; however, determination of “safe” distances between tricolored blackbird colonies and the most devastating of these predators (e.g., black-crowned night-heron colonies) may provide effective protection during nesting.

Knowledge of these “safe” distances, if any, would help in the establishment of the proper location for preserves. Furthermore, predator populations such as black-crowned night herons may have to be discouraged from nesting or roosting near historical or current locations supporting tricolored blackbird colonies.

19.5.4 Pesticide and Herbicide Application

The use of pesticides and herbicides in agricultural areas and their impacts on prey items for tricolored blackbirds is unknown. There is no information on whether tricolored blackbirds could benefit from changes in pesticide or herbicide applications that are still consistent with effective management of agricultural crops.

19.5.4.1 Unknown Factors Affecting Breeding Site Fidelity

Tricolored blackbird colonies are generally thought of as nomadic colonial nesters. This nomadic behavior is hypothesized to have evolved due their dependence upon highly productive, but unpredictable food resources that are necessary during the nestling and fledgling stages of the breeding season. However, recent data suggests an increase in nest site fidelity even at sites that experience complete reproductive failure, suggesting suitable nesting habitat may be limited.

Managing for tricolored blackbirds by establishing preserves may be the desired strategy to ensure populations are maintained and enhanced; however, if tricolored blackbirds leave previously successful breeding sites (i.e., preserves) for unknown reasons, conservation of the species may be difficult.

19.5.5 Effects of Global Climate Change

The scientific community commonly accepts as valid the phenomenon of increasingly rapid global climate change. Specific climatic models for California predict an average increase in temperature over the coming decades, with concomitant unpredictability in annual rainfall patterns. There is uncertainty regarding the exact nature and extent of these changes, as well as the consequences these changes pose to conservation biology.

It is likely that given the expected global climate trends, a response of some kind could be expected for tricolored blackbird populations within the implementation period of this HCP, or at some time beyond.

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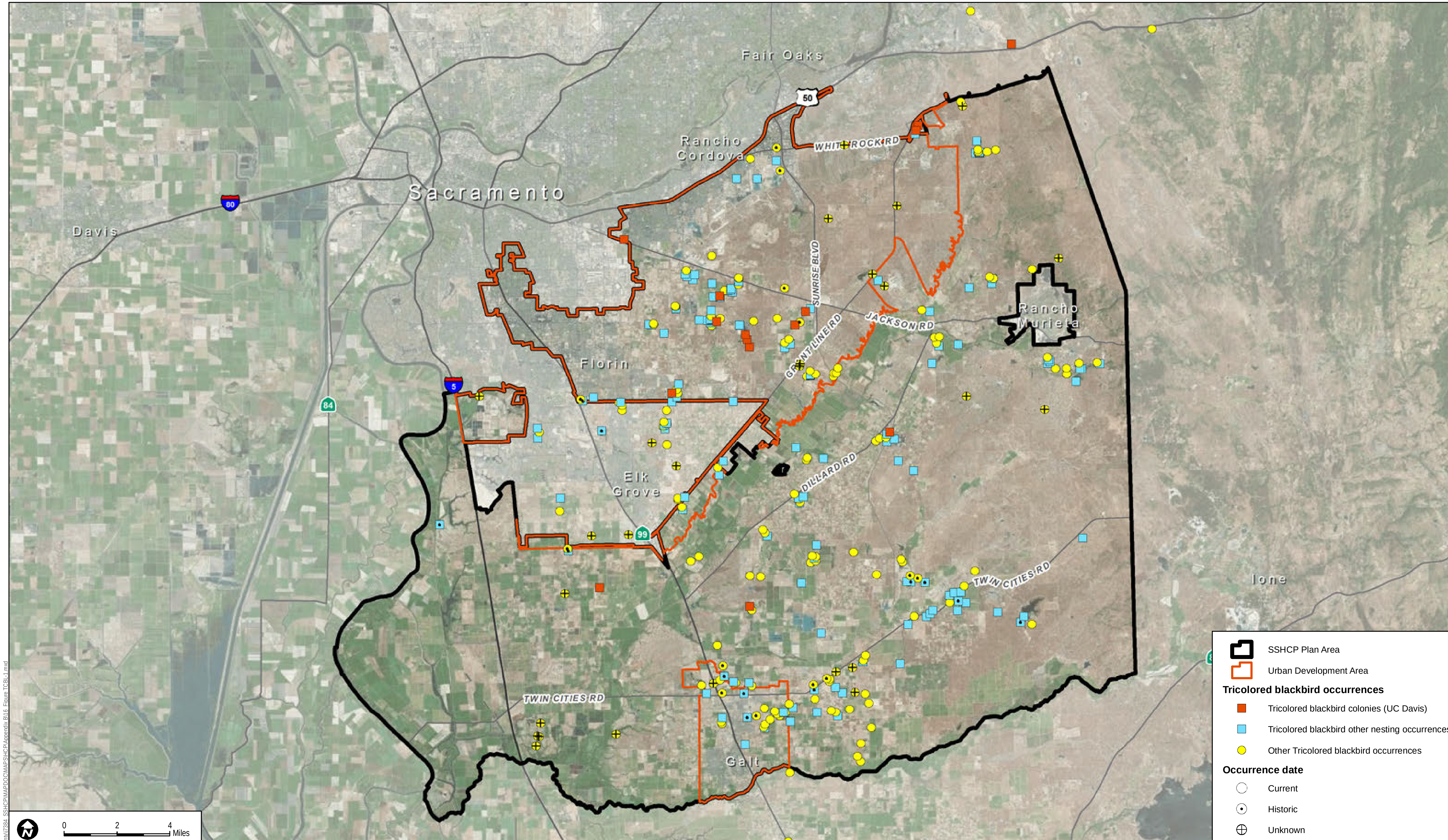

SOURCE: Bing Maps, County of Sacramento 2014, UC Davis 2014, CDFG 2012, BIOS 2012, Lizette Cook 1997, ebird.org

SSHCP South Sacramento Habitat Conservation Plan

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

FIGURE TRIC-1

Tricolored Blackbird Documented Occurrences

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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20 WESTERN BURROWING OWL (BUOW)

Prepared by Henderson Ecology and Planning (Steve Henderson)

Western Burrowing Owl (BUOW)

(Athene cunicularia hypugaea)
Status USFWS: Bird of Conservation Concern

Status CDFG: First Priority Bird Species of Concern

20.1 Legal Status

Western burrowing owl (*Athene cunicularia hypugaea*) is legally protected under the federal Migratory Bird Treaty Act (16 U.S.C. 703-712) and California Fish and Game Code (Sections 3503.5 and 3800). This species is designated as a First Priority Bird Species of Special Concern (BSSC) by the California Department of Fish and Game (CDFG) (Shuford and Gardali 2008); Bird of Conservation Concern (BCC) by the U.S. Fish and Wildlife Service (USFWS) (USFWS 2002); and Sensitive Species by the U.S. Bureau of Land Management (BLM).

On April 7, 2003, conservation organizations submitted to the California Fish and Game Commission a petition to list the California population of the western burrowing owl as an endangered or threatened species under the California Endangered Species Act (CESA) (Center for Biological Diversity [*CBD*] et al. 2003). In December 2003, the commission voted to reject the petition. This decision was certified on February 5, 2004.

20.2 Life History and Ecology

20.2.1 Species Description and Life History

20.2.1.1 Physical Description

Western burrowing owl is a small, round-headed, ground-dwelling owl that inhabits open habitats such as grasslands, deserts, steppes, and agricultural lands. Burrowing owls are unique in physical appearance and behavior among other owls due to their ground-dwelling and non-arboreal natural history. Individuals have long legs relative to their body size, a stubby tail, bright yellow eyes (irises) and white eyebrows, an oval facial ruff, and no ear tufts. Their long legs allow the species to scan over short- or sparsely-vegetated landscapes for predators and prey from the ground, and pursue insect prey on foot. The head, back, and upper wings of adults are brown with thick white or buffy-white spots; while the underparts are generally buffy-white in color with brown barring along both sides. Adults range from approximately 7.5 to 9.8 inches (19 to 25 centimeters) in total length (from bill to tail) and weigh approximately 5.3 ounces (150 grams). Adult burrowing owls have a wingspan of approximately 20 to 24 inches (50.8 to 61.0 centimeters). Their wings are rounded and long relative to body size. Burrowing owls exhibit sexual size and color dimorphism as females are larger and darker than males (Haug et al. 1993.); however, it is often difficult to distinguish between males and females in the field.

20.2.1.2 Taxonomy

Burrowing owl was originally classified as *Strix cunicularia* in 1782. Through several taxonomic and name revisions, it has been moved between the genera *Speotyto* and *Athene* (Haug et al. 1993; Clark 1997). The species was classified as *Athene* by the American Ornithologists' Union (AOU) in 1983 (AOU 1983), reclassified as *Speotyto* in 1991 based on genetic data (AOU 1991), and moved back to *Athene* in 1997 (AOU 1997).

As many as 21 subspecies of *A. cunicularia* have been recognized; however, Konig et al. (1999) recognizes only 13 subspecies. Two subspecies occur in North America: Florida burrowing owl (*A. c. floridana*) occurs in Florida and the Bahama Islands, while western burrowing owl (*A. c. hypugaea*) occurs in North America west of the Great Plains and south to Panama (Haug et al. 1993). The remaining subspecies, with the exception of two island forms (i.e., *A. c. rostrata* [Clarion Island off the west coast of Mexico] and *A. c. troglodytes* [Hispaniola]) are all found in South America.

20.2.1.3 Reproduction

During the breeding season, burrowing owls build nests in excavated burrows, underground tunnels, or burrow facsimiles. They typically adopt burrows or tunnels excavated by fossorial mammals or reptiles, including ground squirrels, prairie dogs, badgers, skunks, armadillos, marmots, foxes, coyotes, and tortoises (Karalus and Eckert 1987). In California's Central Valley, California ground squirrel (*Spermophilus beecheyi*) populations are particularly important to the breeding ecology and conservation of burrowing owls, by creating and maintaining availability of burrowing owl nesting and satellite burrows. Where the number and availability of suitable natural burrows are limited (e.g., where burrows have been destroyed or ground squirrels eradicated), burrowing owls will occupy drainage culverts, cavities under piles of rubble, discarded pipe, and other tunnel-like structures.

Nesting burrowing owls often occur in loose colonies, depending on local population density and site conditions. Breeding adults can exhibit strong nest site fidelity and often return to the same or nearby burrows each year. This life history trait can make burrowing owl populations particularly sensitive to loss of occupied nesting habitat and permanent displacement of owls from nest sites; and it is important that conservation planning efforts for western burrowing owl emphasize *in situ* protection of occupied nesting habitat. During the nesting period, adults and juveniles typically utilize several satellite burrows around the main or nest burrow. During nest site selection, the adult pair will often prepare or "renovate" several neighboring burrows by scraping out dirt with their bills, feet, and wings. One of those burrows is eventually selected as the nest burrow. Adults frequently line the nest burrow with cattle or horse manure, other organic material such as vegetation or feathers, or debris (CBD et al. 2003).

Like other owls, burrowing owls usually breed once per year in an extended reproductive period; however, renesting and production of a second brood within a nesting season, after the first brood successfully fledged, was recently documented in California (Gervais and Rosenberg 1999). Most adults are monogamous, although polygamy and extra-pair fertilizations occasionally occur (Johnson 1997b). Localized high densities of burrowing owls, along with the mobility of their young, facilitate extra-pair copulations, brood amalgamation and mixing, and joint-nesting (and possibly intraspecific brood parasitism). In one study of burrowing owls near Sacramento, at least 37 percent of adults exhibited parental behavior toward offspring that were not their own (i.e., alloparenting). They were similarly non-discriminating in their choice of mates, breeding randomly with respect to the local group of adults (Johnson 1997b).

Both sexes reach sexual maturity at one year of age. The burrowing owl nesting season (including courtship, breeding, and fledging stages) is generally February through August. Most Burrowing owls in California begin pair formation and courtship in February or early March; however in the Imperial Valley, pair formation is initiated as early as mid-January (Coulombe 1971). Courtship and pair formation begins when the male conducts courtship displays and vocalizations. Males produce a "who-who" call to attract females while standing near a potential nest burrow. After a female is attracted to the site, courtship behaviors include a combination of vocalizations and posturing by both sexes, typically within 49 feet (15 meters) of the burrow.

Nest site selection begins once the pair has formed. Males collect and deliver the majority of nesting material (Anderson et al. 2001).

Burrowing owl pairs breed from March through May, although the peak breeding period is April through May. During March through May, eggs are laid at least one day apart and are incubated by both adults for about three to four weeks. Females can lay up to 12 eggs; however, the average clutch size is seven eggs (Haug et al. 1993). The female incubates the eggs for 28 to 30 days. The male forages and delivers food to the female and guards the burrow entrance during the day. Young owlets are brooded in the nest chamber for another two to three weeks, at the end of which time they may be seen at the burrow entrance in their natal-down plumage. Nestlings emerge asynchronously and tentatively. They gradually become bolder, eventually spending more time outside near the burrow entrance. During this period, nestlings can range widely on foot, even before they can fly. The adults guard their brood tenaciously, attacking intruders if provoked. Older nestlings or fledglings may move to nearby satellite burrows as the natal burrow becomes crowded. Fledging occurs six to eight weeks after emergence. Fledglings typically remain near the burrow and accompany the adults in foraging flights at dusk (Rosenberg et al. 1998).

Reproductive success is probably the most important demographic parameter in ensuring population viability for most species with short life spans and low survival rates (Emlen and Pilkitch 1989; CBD et al. 2003); and it is probably the most important demographic parameter for burrowing owl populations (Gervais and Rosenberg 1999); however, accurately estimating reproductive rates for burrowing owls is difficult (Gorman et al. 2003). Up to ten young per pair can be fledged in especially productive years (Gervais and Rosenberg 1999). In recent years, the number of young fledged in central California has ranged between three and six, and was typically four or five (DeSante et al. 1997). In the Sacramento area, the mean per capita rate of reproduction of burrowing owls has been estimated at zero to 4.5 offspring per individual (Johnson 1997c). Anecdotal information suggests that burrowing owl fledging success in the early 1900's was six to eight young per nest (Dawson 1923). The possible decline in fledging success in the Central Valley since the early 1900's corresponds with documented population declines of other avian predators occurring in Central Valley grassland habitats (e.g., loggerhead shrike [*Lanius ludovicianus*], American kestrel [*Falco sparverius*]) (DeSante et al. 1997). Rosenberg and Haley (2004) reported that average fledging success in the Imperial Valley was 2.5 young per nest.

20.2.1.4 Survival and Longevity

Extensive data on burrowing owl longevity are not available. The maximum life span documented for a banded burrowing owl is approximately 8.5 years (Rosenberg et al. 1998). Burrowing owl adult and juvenile survival rates vary considerably among studies. The range of reported between-year return rates is 30–83 percent (Thomsen 1971; Haug et al. 1993; Clayton and Schmutz 1997; CBD et al. 2003). Depending on assumptions about emigration and immigration, the probability that juvenile burrowing owls will survive to one year of age (the age of first breeding) has been estimated between 0.23 and 0.93, while annual adult survivorship has been estimated between 0.42 and 0.93 (Johnson 1997c).

20.2.1.5 Dispersal Patterns

Nest site fidelity is common in resident burrowing owl populations. Breeding adults often return to the same or nearby burrows each year (Botelho and Arrowood 1998). Also, second-year birds will often attempt to nest near (less thean 0.2 mile [300 meters]) their natal sites (Rosenberg et al. 1998). Burrowing owls in migratory populations often renest in or near the same burrow, particularly if breeding was successful there the previous year (Belthoff and King 1997).

As of 1993, the USFWS Bird Banding Lab (BBL) documented 44 records of burrowing owls band returns in California. Nearly all of these records were from the same area in which the birds were originally banded or adjacent areas. Only two records were from owls that moved substantial distances (one between Orange County and Mexico, another between Orange County and Nevada) (Barclay pers. comm., cited in CBD et al. 2003). In two burrowing owl demography studies conducted in the San Francisco Bay Area, owls moved an average distance of 0.5 to 0.9 miles (0.8 to 1.4 kilometers) (n=276 owls) between breeding seasons. Of this sample population, 27 percent remained at the same nest site; 14 percent dispersed less than 265 feet (80.8 meters) away; 34 percent dispersed 0.05 to 0.5 mile (80 to 804.7 meters); eight percent dispersed 0.5 to 1.0 mile (804.7 meters to 1.6 kilometers); 14 percent dispersed 1.0 to 5.0 mile (1.6 to 8.0 kilometers); and two percent moved 5.0 to 10 miles (8.0 to 16.1 kilometers) (Chromczak unpublished data, cited in CBD et al. 2003). Adults that experience failed nesting attempts have been documented to move miles (up to tens of kilometers) away prior to subsequent renesting attempts, sometimes within the same season (Gervais pers. comm., cited in CBD et al. 2003).

20.2.1.6 Diet and Foraging

Burrowing owls primarily eat small rodents and large arthropods (Coulombe 1971; Green and Anthony 1989; Silva et al. 1995; Gervais et al. 2003). Important rodent prey items include mice, voles, rats, kangaroo rats, and young ground squirrels. Arthropod prey includes grasshoppers, beetles, crickets, dragonflies, other insects, and crayfish. Burrowing owls are considered opportunistic predators (Thomsen 1971; Zarn 1974; York et al. 2002) and will also prey on small birds, reptiles, amphibians, and other small live prey. Burrowing owls have been documented preying on several bird species including killdeer (*Charadrius vociferus*), western meadowlark (*Sturnella neglecta*), horned lark (*Eremophila alpestris*), Wilson's warbler (*Wilsonia pusilla*), American avocet (*Recurvirostra americana*), red-winged blackbird (*Agelaius phoeniceus*), Brewer's blackbird (*Euphagus cyanocephalus*), mourning dove (*Zenaida macroura*), and black-headed grosbeak (*Pheucticus melanocephalus*) (see CBD et al. 2003). They have also been documented preying on burrowing owl chicks (Botelho 1996; Rosenberg et al. 1988); spadefoots (*Spea* spp.) (Sperry 1941; Bond 1942); snakes, centipedes, and scorpions (Stoner 1933; Neff 1941); and bats, including hoary bat (*Lasiurus cinereus*) (Thomsen 1971) and Mexican free-tailed bat (*Tadarida brasiliensis*) (Gobalet 1999).

Burrowing owls often hunt from a perch. Foraging behavior is variable but generally consists of hunting while hovering or hover-gliding and returning to the perch. Burrowing owls also chase their prey on foot while walking, running, or hopping. Hunting behavior apparently depends on vegetation type and structure, time of day, and the type of prey pursued (Thompson and Anderson 1988; Haug et al. 1993).

Burrowing owls are primarily crepuscular (i.e., dawn and dusk) foragers, but will hunt at any time (Grant 1965; Marti 1974; Rosenberg et al. 1988). Nesting burrowing owls are also central-place foragers (Gervais et al. 2003; Rosenberg and McKelvey 1999), foraging from and returning to the same location. Some owls may forage up to one mile from their burrow (Johnson pers. comm.) and nocturnal foraging can occur up to several miles away from the burrow. During the breeding season, adult male burrowing owls have been documented foraging over a range of 0.8 to 1.2 square miles (2 to 3 square kilometers) (Haug and Oliphant 1987) and primarily within 0.4 mile (600 meters) of the nest burrow (Gervais et al. 2003; Rosenberg and Haley 2004).

Burrowing owls tend to concentrate their hunting in natural grasslands, agricultural lands, uncultivated fields, ungrazed areas, and open ruderal areas such as roadsides that support abundant small mammal and arthropod populations (Haug and Oliphant 1990; Gervais et al. 2003). In urban areas, burrowing owls are often attracted to street lights, where insect prey congregates. In a recent study conducted in California's San Joaquin Valley, burrowing owls did not appear to differentiate between grassland and cropland in their foraging habitat selection (Gervais et al. 2003).

20.2.1.7 Movement and Migration Patterns

The tendency of burrowing owl populations to migrate annually varies over the species range. Populations are resident in locations where food availability is stable and available throughout the year. Burrowing owl populations in the northern part of the species' range are migratory, leaving their breeding grounds in the fall and returning to the same or nearby areas (often the same burrow) in the spring. However, most California populations are resident (i.e., non-migratory) (Thomsen 1971; Haug et al. 1993) or wander during winter months (Coulombe 1971; Martin 1973; Botelho 1996), especially in central and southern California (CBD et al. 2003). The winter burrowing owl population in California is large relative to other regions throughout the species' range. It is thought that some owls migrating from northern areas (e.g., Canada, Washington, Oregon, and Idaho) winter in California and augment resident populations (Coulombe 1971). Non-migratory seasonal movements in burrowing owl populations can also occur. For example, after the young fledge, family groups will sometimes move among burrows in the fall and juveniles may adopt their own nearby burrow. During winter, pairs will examine and select new burrows as territorial boundaries are relaxed and pair formation proceeds (Thomsen 1971).

During the breeding season, adult burrowing owls remain close to or inside their nest burrows throughout most of the day. They have been documented spending most of their time within 162 to 325 feet (49.4 to 99.1 meters) of their nest or satellite burrows during daylight hours (Haug and Oliphant 1990). Individuals often begin perching outside in the afternoon and foraging at dusk. Nesting adults return to the burrow at night (Thomsen 1971).

20.2.1.8 Territoriality/Home Range

Home range sizes of western burrowing owls vary greatly among individuals (Gervais et al. 2003). During the breeding season, adult male burrowing owls have been documented foraging over a range of 0.8 to 1.2 square miles (2 to 3 square kilometers) (Haug and Oliphant 1987), and primarily within 0.4 mile (600 meters) of the nest burrow (Gervais et al. 2003; Rosenberg and Haley 2004). Although burrowing owls aggressively defend a small territory around their burrows against predators and other owls (CBD et al. 2003), the home ranges of adjacent males may overlap considerably (Haug and Oliphant 1987). Inter-nest distances, which can indicate the limit of an owl's territory, have been found to average between 198 to 695 feet (60.4 to 211.8 meters) (Thomsen 1971; Haug and Oliphant 1990).

Gervais et al. (2003) studied space use and habitat selection of a burrowing owl population in a San Joaquin Valley agricultural landscape (near Fresno, California). Out of several biophysical variables analyzed, including cover-type (e.g., grass, crop) and distance to road edges and irrigation ditches, distance-from-nest was the best predictor of foraging habitat use. In their study, approximately 80 percent of foraging observations occurred within 0.37 mile (600 meters) of the nest burrow, independent of cover-type availability or other factors measured. These results are different than those reported by Haug and Oliphant (1990), who found that burrowing owls used grass-forb habitats more frequently than croplands or grazed pasture. Also, Gervais et al. (2003) reported that variation in burrowing owl home range size was not explained by several variables including cover-type composition, number of neighboring nests, reproductive output, and the proportion of rodents in the diet.

20.2.1.9 Ecological Relationships

In California's Central Valley, perhaps the most important ecological relationship for the burrowing owl is its commensalism with California Ground Squirrels. Because burrowing owls generally need fossorial animals to dig their burrows, burrowing owl population dynamics in the Central Valley are closely linked with California Ground Squirrel populations. California Ground Squirrels create and maintain burrowing owl nest and satellite burrows. Furthermore, burrowing owl habitat quality is considered proportional to the condition and viability of California Ground Squirrel populations. In addition to creating burrows, colonial rodents such as California Ground Squirrels can maintain burrowing owl nest burrows between breeding seasons, and vigilant ground squirrels incidentally alert burrowing owls to predation threats by alarm-calling (Trulio 1994).

Predator-prey relationships are important for burrowing owls, particularly because burrowing owls are both a predator and prey species. Predation on burrowing owls generally occurs in two forms: predation of nests and/or incubating adults in the nest chamber, and predation of juvenile or adult birds outside the nest chamber. Nest predators are typically species that are capable of accessing the nest chamber and include foxes (*Vulpes* spp.), badgers (*Taxidea taxus*), skunks (*Mephitis* spp.), raccoons (*Procyon lotor*), and rattlesnakes (*Crotalus viridis*) (Coulombe 1971; Kemper 1996). Predators of burrowing owls above ground include prairie falcon (*Falco mexicanus*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*Buteo swainsoni*), ferruginous hawk (*Buteo regalis*), northern harrier (*Circus cyaneus*), golden eagle (*Aquila chrysaetos*), foxes, coyote (*Canis latrans*), and domestic dogs (*C. familiaris*) and cats (*Felis catus*).

20.2.2 Habitat Requirements and Ecology

Historically, burrowing owls in California were most abundant in broad, interior, lowland valley bottoms and flat coastal lowlands (Grinnell and Miller 1944). According to DeSante and Ruhlen (1995), 92 percent of breeding burrowing owls in California occurred in these lowland settings, usually below approximately 200–984 feet (60–300 meters) in elevation. In these landscapes, burrowing owls occurred primarily in open prairie and shrub-steppe habitats (Coulombe 1971; Butts 1973). Most of the burrowing owl's original prairie habitat in California has been removed and other open habitats in lowland landscapes are experiencing the most intensive urban development pressures in the state (CBD et al. 2003).

Throughout their life cycle, burrowing owls require habitat with three basic attributes: open, well-drained terrain outside areas at risk of flooding; short, sparse vegetation; and underground burrows or burrow facsimiles. Burrowing owls inhabit grasslands, deserts, sagebrush scrub, agricultural areas (including pastures and untilled margins of cropland), earthen levees and berms, coastal uplands, and urban vacant lots, as well as the undeveloped margins of airports, golf courses, roads, and railroad beds. Burrowing owls typically occur in habitats with less than 30 percent tree or shrub cover (DeSante et al. 1996). In California, the four cover types most frequently occupied by burrowing owls are: grasslands adjacent to intensive agriculture; intensive agriculture where owls nest along irrigation banks; large, unfragmented grasslands; and small grassland and ruderal patches surrounded by and adjacent to urban development (Rosenberg and DeSante 1997; Rosenberg and Haley 2004). The proximity of nest sites to suitable foraging habitat is especially important, as burrowing owls tend to forage near their burrows (Gervais et al. 2003).

The most important habitat consideration for burrowing owls is the availability of underground burrows throughout their life cycle. While burrowing owls nest and roost in these burrows, they do not typically create them. Throughout their range, they use burrows excavated by fossorial mammals or reptiles, including ground squirrels, prairie dogs, badgers, skunks, armadillos, marmots, foxes, coyotes, and tortoises (Karalus and Eckert 1987). Where the number and availability of natural burrows are limited (e.g., where burrows have been destroyed or ground squirrels eradicated), owls may occupy other natural and unnatural sites such as rock outcrops (Gleason and Johnson 1985; Rich 1986), concrete and asphalt (Trulio 1994), cavities under piles of rubble, drainage culverts, discarded pipe and other tunnel-like structures, and human-made artificial burrows (Collins and Landry 1977).

In the Sacramento region, including the Plan Area, burrowing owls most commonly live in natural tunnels created by California ground squirrels. Accordingly, the quality of burrowing owl habitat in the Plan Area is closely and positively related to the occurrence and population viability of California ground squirrels in an area. DeSante et al. (1996, 2003) found that the best predictor of burrowing owl reoccupancy of nest sites in California was ground squirrel presence. Burrowing owls and ground squirrels can co-inhabit the same burrow system (Johnson pers. comm.), but the frequency with which this occurs has not been measured, and underground interactions have not been studied.

Vegetation height and structure, and the availability of roost sites, particularly affect burrowing owl habitat quality, especially because this species is a small ground-dweller (Zarn 1974; Green and Anthony 1989; Trulio 1994). Burrowing owls select sites that support short vegetation, even bare soil, presumably because they can easily see over it and maneuver through it; however, they will tolerate tall vegetation if it is sparse. Owls will perch on raised burrow mounds or other relief, such as rocks, tall plants, fence posts, and debris piles to attain good visibility. During the breeding season, they may also need enough permanent cover and taller vegetation within their foraging range to provide them with sufficient prey, such as small mammals (Wellicome 1994). In Santa Clara County, vegetation cover and average vegetation height at occupied burrow habitat were 44 to 57 percent and six inches (15.2 centimeters), respectively (Trulio 1994).

burrowing owls in Oklahoma occured where vegetation was four inches (10.2 centimeters) or less in height (Butts 1973). Green and Anthony (1989) reported that 28 percent vegetation cover was optimal in the Columbia Basin, and that burrowing owls used areas with high proportions of bare ground. Some land management practices that manipulate vegetation while avoiding burrow damage or disturbance, including moderate grazing or vegetation removal, can enhance or maintain suitable vegetation in burrow habitat (Coulombe 1971; Green and Anthony 1989; Trulio 1994; Jones pers. comm.).

Burrowing owls sometimes occur in small habitat fragments, including grassland or ruderal patches surrounded by urban development (Rosenberg and DeSante 1997; DeSante et al. 2004). In general, burrowing owl colonies often occur in habitat edges and/or disturbed sites characterized by natural or anthropogenic soil disturbance (including soil piles and bare ground) and topographic breaks (Gifford pers. comm.). Their proximate association with these areas may be independent of certain landscape variables such as habitat patch size; therefore, these settings appear to simply provide burrowing owls with some of their required habitat elements, including suitable digging sites for California ground squirrels, short and sparse vegetation, and good visibility. However, the spatial requirements of burrowing owls, and how long-term population viability varies with landscape-level parameters, are not well understood. CDFG's burrowing owl mitigation guidelines (CBOC 1993) imply that breeding pairs or resident individuals of burrowing owls may require a minimum of 6.5 acres (2.6 hectares) of contiguous foraging habitat to persist (based on a 300-foot [91.4-meter] radius around an occupied burrow). For example, the guidelines for avoiding project impacts on pairs or individuals requires preserving a minimum of 6.5 acres of foraging habitat contiguous with occupied burrow sites for each pair of breeding owls or single unpaired resident bird. Guidelines for mitigating the loss of foraging and burrowing habitat on a project site requires protection of at least 6.5 acres of foraging habitat per pair or unpaired resident bird. Whether these guidelines have an empirical ecological or demographic basis is not clear.

Burrowing owl pairs have been observed in isolated habitat patches as small as one acre (0.4 hectare). However, an area this size does not support the foraging requirements of most burrowing owls, and individuals occurring at sites this small must forage offsite. Reproductive success and long-term persistence in small and isolated habitats are unknown. Although the relationship between habitat area and population viability of this species is not well documented, small and isolated habitat patches are not likely to sustain high reproductive success or long-term persistence.

In urban settings, burrowing owls occurring in isolated habitats may experience frequent disturbances from adjacent land uses (e.g., habitat degradation, predation) and barriers to foraging areas. For example, the availability of rodent prey may be limited in isolated habitats, and ground squirrels may abandon or be eradicated from small parcels of habitat in urban settings. Also, small and isolated occurrences are more likely to experience random local extirpation as a result of natural disturbances (e.g., Goodman 1987) and recolonization of small or isolated habitat patches is less likely than recolonization of large habitat areas. Burrowing owls can tolerate considerable levels of non-threatening human activity and noise in locations that sustain their other habitat requirements (e.g., suitable nesting and foraging habitat, and roosting sites) (CBD et al. 2003).

What constitutes an isolated habitat patch for burrowing owl and the minimum size of a viable patch of habitat (i.e., habitat capable of sustaining a population over a long time) are not well documented. These parameters are likely affected by habitat quality, juxtaposition of the site relative to other suitable habitat, surrounding land uses, and prey availability. Burrowing owls have been observed in small lots nearly surrounded by development. Furthermore, burrowing owls will fly through urban areas to forage in nearby areas; however, the type and minimum extent of development that constitutes a barrier to movement between occupied patches and nearby foraging areas is not known. Although small and isolated patches of habitat can support owls, these sites may be unlikely to attract new pairs.

20.2.2.1 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for burrowing owl are identified in Table BUOW-1 and have been derived from input from local species experts.

Table BUOW-1
Essential Habitat Elements for Burrowing Owl

Essential Activities	Land Cover Types	Habitat Elements
Foraging, breeding and dispersal	Blue oak savanna, cropland, irrigated pasture grassland, and valley grassland.	Open, well-drained terrain outside areas at risk of flooding; short, sparse vegetation; and underground burrows or burrow facsimiles. Requirement for burrows is facilitated by healthy populations of California ground squirrel.

20.3 Species Distribution and Population Trends

20.3.1 Species Distribution

Western burrowing owl occurs throughout western North America west of the Mississippi River, and south through Mexico to Panama (Haug et al. 1993). In California, western burrowing owl is a year-round resident. Historically, burrowing owl was widespread and occurred in suitable habitats throughout the state (Grinnell and Miller 1944), but its range has contracted significantly, particularly in coastal grasslands. Its present range includes lowlands from north-central California west of the Sierra Nevada and south to Mexico, desert regions of southwestern California, and scattered locations in the Great Basin (DeSante et al. 1996). Burrowing owls are absent from coastal areas north of Sonoma County. They are also absent from montane regions such as the Sierra Nevada and the ranges between Santa Barbara and San Bernardino Counties.

20.3.2 Central Valley Distribution

There are historical records of burrowing owl occurrence from nearly every county in the Central Valley (DeSante et al. 1996). DeSante et al. (1996) described the western burrowing owl's Central Valley range in terms of its county distribution within three geographic zones: Northern Central Valley, Middle Central Valley, and Southern Central Valley. Approximately half of all breeding groups known to occur in the Central Valley during the 1980's disappeared by the early 1990s (DeSante and Ruhlen 1995).

20.3.3 Range within the Plan Area

The Plan Area occurs within the Middle Central Valley portion of the burrowing owl's range. DeSante et al. (1996) estimated that the Central Valley supports 14 percent of the total California burrowing owl population (and some of the highest population densities, along with Imperial Valley); and 11 percent of the total population occurs in the Middle and Northern Central Valley, and southern San Francisco Bay Area combined. The Plan Area lies within the core of this region. This area is particularly important to the current and future western burrowing owl population in California for several reasons: 1) it is located within a complex that supports some of the highest burrowing owl population densities in the state; 2) it historically supported some large burrowing owl populations (see below); 3) breeding populations still remain within this area, and there are opportunities to enhance existing populations; 4) large areas of suitable habitat remain in the area; and 5) the greater region is threatened by intensive development and urbanization pressure.

Western burrowing owls occur in suitable habitat within the Plan Area; however, their overall distribution, abundance, and population structure are not well known. Land-cover types used by burrowing owls, such as grasslands, vernal pool grasslands, fallow agricultural fields, and open oak savannah occur throughout most of the Central Valley and are well-represented in Sacramento County and the Plan Area, particularly outside the Urban Development Area (UDA); however, at most sites within these land-cover types, the presence of burrowing owls is not known, and it is assumed that most of this habitat is not occupied

Since the 1950's, large colonies of burrowing owls have been recorded in the Plan Area at Executive Airport, Sacramento Army Depot, Cosumnes River College, and Mather Air Force

Base (DeSante et al. 1996; CDFG 2010; Johnson pers. comm.). Large colonies have also been documented in Sacramento County outside the study area at the California State University Campus. Effects from surrounding development and habitat degradation have reduced burrowing owl numbers in these areas. Some populations remain in increasingly isolated tracts of urban open space south of the American River and in the North Natomas area, in Sacramento County but outside the Plan Area.

Although burrowing owl populations have declined or disappeared from much of their historical habitat, outlying areas of the County still provide suitable habitat for the species. Burrowing owls are known to occupy patches of habitat that extend from the Sacramento Regional County Sanitation District (SRCSD) Bufferlands (Jones pers. comm.) to The Nature Conservancy's Cosumnes River Preserve (Reiner pers. comm.), as well as habitat in the rolling grasslands in eastern Sacramento County. The Meadowview and Pocket areas within the City of Sacramento (outside the Plan Area) support disjunct, isolated populations north to Florin Road (Roscoe pers. comm.). No comprehensive data exist on the distribution or abundance of these owls or on their demographic relationship to the burrowing owls within the city limits of Sacramento. It seems likely, however, that extant habitat south and east of the city boundary has served for some time as a "refuge" for burrowing owls being displaced from the Sacramento Metropolitan Area by urbanization.

Because comprehensive surveys or monitoring efforts for western burrowing owl in the Plan Area have not been conducted, and because the existing data of known occurrences are based mostly on incidental observations or limited surveys (e.g., CNDDB, anecdotal records, surveys conducted over a limited area), the population size and nesting distribution of this species in the Plan Area are not known. There are 36 previously recorded occurrences scattered throughout the Plan Area, 17 of which are within the UDA (CDFG 2010). For the purposes of the SSHCP, the species is considered to range throughout the Plan Area in areas of suitable habitat.

20.3.4 Population Levels and Trend

The burrowing owl is experiencing precipitous population declines throughout North America. In Canada, its numbers are rapidly declining, and in 1995 the Committee on the Status of Endangered Wildlife in Canada listed it as an endangered species. In Mexico, it is officially considered a threatened species. The burrowing owl is also declining throughout most of the western United States, and has disappeared from much of its historical range in California. Nearly 60 percent of California burrowing owl colonies that existed in the 1980's had disappeared by the early 1990s (DeSante and Ruhlen 1995; DeSante et al. 1997). In the San Francisco Bay Area and the central portion of the Central Valley (from Yolo and Sacramento Counties to Merced County), the burrowing owl population has declined by at least 65 percent since 1986 (DeSante pers. comm.).

Burrowing owls remain throughout nearly all of their Central Valley range. Approximately half of all breeding groups known to occur in the Central Valley during the 1980s disappeared by the early 1990s (DeSante and Ruhlen 1995). Due to severe losses of habitat suitable for burrowing owls in the Plan Area over the past several decades, as a result of development and certain agricultural conversions, it is assumed that western burrowing owl populations in the Plan Area have declined substantially over recent decades.

20.4 Threats to the Species

Western burrowing owl is threatened over most of its range by several factors. The Center for Biological Diversity et al. (2003) provides a thorough description of threat factors, including documentation by specific studies in several cases. The following section summarizes threats to western burrowing owl populations. Immediate threats to western burrowing owl include the conversion of grassland habitat to urban and agricultural uses, and the loss of suitable agricultural lands to development. Approximately 91 percent of burrowing owls in California occur on private land. Statewide, over 86 percent of grasslands are in private ownership (Bates 2006). Equally important is the loss of fossorial rodent populations such as prairie dogs and ground squirrels across much of the owl's historical habitat. Eradication programs have decimated populations of these rodents and have in turn disrupted the commensal ecological relationship the owls have with these species. Another cause of population declines is thought to be pesticide use (especially organophosphates in southern Canada); however, the available evidence does not clearly indicate that other contaminants are reducing populations (Gervais et al. 1997). Habitat fragmentation (Remsen 1978) probably increases foraging distances, making hunting less efficient, and potentially reducing reproductive success. Furthermore, fragmentation may reduce the chances that a male owl will attract a mate and successfully reproduce.

Studies of island biogeography suggest that small, isolated populations can suffer from genetically induced problems that may jeopardize the long-term survival of a species (Goodman 1987; Hanski and Gilpin 1997), and recent studies of burrowing owls suggest that such genetically induced problems may threaten the species. One study suggests that small owl populations many be genetically isolated from other populations (Johnson 1992). Another study found a population of owls near Sacramento to be inbred due to small population size rather than non-random mating (Johnson 1997a).

Other documented threats to western burrowing owl throughout the species' range include predation, mortality due to collisions with vehicles and wind turbines, and relocation of burrowing owls away from occupied habitat for development (CBD et al. 2003). Attempts to exterminate rodents by the use of poisons may also kill burrowing owls (Rosenberg et al. 1998).

Western burrowing owls in south Sacramento County are specifically threatened by habitat loss and fragmentation as a result of conversion of habitat to urban uses and agriculture, particularly the conversion of grasslands to vineyards. Also, the loss of suitable agricultural land to development has reduced the extent of suitable habitat. It is assumed that control of ground squirrels has reduced the extent and quality of burrowing owl habitat by reducing the number of suitable nesting burrows. It is possible that the use of rodenticides and insecticides have reduced prey populations, resulting in lowered survivorship and reproductive success.

20.5 Data Gaps and Conservation Implications

The ecology, status, and management of western burrowing owl have received considerable attention in recent years; however, there are several sources of uncertainty regarding burrowing owl and its requirements in the Plan Area. These data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

20.5.1 Population and Habitat Distribution within the Plan Area

Because comprehensive surveys for western burrowing owl in the Plan Area have not been conducted and the existing occurrence data are based primarily on incidental observations (e.g., CNDDB, anecdotal records), the population size and nesting locations of this species throughout the Plan Area are not known. In addition, though the distribution of grassland, agricultural, and ruderal land-cover types is mapped and quantifiable, the quality of habitat for burrowing owls within most of these areas is unknown.

These information gaps limit our ability to identify the best lands available for preserving burrowing owl habitat, and accurately estimate the impacts resulting from covered activities. Until these data gaps are remedied, the conservation value for burrowing owl will be considered relatively high in lands that support (or recently supported) known occurrences, are large in extent, or are adjacent to these areas.

20.5.2 Landscape-level Habitat and Preserve Design Requirements for Viable Populations

The minimum habitat size and connectivity requirements for the western burrowing owl are not well documented. This causes uncertainty in determining what preserve design will be effective in meeting the conservation goals for burrowing owls.

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21 FERRUGINOUS HAWK (FEHA)

Prepared by Todd Sloat Biological Consulting (Todd Sloat)

Ferruginous Hawk (FEHA)

(Buteo regalis)
Status USFWS: None

Status CDFG: None

21.1 Legal Status

Ferruginous hawk (*Buteo regalis*) is legally protected under the federal Migratory Bird Treaty Act (16 U.S.C. 703-712) and California Fish and Game Code (Sections 3503.5 and 3800).

21.2 Life History and Ecology

21.2.1 Species Description and Life History

21.2.1.1 Physical Description

Ferruginous hawk is a large broad-winged hawk that occurs in two morphs (light and dark) with no intermediate morph. The dark morph is less frequent. Adult light morphs are rust colored on the back and shoulders, with a pale head, and white tail with pale rust washings. When observed in flight from below, the species appears mostly white, with a rufous "V" patch that is formed from the leg feathers. Observed from above, a white crescent-shaped patch is distinctive in the outer primaries. Dark morphs have a deep brown-colored head and body, upper-and lower-wing surfaces, and tail coverts. The back and breast are a dark rufous color. The tail, primaries, and secondaries are white or pale (Bechard and Schmutz 1995; Sibley 2000; Udvardy 1998). Adults are not sexually dimorphic in plumage, but females tend to show more pigmentation on the legs and belly (Bechard and Schmutz 1995).

Juvenile light morphs are generally similar to adults; however, the darker colored feathers are more brown than rufous. When observed from below in flight, juvenile feathers are more white or pale as compared to adults. They also lack the rufous "V" shape that is formed from the leg feathers on adults. Like light morphs, juvenile dark morphs are similar to adults, but have feathers that are more brown than rufous. In both morphs, juvenile iris color is pale, while adult iris color is reddish-brown (Sibley 2000).

21.2.1.2 Reproduction

Ferruginous hawks do not regularly breed in California, with the most recent breeding being recorded in 1989 in northeastern California (Harlow and Bloom 1989). Since the species is not a regular breeder in California and has not been recorded breeding in the Central Valley, reproduction will not be discussed in detail in this account.

Ferruginous hawks are apparently monogamous, and pairs initiate nesting mid-March to mid-April depending on location (Bechard and Schmutz 1995). Clutch size in this species is larger than in most raptors, generally ranging from two to four eggs, but occasionally ranging up eight eggs in years of high prey abundance (Smith and Murphy 1978). Both sexes participate in nest building. Nests are most often located in trees and shrubs, followed by cliffs, utility structures, and ground outcrops (Olendorff 1993). Incubation is estimated to range between 32 and 33 days (Palmer 1988), while young leave the nest between 38 and 50 days after hatching (Powers 1981 *in* Bechard and Schmutz 1995).

Suitable nesting sites have declined in some portions of the breeding range given that isolated trees are uncommon, many have fallen, and little new regeneration is occurring. Furthermore, ferruginous hawks may experience reduced reproductive success due to harassment by later arriving Swainson's hawks and competition for nest sites (Leslie 1992). Establishment of artificial nesting platforms in regions with limited available nest sites has proven successful in addressing this issue (Bechard and Schmutz 1995).

21.2.1.3 Longevity, Survival, and Mortality

Maximum potential longevity is believed to be 20 years of age (Lloyd 1937; Houston 1984 in Bechard and Schmutz 1995). The oldest known age of a wild ferruginous hawk is 17 years 11 months. Banding data from Schmutz and Fyge (1987) was used to estimate first year mortality at 65 percent, while reoccupancy of nest data from Woffinden and Murphy (1989) has been used to estimate annual adult mortality at 25 percent.

Ferruginous hawks fall prey to birds and mammals. Great horned owls (*Bubo virginianus*) take nestlings, common ravens (*Corvus corax*) and American crows (*Corvus brachyrhynchos*) prey on eggs and nestlings, and ground predators such as coyotes (*Canis latrans*), American badgers (*Taxidea taxus*), and foxes (*Vulpes* spp.) may be a serious threat to ground-nesting pairs and young after fledging (Bechard and Schmutz 1995).

Other sources of mortality include illegal shooting, presumed collisions with automobiles, and high-tension wire collisions or electrocution (Gossett 1993). Olendorff (1973) also reported that eggs and young are killed when blown or pushed from nests.

21.2.1.4 Dispersal Patterns

Band return data for juvenile ferruginous hawks from the first 90 days after banding found that 48 individuals moved less than 15.5 miles from their natal site, while 33 individuals dispersed as far as 1,056 miles (Gossett 1993 in Bechard and Schmutz 1995). No other dispersal information is available for the ferruginous hawk.

21.2.1.5 Diet and Foraging

Prey selection by ferruginous hawks is determined primarily by availability (Steenhof and Kochert 1985 *in* Bechard and Schmutz 1995). Some individuals have even been reported to forage on prairie dogs (*Cynomys* spp.) immediately after the prey was shot by squirrel hunters (Chesser 1979).

Ferruginous hawks opportunistically forage at times during the day when their main prey items are available. Four types of prey pursuit have been described and include: 1) still hunting from perches with flights of less than 100 meters to capture prey; 2) short-distance strikes originating from the ground; 3) aerial hunting; and 4) hovering. No communal feeding has been reported, though 10 to 20 ferruginous hawks have been observed standing or perching in the same general area (Bechard and Schmutz 1995).

Mammals are the most common food items with rabbits and hares (*Syvillagus* and *Lepus* spp.), ground squirrels (*Spermophilus* spp.), and prairie dogs *Cynomys* spp.) comprising most of the food consumed by adults and juveniles throughout the year. Bechard and Schmutz (1995) summarized ferruginous hawk prey reported from several studies throughout the species' range by percent occurrence and percent biomass. Mammals were most frequently preyed upon (83 percent) and constituted 95 percent of the food biomass, while birds were the second prey group most frequently eaten (13 percent), but only constituted 3.8 percent of the food biomass. Amphibians, reptiles, and insects were also consumed, but were found to be much less frequent and comprised less than one percent of the food biomass. No food habit studies of wintering ferruginous hawks in California have been conducted.

21.2.1.6 Movement and Migration Patterns

The ferruginous hawk is a migratory species in the northern part of its breeding range, but little is known regarding migration for southern nesting individuals. Fall migration of juveniles begins in early August, while most ferruginous hawks migrate in September and October. Adults begin migration later in August and peak migration occurs in late October and early November. Migration of both juveniles and adults is completed by the end of November (Bechard and Schmutz 1995).

Spring migration is different in that hatch-year birds migrate later than adults. As with most bird species, the migration period of ferruginous hawks is shorter during spring. Adults migrate between mid-February and early April, with peak activity occurring during the month of March. First year birds start spring migration in early April, peak between mid-April and mid-May, and finish with the latest migrating individuals leaving in early June.

Most individuals that winter in California are believed to have originated in the states west of the continental divide. Gossett (1993) used band recovery data to calculate that 4.1 percent of eastern nesting birds were recovered west of the continental divide, while 27.5 percent of western birds were recovered east of the divide. In California, Garrison (1990) reported that 66 percent of band recoveries were from breeding populations west of the Rocky Mountains, while the remaining recoveries were from the north and east. Fidelity to wintering areas by migratory individuals is unknown (Bechard and Schmutz 1995).

21.2.1.7 Territoriality/Home Range

Bechard and Schmutz (1995) suggest that the ferruginous hawk may defend winter territories. Winter densities in Utah have been reported at one individual per 3.60 square miles (Smith and Murphy 1978), while Plumpton and Andersen (1997) found a mean daily minimum convex polygon home range size of 1.36 square miles. Data on nesting territory size has been reported by several researchers and may also be useful as an estimate for winter habitat requirements (Hunting 2001). Breeding home ranges have been reported between 2.28 and 2.93 square miles per pair (Smith and Murphy 1978; Bechard and Schmutz 1995).

21.2.1.8 Ecological Relationships

Ferruginous hawks depend on a small number of prey species for their main food items. Consequently, population cycles and abundance of these species are highly correlated with the number of breeding pairs, eggs laid, and young fledged (Thurow et al. 1980; White and Thurow 1985; Woffinden and Murphy 1989; Steenhof and Kochert 1985; Schmutz and Hungle 1989 *in* Bechard and Schmutz 1995).

21.2.2 Habitat Requirements and Ecology

The ferruginous hawk is considered an “open country” species that inhabits the grasslands, shrub steppes, and deserts of western North America. Since the species does not regularly nest in California, only the habitat requirements and ecology of wintering ferruginous hawks will be described herein. During the winter, ferruginous hawks use grasslands and arid areas, particularly where pocket gophers, ground squirrels, rabbits, or prairie dogs are abundant. Ferruginous hawks also winter near cultivated fields that support populations of pocket gophers (Bechard and Schmutz 1995), and are known to use urban open space grasslands as long as prey is available (Berry et al. 1998).

Few field studies of the ferruginous hawk have been conducted in wintering areas, and none are known for the Central Valley of California. Therefore, descriptions of the species' winter habitat requirements in California are based mostly on the personal observations of birders. Manolis (pers. comm.) has observed ferruginous hawks in open grassland habitats and non-vineyard agricultural areas in the Plan Area. Characteristics of these grasslands and agricultural lands are that they support abundant prey and include friable soils (for digging and burrowing), moderate to dense vegetative cover (particularly grasses), and some topographic variation (West pers. comm.).

Ferruginous hawks wintering in Utah have been found in higher numbers in irrigated pastures and dry croplands (Brouse 1999). The spatial requirements of ferruginous hawks during winter have not been widely reported (Bechard and Schmutz) and what constitutes the minimum size of suitable winter foraging habitat is unknown for most areas. In Colorado, Plumpton and Andersen (1997) found a mean daily minimum convex polygon home range size of 1.36 square miles. The minimum patch size for ferruginous hawks is likely affected primarily by prey availability, but also by the juxtaposition of the site relative to other suitable habitat, and by surrounding land uses. Ferruginous hawks generally roost individually, but sometimes roost communally in groups of up to 24 birds (Olendorff 1993).

21.2.2.1 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for ferruginous hawk are identified in Table FEHA-1 and have been derived from input from local species experts. This species does not nest within the Plan Area and therefore essential habitat elements for nesting is not included.

Table FEHA-1
Essential Habitat Elements for Ferruginous Hawk

Essential Activities	Land Cover Types	Habitat Elements
Foraging	Blue oak savanna, cropland, irrigated pasture grassland, and valley grassland.	Abundant rodent populations.

21.3 Species Distribution and Population Trends

21.3.1 Species Distribution

Ferruginous hawks nest in western North America, from southern Saskatchewan and Alberta south to central New Mexico and Arizona, east to the Great Plains, and west to central Nevada and Oregon. Nesting occurs in 17 states and three provinces in western North America (Bechard and Schmutz 1995).

The winter distribution includes the southwestern United States and northern Central America. In California, ferruginous hawks occur commonly in each of the eight geographic regions used in analysis of the National Audubon Society's Christmas Bird Count (CBC) data (Garrison 1990). In each region, ferruginous hawks were reported to occur in over 22 percent (range 22 to 56percent) of CBC's between 1950 through 1988. When CBC data was standardized by search effort, Ferruginous hawks were most commonly observed in the North Interior, followed by the South Interior, Central Coast, and South Coast. Fewer individuals were found in the North and South Sierras, North Coast, and Central Valley.

Analysis of more recent CBC data found more ferruginous hawks in the Sierra Nevada, Cascades, and Inner Coast Range physiographic regions than other regions. Regions reporting moderate numbers of ferruginous hawks included the South Coast, Central Coast, and Central Valley. Those regions reporting the fewest ferruginous hawks included the Mojave and Colorado Deserts, North Coast, and High Desert (Hunting 2001).

21.3.2 Central Valley Distribution

Ferruginous hawks were detected regularly on more than 97 percent of the CBCs in the Central Valley between 1980 and 1997 (Hunting 2001); however, no additional data analysis on these records has been reported.

21.3.3 Range within the Plan Area

Observations of ferruginous hawk in the Plan Area are primarily opportunistic sightings of individuals by birders or observations during CBCs. Most observations of ferruginous hawks have been reported from open grassland habitats in the eastern portion of the Plan Area from Interstate 50 south to Howard Ranch (Manolis pers. comm). Winter observations have also been recorded from non-vineyard agricultural habitats in the south and southwestern portions of the Plan Area. There are three previously recorded occurrences of ferruginous hawk reported to the CNDDB within Sacramento County, all of which are within the UDA (CDFG 2010). Figure FEHA-1 shows the occurrences within the Plan Area according to CNDDB (CDFG 2010) and other sources (ebird.org 2005-2010).

21.3.4 Population Levels and Trend

The ferruginous hawk range-wide population was estimated at between 5,842 and 11,330 individuals between 1990 and 1995 (Olendorff 1993). In the grasslands of the Great Plains, Schmutz et al. (1992) estimated 14,000 individuals; however, no range-wide breeding population or California wintering population estimates have been conducted to date (Bechard and Schmutz 1995, Garrison 1990).

Garrison (1990) analyzed CBC data and found the species winters throughout the state. Analysis was grouped in eight regions and two time periods (Table FEHA-2). The greatest number of ferruginous hawks occurred in the North Interior, Central Coast, South Coast, and South Interior regions.

Table FEHA-2
Measures of Abundance for Wintering Ferruginous Hawks in California based on Christmas Bird Count Data Between 1949-1988 (Garrison 1990)

Region	N (#)	% of CBCs with Ferruginous hawks	Avg. No. Ferruginous hawks/CBC	Avg. No. Ferruginous hawks/100 party mi.
North Coast	17	32.5	0.64	.20
North Interior	6	56.8	2.51	1.07
North Sierra	4	28.6	0.50	0.16
Central Valley	21	36.5	0.94	0.33
Central Coast	19	34.4	1.40	0.65
South Sierra	7	22.4	0.31	0.28
South Interior	14	35.0	2.25	0.78
South Coast	23	37.0	1.63	0.63

Regional populations have been documented as both increasing and decreasing; however, the North American population is generally considered to be declining (Bechard and Schmutz 1995). In California, Garrison (1990) and Hunting (2003) used CBC data to investigate trends and found increases in wintering ferruginous hawks. Although many comparisons between time periods (1949-1969 compared with 1970-1988) within regions lacked adequate sample sizes, ferruginous hawks were significantly more frequent and more individuals were observed per CBC in the Central Coast and South Coast regions. No significant differences were found in the North Coast and Central Valley regions, although the Central Valley showed increases in the percentage of ferruginous hawks/CBC and more individuals/CBC. Garrison provided several reasons why the recorded increases in wintering birds may be artificial, and could not unequivocally conclude these increases were "real."

More recent analysis of CBC data by Hunting (2001) also reported increases in wintering ferruginous hawks (Table FEHA-3). Both mean ferruginous hawk detections per count circle and mean number of count circles detecting ferruginous hawks increased in six of seven physiographic regions with a decrease noted only in the South Coast region. Some increases, however, were attributed to an increase in the absolute number of count circles (Hunting 2001).

Table FEHA-3
Mean Ferruginous hawk Observations (Circles Detecting Ferruginous hawks) for Each of Seven California Physiographic Regions[1]

Physiographic Region	Mean Count Circle Observations (Circles) 1980-89	Mean Count Circle Observations (Circles) 1990-97	Numeric (percent) Change
North Coast	2.43 (4.8)	2.76 (7.5)	0.33 (12.1)
Sierra Nevada, Cascades and Inner Coast Range	3.53 (2.2)	8.14 (3.8)	4.61 (56.7)
Great Central Valley	2.73 (11.6)	4.43 (14.7)	1.7 (38.5)
Central Coast	2.70 (20.4)	4.63 (27.0)	1.93 (41.7)
South Coast	5.06 (13.6)	4.77 (15.8)	-0.29 (-6.1)
Mojave and Colorado Deserts	3.17 (4.2)	3.83 (4.7)	0.66 (17.4)
High Desert, Mono and Inyo Counties	0.33 (0.2)	1.30 (0.8)	0.97 (77.5)
Mean Observations[2]	3.27 (+-0.96)	5.22 (+-2.88)	

1 Table copied from Hunting 2001
2 Due to small sample size, values for High Desert, Mono and Inyo Counties omitted from calculation

21.4 Threats to the Species

Threats to ferruginous hawks occur in their breeding and wintering areas; however, since this species does not regularly nest in California, only threats in their wintering areas will be discussed in this account. Also, some historical threats such as egg collection, which occurred from 1900 to 1930 (Bechard and Schmutz 1995), no longer occur and are not considered a key factor in population declines (Bechard and Houston 1984; Bechard and Schmutz 1995). The use of organochlorine pesticides between the 1940's and 1960's also caused severe reductions in raptor populations from secondary poisoning. These pesticides have been banned in the United States since the 1970's, although they are still used in Central and South America (Sibley 2000).

21.4.1 Habitat Loss and Alteration

Foraging habitat (i.e., grasslands) for ferruginous hawks has been lost to urbanization or converted to agricultural crops that do not support prey species or are not used for foraging. Conversion of grassland habitats to urban and agricultural uses proportionately exceeds the conversion of any other habitat type in California (Ewing et al. 1988; Moore et al. 1990 *in*

Hunting 2001). DeHaven (2000) quantified changes in California cropping patterns and found that ferruginous hawk "friendly" habitats such as rangelands, grassland, and pastures have decreased. These habitats have been replaced by a variety of other crops (e.g., fruit and nuts, cotton, and vineyards) that are not used by ferruginous hawks, or by crops (e.g., vegetables and melons, tomatoes, beans, potatoes, sugar beets) that are suspected as having lower quality foraging value. Unlike other wintering raptors in California, ferruginous hawks do not use agriculture areas as frequently. Instead, they are more frequently found using natural habitat types such as grasslands and vernal pool/grassland complexes for foraging.

21.4.2 Shooting

Historically, raptors were illegally shot for sport like many other bird species (Bendire 1892; Cameron 1914; Salt 1939 *in* Bechard and Schmutz 1995). Shootings are still reported (Howard 1975; Harmata 1981), but decreases in the rate of band recoveries since the mid-1940's suggest a decrease in the numbers shot (Houston and Bechard 1984). Bechard and Schmutz (1995), however, suggest that shootings may still be a problem on the wintering grounds (Harmata 1981; Gilmer et al. 1985).

21.4.3 Pesticides

The control of ground squirrel and prairie dog populations with pesticides (i.e., strychnine) may affect ferruginous hawks (Hunting 2001). Eradication programs have decimated populations of these rodents. In addition, secondary poisoning has been documented for several raptors species; however, no studies have been found that document secondary poisoning of ferruginous hawks, and Bechard and Schmutz (1995) suggest pesticides pose little threat to the species.

21.5 Data Gaps and Conservation Implications

The ecology, status, and management of ferruginous hawks have received attention in recent years. However, there are several sources of uncertainty regarding ferruginous hawk and its requirements in the Plan Area. These data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

21.5.1 Population and Habitat Distribution within the Plan Area

Ferruginous hawks occur in suitable habitat within the Plan Area; however, their overall abundance and population structure are not well known. Land-cover types used by ferruginous hawks, such as grasslands, occur throughout much of the Central Valley and are well-represented in Sacramento County and the Plan Area; however, at most sites with these land-cover types, the status of ferruginous hawk is not known.

Because comprehensive surveys for ferruginous hawk in the Plan Area have not been conducted and because the existing occurrence data are based primarily on incidental observations (e.g., anecdotal records), the population size and important wintering areas of this species throughout the Plan Area are not known. Although the distribution of grasslands is mapped and quantifiable, the quality of habitat for ferruginous hawks within most of these areas is unknown.

These information gaps limit our ability to identify the best lands available for preserving ferruginous hawk habitat and accurately estimate the impacts resulting from covered activities.

Until this data gap is remedied, the conservation value of grassland and agricultural land-cover types for ferruginous hawk will be considered relatively high in lands that support (or recently supported) known occurrences, are large in extent, or are adjacent to these areas.

21.5.2 Landscape-level Habitat and Preserve Design Requirements for Viable Populations

The minimum habitat size and connectivity requirements for ferruginous hawk are not well documented. This causes uncertainty in determining whether the preserve design will be effective in meeting the conservation goals for ferruginous hawk.

21.5.3 Effectiveness of Mammalian Prey Population Enhancement Measures in Improving Foraging Habitat for Ferruginous Hawk

Achieving the conservation goals and objectives for ferruginous hawk may require successful enhancement of mammalian prey populations. Mammalian prey populations, particularly leporids and ground squirrels, should be passively or actively promoted on all lands acquired and managed for ferruginous hawk habitat. However, whether these efforts will succeed at increasing the available prey base and enhancing habitat for ferruginous hawk is unknown.

21.5.4 Other Data Gaps

Other data gaps that could be important for ferruginous hawk conservation include: 1) responses of ferruginous hawk populations to habitat management and enhancement techniques; 2) prey population dynamics and cycles; and 3) an appropriate livestock grazing and fire regime appropriate for ferruginous hawk habitat management and enhancement.

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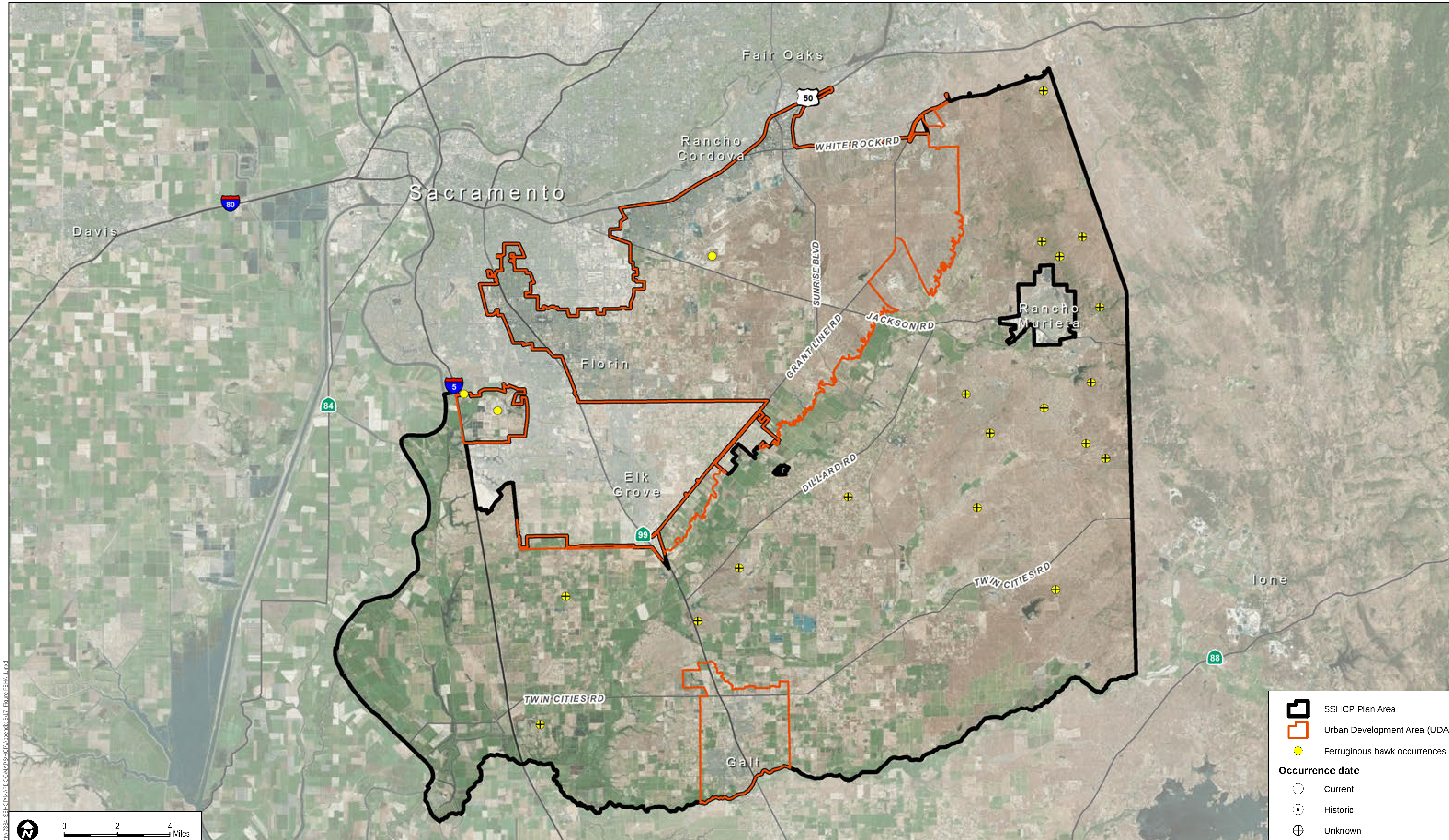

SOURCE: Bing Maps, County of Sacramento 2014, CDFG 2012, ebird.org

FIGURE FEHA-1

Ferruginous Hawk Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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22 SWAINSON'S HAWK (SWHA)

Prepared by Waldo Holt

Swainson's Hawk (SWHA)

(Buteo swainsoni)
Status USFWS: None

Status CDFG: Threatened

22.1 Legal Status

Swainson's hawk (*Buteo swainsoni*) is a migratory bird that is provided protection by the Migratory Bird Treaty Act of 1918. In 1983, the California Fish and Game Commission, acting on the recommendation of the California Department of Fish and Game (CDFG), listed the Swainson's hawk as a Threatened species, thereby providing protection under the California Endangered Species Act (CESA).

22.2 Life History and Ecology

Swainson's hawk is a member of the genus *Buteo*. Other members of this genus that are found on an annual basis in the South Sacramento Habitat Conservation Plan (SSHCP) area (i.e., Plan Area) include two resident species: red-shouldered hawk (*B. lineatus*) and red-tailed hawk (*B. jamaicensis*). Although many red-tailed hawks are resident in the Sacramento Valley, substantial numbers of red-tailed hawks from other portions of western North America migrate to and overwinter in the Plan Area each winter. Two additional *Buteo* spp. also are found in the Plan Area, but are strictly winter visitors and do not nest in the Plan Area: ferruginous hawk (*B. regalis*) and rough-legged hawk (*B. lagopus*). Swainson's hawk is a summer visitor that nests in the Plan Area, but winters in Central and South America. Swainson's hawk is not closely related to the other *Buteo* spp. in the Plan Area. It is thought to be most closely related to Galapagos hawk (*B. galapagos*) and white-tailed hawk (*B. albicaudatus*) (Palmer 1988).

22.2.1 Species Description and Life History

22.2.1.1 Adult Description

The Swainson's hawk is a medium-sized *Buteo*, weighing 1.5 to 2.5 pounds. It is less than two feet long and has a wingspan of approximately four feet. In general, it is slightly larger than a red-shouldered hawk, but it is slightly smaller than the other *Buteos* in the Plan Area. It appears more slender than other *Buteos* due to its relatively long tail and more pointed wings. When perched, the wingtips extend to the tip of the tail. When in flight, the wings are extended in a shallow "U" shape. This slight dihedral silhouette in flight and the more pointed wings are good field marks for distinguishing Swainson's hawks from other flying *Buteos*.

Adult Swainson's hawks, like several other *Buteos*, have different color variations. These color variations are referred to as "morphs" that are generally described as one of the following: light, rufous, intermediate, or dark. These are not discrete color variations, but represent attempts to broadly classify what is a continuum of variation in color. The color variation is readily observed on the underside of the bird and is largely confined to the lower belly, underwing linings and throat. Color on these feathers can range from almost completely white to almost completely black but is usually between these extremes, and is most often represented by brown or rufous speckling, or bars, or washes of color. Clark and Wheeler (1987) noted that dark morphs represent only one to 10 percent of local populations in the Swainson's hawk's entire breeding range, and that the overwhelming majority of individuals are light morphs. However, in the Central Valley roughly 33 percent can be classified as light morph and another 33 percent as dark morph, while the remaining 33 percent are an intermediate morph that has some of the characteristics of dark morphs (Estep 1989; England et al. 1997).

The eye of the adult is dark brown. The hooked, medium-sized beak is dark with a yellow cere (the unfeathered nasal area at the base of the upper mandible). There can be a varying amount of white feathering just above the cere. Otherwise, the feathering on the head is a solid brown to chocolate-gray. This color spreads down the nape and the back to the rump, and extends onto the upperwing coverts (feathers covering the forward part of wing). The chin and throat color is variable. In lighter individuals the chin can have a squared-off white patch. While darker individuals can lack this patch entirely with the chin and throat being completely brown. On other individuals the chin and throat patch can be streaked or otherwise partially present. The breast is always a solid brown bib, with a well-defined horizontal demarcation between breast and belly that is most prominently observable on light morph individuals. Much of the underparts are variable in color. The belly, flanks, axillaries, and underwing coverts can be anything from an immaculate white to rufous or a very dark brown. Throughout most of the species' range, its underparts are usually white, however, in the Central Valley, a multitude of color variations are found. The majority of birds in the Central Valley exhibit characteristics of dark or intermediate morphs.

Swainson's hawks of all color morphs have dark gray remiges (i.e., the large primary and secondary flight-feathers). In all morphs, one can see contrast between the brown coverts and darker flight-feathers of the upperwing. The contrast is most prominently seen on the underside of the wings. When viewed from below, the darker gray trailing edge of the wings stands out against the lighter underwing coverts. This field mark is widely used to identify the species and, though less pronounced, is even evident on most dark morph Swainson's hawks.

The undertail coverts (feathers between vent and tail on underside) are white, often with some amount of sparse brown barring. This is the case with all color morphs of the species. The tail is a light gray-brown with numerous darker horizontal bands. The sub-terminal band is a bit wider. The prominence of these bands is variable and tends to become fainter toward the base of the tail. The tail can sometimes appear to be slightly reddish when viewed from below (especially when sunlight is shining through it). The legs and feet are yellow or yellow-green while the talons are black.

22.2.1.2 Sub-Adult Description

Juveniles are similar in size and shape to adults, but have coloration different plumage. The eye is lighter and gray. The head is mainly brown, forehead white and crown streaked. The supercilium (line above eye) is pale, while the cheeks and throat are buffy with dark brown malar streaks (lines at sides of throat). The back and upper wing coverts are brown with buffy edges to the individual feathers. The primary and secondary flight-feathers are dark. The underparts are creamy to buffy, with varying amounts of dark brown spotting. The breast does not have a well-defined bib (unlike in adults) and is buffy with dark brown irregular spots. The tail is usually more distinctly banded with the sub-terminal band not noticeably wider. The cere, legs and feet are yellow, while the talons are black. Individuals that will ultimately attain a dark or light plumage as adults are noticeably more heavily or, conversely, less heavily spotted respectively as juveniles. Second-year plumages are best identified by the juvenal plumage features that are retained: the pale supercilium on a head that usually is otherwise paler than in the adult plumage; the breast is not yet a solid, well-defined bib, but can have irregular dark blotches; and the tail can be less evenly banded.

22.2.1.3 Sexual Dimorphism

Female Swainson's hawks are, on average, larger than males. Total length of males is 48 to 51 centimeters and mass is 693 to 936 grams, while females are 51 to 56 centimeters long and weigh 937 to 1367 grams (J.K. Schmutz *in* Palmer 1988). In the Central Valley of California, sexual dimorphism is apparent in the color morphs. The female, in virtually every mated pair in the Central Valley is the darker of the pair (Estep 1989; Holt pers. obs.). Females, therefore, tend to account for more of the dark morph individuals, while more of the light morph individuals are male. Clark and Wheeler (1987) notes that "(B)irds of each color morph tend to mate preferentially with their own morph." Sharp (1902) noted that the ample Swainson's hawk population that once existed in southern California was exclusively dark morph. Heerman (*in* Cassin 1856) reports a "new species" of hawk from the Central Valley of California that he calls the "black hawk" (*Buteo insignatus*). It is evident from his description and an illustration made from specimens that he was referring to female dark morph Swainson's hawks standing next to fledgling Swainson's hawks near nests. No description of an adult male Swainson's hawk is given by Heerman.

22.2.1.4 Longevity

Data concerning longevity is not abundant. A recovered band from an individual killed in Argentina indicated an age of 19 years six months (Woodbridge *et a*l. 1995b). A female observed at a nesting site in the Butte Valley, California was banded nearby as a nestling 24 years earlier (Bradbury pers. comm. 2004). These individuals likely are representative of the maximum lifespan for the species.

22.2.1.5 Age at Sexual Maturity

Sexual maturity is perhaps achieved by the third year (Cameron 1913). Instances of breeding at two years have been observed (Woodbridge et al. 1995a). In the Central Valley, individuals in sub-adult plumage have been observed paired with an adult and attempting to breed, but most encounter difficulties, probably due to inexperience, and fail entirely or loose chicks from starvation (n=5, Holt unpubl. notes). Individuals, once mature, are capable of breeding annually throughout the remainder of their life.

22.2.1.6 Reproductive Strategy

Mated pairs are largely reported to establish nesting territories that are in the same general area from where they were hatched (Woodbridge et al. 1995a; Gilmer and Stewart 1984; Bechard 1980). Pairs are monogamous and can remain together for many years (England et al. 1997). Site tenacity is evident, as the same individuals will return year after year to the same nesting territory (England et al. 1997). Estep (1989) had each of nine color-banded individuals return in successive years (1986-87) to the same nesting territory in the Central Valley. Pair bonding and courtship can take up to several weeks. A pair bond is formed while engaging in: soaring together in the nesting territory, displays of leg-dragging while soaring, undulating swoops, calling to each other, food sharing, copulating and, nest building. Nest building takes one to two weeks and eggs are laid approximately one week after copulation (Fitzner 1980). Clutch size is between one to four eggs. The female does almost all of the incubating of the eggs with the male incubating only briefly to allow the female a respite and an opportunity to stretch her wings. The male provisions the female during incubation and continues provisioning the female and chicks into the nestling and fledgling stages, at which time the female assists with provisioning from areas closer to the nest (Estep 1989; England et al. 1997).

Throughout the North American breeding range, adults arrive on nesting territories in March to May, lay eggs between April and June, and the young fledge between June and August (England et al. 1997). The Central Valley population is disjunct from the remainder of the species breeding range. The Central Valley has a relatively warmer climate than many other parts of the species' breeding range; therefore, the nesting season proceeds a bit earlier than in the more intemperate parts of the range. In the Central Valley, Swainson's hawks arrive at nesting territories from mid-February to the first week in April. Eggs are laid April to mid-May and fledging takes place from mid-June through early August (Swainson's Hawk Technical Advisory Committee 2000; Holt pers. obs.). The latest known nesting dates from the Central Valley population are associated with a nest in Yolo County and another in Sacramento County in 2003. Due to unrelenting inclement weather in April of that year, initial nesting attempts of these pairs were interrupted and secondary nest building and egg-laying took place as late as May 19 to 23 (Holt pers. obs.). Nest-building generally takes one week (Fitzner 1980). Egg-laying involves the laying of a single egg every other day until the clutch is completed (Fitzner 1980). The incubation period is 34 to 35 days (Fitzner 1980). Chicks take two to four days to hatch (Fitzner 1980). Chicks are altricial (helpless) and hatch asynchronously. This allows the first chicks that hatch to get a head start on their younger siblings. The first chick is able to beg for food earlier than the younger chicks and therefore, gains extra strength so that in those years when food resources are short, the available supply will go only to the older chick(s). This strategy ensures the survival of the largest number of offspring that the food resources will allow when the abundance of food for chicks cannot be predicted at the time when eggs are laid. With asynchronous hatching, the smallest chicks will not garner their fair share when times are tough and will only survive in years of abundant resources. Elimination of the smallest chicks usually occurs by starvation as a result of competition with their more developed siblings.

Chicks develop in the nest for 27 to 33 days (Fitzner 1980) before they are able to walk or hop onto nearby limbs (branching). First flight (fledging) takes place between 38 to 46 days (Fitzner 1980). For the first seven to 10 days after first flight the young stay near the nest (Fitzner 1980). The parents continue to feed the young for one month (Fitzner 1980). After that, the fledglings must fend for themselves. They then range widely in search of prey, covering up to one hundred miles in a day and associate in loose groups with other fledglings (Anderson et al. in progress).

The pair bond and parental bonds are then relinquished and adults and juveniles migrate separately in autumn (Woodbridge et al. 1995b; Bradbury et al. in prep).

Multi-year studies addressing reproduction have documented the mean number of fledged young per nesting attempt. The high is 1.67 fledglings per attempt (Bednarz 1988), while the low is 1.11 fledglings (England et al. 1995). Eight studies from six states and one province document 2,023 chicks fledged out of 1,444 nesting attempts for an average of 1.40 fledglings per nesting attempt (synthesized from England et al. 1997). It is assumed that a high percentage of first-year individuals do not survive to breeding age, but data concerning survivorship and recruitment is currently inadequate to address this question.

22.2.1.7 Seasonal Movements

At the conclusion of nesting when fledglings no longer are dependent upon adults, Swainson's hawks become gregarious and nomadic. Nesting territories and local foraging areas are abandoned and no longer defended. Large flocks of Swainson's hawks join together and range widely in pursuit of prey. They roost communally in trees at night. These flocks are loose associations joined primarily to exploit a common prey source and are not necessarily concerned with pre-migratory staging (Johnson et al. 1987). They remain gregarious and nomadic throughout the entire non-nesting period.

The Swainson's hawk is a neotropical migrant. Migratory movements of the atypical, disjunct Central Valley population are discussed below. The overwhelming majority of the population funnels through the Isthmus of Panama each Boreal autumn/Austral spring and then returns through Panama each Boreal spring/Austral autumn. In migration, they stay over land and do not attempt over-water crossings of extended length. They are reported to roost in trees or on the ground at night in Central America (Smith 1980; Smith et al. 1986).

Migration routes are primarily east of the Rocky Mountains and down the eastern coast of Mexico through Central America and over mountain passes in the Andes in Columbia. The return trip north covers roughly similar routes, only in reverse (Palmer 1988; England et al. 1997). They travel diurnally, seeking thermal updrafts and soaring upward in circles, barely flapping their wings. They then glide for as far as they can go, taking advantage of updrafts with skill while efficiently conserving stored fat reserves (Smith 1980; Smith et al. 1986). They will surf along weather fronts, using the change in air pressure to coast great distances with as little wasted effort as possible. Great masses of Swainson's Hawks have been observed passing over a single spot in Costa Rica or Panama (Smith 1973; Smith 1980). Brown and Amadon (1968) consider the immense migrating flocks of Swainson's hawks to be the most impressive avian gatherings in North America since the demise of the passenger pigeon.

During the Austral summer/Boreal winter, Swainson's hawks remain gregarious and nomadic. They use communal roosts at night (Woodbridge et al. 1995b; Bradbury et al. in prep). They flock together in pursuit of prey, which are almost exclusively insects such as swarms of locusts or dragonflies (Orlog *in* Smith 1980; Jaramillo 1993; Woodbridge et al. 1995b). Seasonal migration can involve many thousands of miles each way. Those that nest furthest north may face the extreme journey of a complete migration of 14,000 miles (Palmer 1988). Six to eight months is spent in migration and wintering, with each leg of migration capable of taking up to two months (Palmer 1988).

22.2.2 Habitat Requirements and Ecology with Emphasis on the Central Valley of California and Plan Area

22.2.2.1 Nesting Habitat

Swainson's hawks build their nests with sticks and twigs and some stems from other vegetation. A nest is about two feet in diameter and about one foot deep (England et al. 1997). In the Central Valley of California, there are about 25 different tree species that have been utilized for nesting (Holt pers. obs.; CDFG 2010). The most common nest trees are Fremont's cottonwood (*Populus fremontii*), oaks (*Quercus* spp.), willows (*Salix* spp.), walnuts (*Juglans* spp.), eucalyptus (*Eucalyptus* spp.), pines (*Pinus* spp.), and Deodar cedar (*Cedrus deodara*). They build the nest in the top part of the tree (Bloom 1980). Swolgaard (2004) found nests to be located on average at 79 percent of tree height (n=94). Estep (1989) found average nest height to be 81.8 percent of the average tree height (n=40). In oaks, the nest is often situated in smaller branches toward the top of the tree. In cottonwoods, willows and eucalypts it often is in a crotch of vertical branches. In cottonwoods, nests are also commonly placed atop large mistletoe clumps. Selected conifers are often ones that are very tall, frequently with the tops broken off, being flattened on top or having a large limb projecting from the side (England et al. 1995). In the Central Valley, Estep (1989) documents the mean height of nest trees in his study area at 57.7 feet and the mean height of the nest at 47.2 feet (n=40). In a study done on the Sacramento River (Moreno 1994), the mean tree height was 63.3 feet and the mean height of the nest was 50.6 feet (n=32). In northern San Joaquin County, Swolgaard (2004) found mean tree height to be 62 feet and mean nest height to be 49 feet (n=94). Mature tall trees provide extra safety from dangers below, sturdiness during storm events, and superior vantage points from which to assess potential threats and hunting opportunities.

Most nest trees are associated with riparian systems. Schlorff and Bloom (1984) found 87 percent of all Swainson's hawk's nests in the Central Valley to be associated with riparian systems. Within his study area in parts of Yolo, Sacramento and San Joaquin Counties, Estep (1989) found 78.1 percent of nest trees to be in riparian systems. This, however, is not due to any known affinity for aquatic systems by Swainson's hawks, but may reflect a relationship of superior nesting territories located adjacent to superior foraging habitat. Swainson's hawk's nests are also found well away from waterways in lone trees in fields and pastures, in trees along roadside edges, in small groves, around farm buildings, and in some urban areas.

Nest trees selected in riparian strips or groves are typically among the tallest trees in the stand and they are also situated at an edge of the stand. When in a grove, the nest tree is at the outer edge of the grove (Bloom 1980; Estep 1989). Curiously, in riparian strips a nest tree is typically on the riverside edge much more so than on the landside edge (Wilkinson and Levy 1993; Moreno 1994; Holt pers. obs.). This may be because a particular riverside tree may be taller than other nearby trees, it may have fewer disturbances at the river's edge, or it could offer the best vantage of the surrounding territory. Nest trees can also be found in close proximity to farm buildings (Bloom 1980; Swolgaard 2004); often in large, well-established, exotic tree species or relict natives. It is likely that a tradeoff exists between the amount of extra disturbance at farm buildings versus the safety of a truly superior nesting tree. Or, it may simply be that a marginally suitable nest tree occurs in an agricultural landscape of cleared open fields that is a vastly superior territory.

22.2.2.2 Urban Nesting

Nesting in completely urbanized areas is an unusual phenomenon that has recently been discovered in some particular urban settings: 1979 in Davis (P. Bloom pers. comm.) and 1983 in Stockton (D. Yee pers. comm.). England et al. (1995), reported on a five-year study that compared urban-nesting Swainson's Hawks in Davis and Stockton with nearby rural-nesting populations. They found that urban-nesting Swainson's hawks selected nest trees that were among the tallest trees and the trees were either exotic conifers or relict native trees that existed prior to the human constructions. Conifers were particularly selected in urban landscapes: 79 percent in Davis (n=14) and 94 percent in Stockton (n=17). Nests located at the top of 80-foot deodar cedars are common in Stockton (pers. obs.). From this height the hawks have unobstructed views in all directions. England et al. (1995) offered that the preference for conifers is due to their abundance in urban settings, they are the tallest trees, and the dense evergreen foliage and radial branching pattern provide extra screening from activity below.

Urban-nesting always occurs in association with suitable foraging habitat being relatively close to the nest (e.g., Stockton and Davis are surrounded in all directions by high quality foraging habitat in suitable agricultural crops). Comparatively, both Lodi, which is surrounded by vineyards, and Sacramento, with its urban sprawl, lack urban nests (England et al. 1995). At some point the energetic demands on the provisioning male of carrying prey items long distances outweighs the energy value gained. England et al. (1995) calculated that when suitable foraging habitat is beyond five to eight kilometers from suitable urban-nesting habitat, such as in Lodi and Sacramento, urban nesting does not occur. Furthermore, England et al. (1995) reported that the reproductive success of urban-nesting Swainson's hawks was lower than rural-nesting Swainson's hawks during the same period.

22.2.2.3 Nest Territory Characteristics

Although a nest territory can include only a single tree, it more typically has multiple trees. A lookout-perch that affords a good vantage of potential threats or hunting opportunities in the surrounding area is a necessary component of a nest territory. Such a perch can often be in a tree that is not the nest tree. In alternate years, a nest might be placed in a different tree within a nesting territory, but the same lookout-perch will be used. Multiyear studies (Wilkinson and Levy 1993; England et al. 1995) and long-term data collections (CDFG 2010) reveal that it is quite common to have alternate nesting sites within the same nest territory. This is necessary when the nest or nest tree from the previous year has been destroyed is appropriated by other raptors, or is found to be newly situated too close to a neighboring raptor's territory or to some other disturbance. The overall size of a nesting territory, as such, can vary substantially from year to year. Over the years, nest territories can dynamically shift, having differing shapes and components. Some nesting territories do remain constant, with the same nest in the same tree for many years, while others are subject to various changes on an annual basis (Holt pers. obs.; Estep pers. comm.).

Estep (1989) found that territories surrounded by preferred foraging habitats were defended more aggressively than territories surrounded by less-favorable foraging habitats. Furthermore, this suggests that a high quality nest territory and its associated foraging habitats and prey base is more important than a particular nest tree.

22.2.2.4 Nesting Density

Estep (1989) found, in four plots comprising a 374-square-mile study area in the Central Valley, the average distance between nests was 1.14 kilometers. This is the closest average spacing of Swainson's hawk nests recorded (England et al. 1997). It is attributed to riparian nesting habitat being largely contained in thin strips next to treeless agricultural fields of suitable foraging habitat, while in other parts of the breeding range conditions are more savannah-like with trees dotted throughout the foraging habitats.

22.2.2.5 Competition for Nest Territories

Selection of a poor nest site can be a factor in nesting failure. Competition exists for nest sites. Conflicts with red-tailed hawks and red-shouldered hawks, as well as white-tailed kites (*Elanus leucurus*) erupt into territorial fights over nest sites when Swainson's hawks arrive from spring migration and find a favored nest site occupied by another raptor. The Swainson's hawks begin nesting later in the year when other raptors have already selected nest sites and may be brooding eggs. Nesting raptors are not happy to be dislodged. Territorial fighting can go on for days and can include calling, swooping, stooping with talons outstretched, and even contact with strikes of sharp talons or wheeling in flight with talons interlocked. Swainson's hawks are often forced to accept a second choice in these interactions. They usually have little success evicting red-tailed hawks, but apparently fair better against white-tailed kites. Great-horned owls begin nesting months earlier and do not build their own nest. They appropriate existing raptor nests, including Swainson's hawk's nests that are left over from the previous year. Swainson's hawks have not been observed to succeed in evicting these large, predatory owls.

American crows (*Corvus brachyrhynchos*), yellow-billed magpies (*Pica nuttalli*), American kestrels (*Falco sparverius*), and western kingbirds (*Tyrannus verticalis*) often harass and mob Swainson's hawks at nest sites, but these smaller birds, while undoubtedly are annoying, have not been observed to thwart Swainson's hawks in their nest site selection.

Intra-specific competition between Swainson's hawks for nest territories also occurs, but such disputes have not been reported to rise to the level where breeding success is impacted.

22.2.2.6 Diet and Foraging

The Swainson's hawk is considered to be largely insectivorous, but breeding pairs are thought to switch to vertebrate prey due to the energetic demands of reproduction (Johnson et al. 1987). Locusts, grasshoppers, dragonflies, crickets, grubs, etc. are the major staple of the Swainson's hawk's diet (Palmer 1988; England et al. 1997). They snatch locusts and dragonflies out of the air with their talons and transfer the prey to their beaks while on the wing (Orlog *in* Smith 1980; Johnson et al. 1987; Jaramillo 1993). They hunt on the ground, sometimes running after grasshoppers and crickets (Bloom 1980; Johnson et al. 1987; Estep 1989). On their wintering grounds, Swainson's hawks are almost exclusively insectivores (Orlog *in* Smith 1980; Jaramillo 1993; Woodbridge et al. 1995b). They are known in Spanish-speaking South America as the locust hawk (aguililla de langosta) or the grasshopper hawk (aguililla de saltamontes). During migration, it is thought that they fast for much of the journey (Smith et al. 1986; Brown and Amadon 1968)

Returning spring migrants in northeastern California were measured to be eight to 14 percent lighter than adults that were weighed in July (Bloom pers. comm.).

During the nesting season dragonflies, grasshoppers, dobsonflies, crickets, etc. continue to be a part of the Swainson's hawk's diet (Grinnell et al. 1930; Bloom 1980; Johnson et al. 1987; Estep 1989). However, insects are not a primary food source for provisioning at the nest. They might be considered as just a "snack" that the male devours for himself (Estep 1989). Insects individually do not have very much caloric bulk. Instead, the male Swainson's hawk provisions its mate and offspring by switching to a variety of larger vertebrate prey. In Alberta and Saskatchewan, ground squirrels are the major prey item (Schmutz et al. 1980; Houston 1990). In Utah they have a preference for whitetail jackrabbits (Smith and Murphy 1973). In New Mexico, they prefer black-tailed jackrabbits (Bednarz 1988). In Arizona, they take a variety of lizards and snakes (Bednarz 1988). In North Dakota, the species takes pocket gophers (Gilmer and Stewart 1984). In Washington, pocket gophers and snakes are the major food items (Fitzner 1980; Bechard 1980). In northeastern California, voles and ground squirrels are a big part of the diet (Woodbridge 1985; Bloom 1980). Bird species are also a large component of their vertebrate diet everywhere (England et al. 1997). Overall, this paints a picture of the Swainson's hawk as an opportunistic hunter that can handle a variety of vertebrate prey depending upon the prey's availability in a given region.

Hunting techniques include snatching insects out of the air or running insects down on the ground as mentioned above. The Swainson's hawk takes much of its prey while foraging on the wing over open country. This is different from the red-tailed hawk, which hunts from perches with much more frequency, and red-shouldered hawks that hunt from perches almost exclusively. Vertebrate prey is captured usually by descending upon the targeted animal from the air. Besides soaring over open country looking for available prey, Swainson's hawks also commonly will stand on the ground and wait for a burrowing animal such as a gopher to reappear at the surface to pounce upon it (Bechard 1980; Holt pers. obs.). They are everywhere noted (Woodbridge et al. 1995b; England et al. 1997) to use farm machinery as a beater as tractors mowing or plowing in fields displace small rodents, birds or insects making them easy targets as they scurry for cover. Fire and flood-irrigation also provide events when Swainson's hawks take advantage of dislodged prey (Estep 1989). Swainson's hawks appear to look for and to key on these events knowing that they will produce available prey.

22.2.3 Foraging Habitats

22.2.3.1 Diet

Reproductive success for the Swainson's hawk in the Plan Area is directly correlated to the adults' ability to capture and deliver sufficient prey to successfully fledge young from the nest. Key components in this success involve prey densities, prey availability, and distance to the nest site. The Swainson's hawk is an opportunistic hunter that can handle a variety of vertebrate prey depending upon the prey's availability in a given area. In the Central Valley a wide variety of prey items are taken including: small mammals, birds, reptiles, and insects; however, the California vole (*Microtus californicus*) is the preferred prey item (Bloom 1980; Estep 1989; Babcock 1995; Swainson's Hawk Technical Advisory Committee 2000; Ron Schlorff pers. comm. 2003; Joe Papp pers. comm. 2004; Holt pers. obs.). Estep (1989) found that California vole was the single most important prey item in his study areas in Yolo, Sacramento and San

Joaquin counties. Eight species of mammal, including California vole, Botta's pocket gopher (*Thomomys bottae*), deer mouse (*Peromyscus maniculatus*), western harvest mouse (*Reithrodontomys megalotis*), Norway rat (*Rattus norvegicus*), California ground squirrel (*Spermophilus beecheyi*), house mouse (*Mus musculus*), and black-tailed jackrabbit (*Lepus californicus*),were found among prey remains and regurgitated pellets, with the California vole comprising 69.2 percent of all mammalian prey. Birds represented a very significant dietary component as well, with at least 15 different species found (including juvenile ducks and pheasants). Other species taken include Pacific gopher snake (*Pituophis catenifer*), western toad (*Bufo boreas*), crayfish species (*Pacifastacus* spp; *Procambarus* spp.), and numerous insects (mostly grasshoppers and crickets). J. Papp, a nest-tree climber who bands dozens of Central Valley Swainson's hawk nestlings each year in a long term telemetry study, confirms that the overwhelming majority of prey items in nests are California voles (Papp pers. comm.). While the variety of prey species that can be taken by Swainson's hawks is important to the nesting success of many Swainson's hawks, the consensus of field biologists who have examined prey remains or pellets and observed numerous prey captures and deliveries at nest sites is that the California vole is clearly the favored prey species of Swainson's hawks in the Central Valley (Babcock 1995; Bloom 1980; Bradbury et al. *in prep*.; England et al. 1995; Estep 1989; Schlorf pers. comm.; Swolgaard 2004).

Prey Availability

The availability of prey, rather than prey densities, appears to be the most important factor for foraging success (Estep 1989; England et al. 1997). Swainson's hawks in the Central Valley are very effective at exploiting prey when that prey is made available to them due to the effects of agricultural activities such as harvesting, disking, mowing, flood irrigating, and burning of fields (Palmer 1988; Estep 1989; England et al. 1997). These activities make prey available to predation by dislodging them or reducing their cover. Estep (1989) found that 12 radio-tagged Swainson's hawks spent 52.8 percent of their observed foraging time hunting in response to these activities. He also observed that 73.4 percent of all observed prey captures were made in association with these activities (n=143). Similar observations are noted in several other studies of Central Valley Swainson's hawks (Bloom 1980; Babcock 1995; England et al. 1995; Herzog 1996; Swolgaard 2004). The dense vegetative cover that is in place during the extended growing period of a particular crop provides good rodent habitat, allowing prey populations time to increase their numbers. The rapid removal of that cover then leaves prey species suddenly vulnerable to predation by Swainson's hawks.

Agricultural Foraging Habitats

In four study plots in Sacramento, Yolo and San Joaquin Counties, Estep (1989) analyzed agricultural habitats based on 724 hours of preference data gathered on 12 radio-tagged

Swainson's hawks between May 6, 1986 and September 12, 1987. He then ranked Swainson's hawk agricultural foraging habitats in descending order of importance: alfalfa, disked field, fallow, dry-land pasture, beets, tomatoes, irrigated pasture, grains, other row crops, and other. Estep (1989) also extensively trapped for small rodents in these habitats. Swolgaard (2004) did not use radio-tagged individuals, but did record 246 observations of Swainson's hawks foraging in agricultural habitats from April through August of both 2002 and 2003. His findings are generally corroborative of Estep's (alfalfa is high preference, vineyards are low, etc.). A discussion of agricultural foraging habitats ranked by Estep (1989) in descending order of preference is provided below.

Alfalfa is generally associated with the dairy industry. The process of harvesting alfalfa occurs four to seven times a year. The entire field is mowed and the cut hay is left to dry in a row. It is turned over on another day for further drying and on a later day, it is baled and removed. The field is then flood-irrigated and the whole process is repeated. Each of these activities provides a foraging opportunity for Swainson's Hawks. Swolgaard (2004) also rated irrigated hay (alfalfa) as clearly being the first preference. He observed that Swainson's hawk's foraging in alfalfa is correlated to harvest and irrigation, but further noted that there is a preference for alfalfa fields that are not in the first year of production. Alfalfa often stays in place for several years (three to seven years). This allows the population of voles and gophers to increase as the field becomes well established. After the alfalfa crop has run its course for a number of years, grains such as corn, oats, or wheat (crops also important as fodder for dairy cattle) are the most common crops that will be planted in that field for a few years before alfalfa is planted again.

Disked fields are fields in a temporary state of dormancy and are between crops. They constitute a small portion of the total amount of agricultural habitats that may be available at any one time. Because they lack vegetative cover, they also lack significant numbers of small rodents. Estep ranked them highly because it was a daily activity for some Swainson's hawks to spend time running down grasshoppers and crickets in these fields.

Fallow fields make up a rather small amount of total agricultural habitats. Unlike disked fields they have significant weedy vegetation and therefore have significant rodent populations. Swolgaard (2004) observed that 76 percent of foraging observations in this habitat were when machinery was removing vegetation.

Dry pasture is largely comprised of annual grasslands and is grazed primarily by cattle during some part of the year. A large portion of the Swainson's hawk's historical habitat is believed to be similar to this current habitat, although the prey species, their abundance, and availability are likely quite different today as introduced grasses and forbs and introduced grazers now dominate this habitat. Therefore, direct comparisons with historical conditions should be considered with caution. Estep's relatively high ranking of this agricultural habitat was based largely on two radio-tagged hawks that had nests immediately adjacent to this habitat. Therefore, they used dry pasture regularly during foraging. These same individuals were observed to use other habitats opportunistically in response to farming activities. The reverse was not observed. Swainson's hawks with nests not adjacent to dry pasture did not utilize dry pasture for foraging. Swolgaard (2004) observed Swainson's hawks foraging in this habitat, but noted that its frequency of use was lower than expected based on its availability

Sugar beets (which are no longer in production in Sacramento County) and tomatoes have been observed as a foraging habitat, but only for a short time when they are being harvested. Sugar beets were an important foraging habitat for Swainson's hawks because they could be harvested at different times of the year, resulting in staggered availability throughout the nesting season. Tomatoes, on the other hand, are harvested beginning in late July. The main harvesting period therefore occurs from late summer into autumn. Swainson's hawks are largely finished with nesting as the tomato harvest begins; however, tomato fields are observed to be important foraging habitats for fledglings and pre-migratory adults (Anderson et al. in progress; Holt pers. obs.). First-year mortality in Swainson's hawks is undoubtedly high and migration is a perilous journey. Therefore, tomato fields have important value for Central Valley Swainson's hawks immediately after nesting. Irrigated pasture is occasionally used for foraging. Estep (1989) noted use during periods when the pasture was being irrigated. Swolgaard (2004) observed use when the vegetative cover was at its lowest (grazed).

Grains include wheat, oats and rice. Wheat is a common crop in the Central Valley and Plan Area where it is typically planted in fall and harvested in the spring. Both Estep (1989) and Swolgaard (2004) observed limited foraging in wheat. Furthermore, foraging in this crop occurred primarily during or immediately after harvest. Estep trapped in harvested wheat where he found relatively low numbers of house mouse and deer mouse. Estep observed no foraging in rice fields.

Corn and sunflower are the main component of "other row crops." Estep (1989) considered that the low preference for foraging in these crops is a feature of these crops' attaining a vegetative height that excludes Swainson's hawks. Swolgaard (2004) also observed a low preference for foraging in these habitats. Estep trapped relatively low numbers of deer mouse in cornfields in early summer. However, as in other agricultural habitats, rodent populations build up during the growing season in cornfields. During the beginning of harvest, in September and early October, just prior to southern migration, Swainson's hawks take advantage of the foraging opportunity that corn harvesting offers (Herzog 1996; Holt pers. obs.). Therefore, corn and sunflower crops have some limited value to foraging Swainson's hawks. Also, when taken in combination with other foraging habitats that are rotated on a regular basis (wheat, oats, hay, tomatoes, alfalfa, disced field, etc.), the value of corn and sunflower acquires some added value as a piece in the over-all mosaic of suitable foraging habitats. Lastly, the small population of Swainson's hawks that winter in the

Sacramento – San Joaquin Delta forage for small rodents (mainly house mouse) almost exclusively in harvested corn and sunflower fields (Yee pers. comm.; Holt pers. obs.; Herzog 1996).

Other is a category where Estep (1989) groups various infrequently used habitats. Taken collectively these are the lowest ranked habitats and either have very low prey populations or are inaccessible to Swainson's hawks. These habitats include lawn, riparian vegetation, vineyards, orchards, residential areas, oak woodland, asparagus, onions, parks, golf courses, and edge habitats. It should be noted that Estep (1989) trapped a rather high rodent population, primarily house mouse and western harvest mouse, in edge habitats. Swolgaard (2004) grouped edge habitats differently and included them in a category he termed Ag-urban. His Ag-urban habitats included roadside edges, median strips, weedy lots, railroad right-of-ways, canal levees, and margins along a local airstrip. Swolgaard observed these areas to be used for foraging in disproportion to the small amount of area they covered in his study area. Furthermore, most foraging occurred when these edges were being mowed. Swolgaard noted that Estep had trapped rodents in high densities in edge habitats and cited references documenting voles using road edges as habitat corridors and dispersal routes (Getz *et a*l. 1978; LaPolla and Barrett 1993). Therefore, it may be appropriate to consider edge habitats separately because they may have value as prey refugia and corridors connecting agricultural habitats.

Common agricultural habitats in the Central Valley that are not thought to provide much, if any, foraging opportunities for Swainson's Hawks include safflower, orchards, cotton, vineyards, and rice (Bloom 1980; Estep 1989; England et al. 1995; Babcock 1995).

The purpose of Swolgaard's study (2004) was to determine habitat use by Swainson's hawks in the lower Mokelumne River watershed, an area in northern San Joaquin County adjacent to the Plan Area. The study area supports extensive viticulture. Swolgaard cites vineyard acreage increasing in this study area by 54 percent during the period 1987 to 1997 (DWR 2002). Swolgaard found that foraging by Swainson's hawks does occur in vineyards; however, statistical analysis of habitat selection revealed that foraging in vineyards occurred less than would be expected by random choice. It was evident that Swainson's hawks did not select for vineyards, and that foraging occurred in vineyards perhaps only by members of pairs whose nest trees are in areas that have now become surrounded by vineyards. Foraging was also observed disproportionately at edges of vineyards and along interior road edges of vineyards.

In summary, Swainson's hawks forage successfully in a variety of agricultural habitats. Alfalfa is the crop that provides the highest foraging due to high prey densities and regular harvesting and irrigation that make prey available for capture. However, a variety of suitable agricultural habitats also provide valuable foraging habitats at differing times and for different prey species during the period of time when Swainson's hawks are in the Plan Area. This mosaic of suitable foraging habitats that provides the best opportunity for regular and successful hunting during the nesting season.

Home Range Size

The home range (total area utilized during the nesting period) for Swainson's hawks in the Central Valley is reported as larger than for Swainson's hawks in general (England et al. 1997). Estep (1989) found mean home ranges to be 6,818 acres, while Babcock (1995) plotted 9,978 acres as the mean home range in his study area in eastern Yolo County. These large-sized home ranges are due to the fact that the best agricultural foraging habitats are fragmented. Estep (1989) and Babcock (1995) both observed Swainson's hawk home ranges to expand to include distant agricultural foraging areas when prey availability was superior at more distant locations. During periods of low prey availability, radio-tagged male Swainson's hawks were recorded to travel as far as 17 miles (Estep 1989) and 18 miles (Babcock 1995) from a nest to exploit more favorable agricultural foraging opportunities. Although at these distances, it was observed that prey items were consumed in the field and not transported back to the nest, likely due to the excessive energy demands required to do so (Estep 1989; Babcock 1995). England et al. (1995) discovered that urban nests, which are in some cases completely surrounded by unsuitable foraging habitat, must have suitable foraging habitat within three to five miles from the nest tree to successfully fledge young (England et al. 1995). Furthermore, urban nest sites typically fledged fewer young than non-urban nest sites.

Nest-site Selection

In the Plan Area nest-site selection is strongly correlated to alfalfa and row and field crop agricultural habitats. Almost all Swainson's hawk nesting sites are located in portions of Sacramento County where irrigated pasture, hay, grain and field crops are being cultivated even though suitable nesting habitat exists elsewhere in the county. For example, there are large cottonwood trees on numerous streams on the eastern side of the Plan Area, there is nesting habitat in the older urbanized areas of the county, and there are unused trees on Delta islands. However, Swainson's hawks are rarely selecting nesting sites in these areas. In each of these situations, the failure to select nesting sites in these areas appears to be related to the lack of nearby suitable foraging habitat throughout the entire nesting season.

Vineyards in the Plan Area are fragmented in distribution and have only recently been converted from other crop types in the last two decades. Viticulture has increased in Sacramento County by 263 percent during the period 1987 to 1997 (DWR 2002). Swolgaard (2004) found that Swainson's hawks do not prefer nest-sites in vineyard habitats; however, the species' avoidance of vineyards is not as strong in some nearby portions of the species' range (e.g., the Lodi area in northern San Joaquin County where vineyards have been a regular part of the landscape for more than 50 years).

Agricultural Foraging Habitat Crop Rotations

Swainson's hawk nest-site selection is strongly correlated to suitable agricultural habitats. The most favored agricultural foraging habitats: alfalfa, row, and field crops are usually planted in cyclical rotations, changing from one field to another in one year to the next, or as with alfalfa, the crop stays in one place for four or five years before it is then removed. For example, a field with hundreds of acres of suitable foraging habitat can be planted with a crop that is largely unsuitable for foraging the next year. Nonetheless, Swainson's hawks often show strong nest-site fidelity and return to the same nest territory year after year. The landscape that they return to may be different each year due to crop rotations and conversions. Within the several thousand acres typically associated with a home range/nest territory, it is likely that multiple suitable agricultural habitats will be present within any given year and high quality foraging habitat will occur somewhere within the territory at all times during the nesting season due to differences in planting, irrigation, and harvesting schedules (i.e., activities that make prey available in high numbers).

22.2.3.2 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for Swainson's hawk are identified in Table SWHA-1 and have been derived from input from local species experts.

Table SWHA-1
Essential Habitat Elements for Swainson's Hawk

Essential Activities	Land Cover Types	Habitat Elements
Foraging	Blue oak savanna, cropland, irrigated pasture grassland, valley grassland.	Valley grassland and open agriculture, especially alfalfa, irrigated pasture, or other field or row crops that support rodent populations and are managed such that the rodents become available through activities such as flood irrigation and harvesting.
Nesting	Blue oak savanna, blue oak woodland, mine tailing riparian woodland, valley oak riparian woodland, and mixed riparian scrub.	Mature trees for nesting (approx. 50 feet) near (less than five miles) foraging habitat. Generally includes isolated trees adjacent to foraging habitat.

22.3 Species Distribution and Population Trends

22.3.1 Breeding Range

The Swainson's hawk's breeding range is distributed over much of western North America: in the south from Sonora, Chihuahua, Durango, Coahuila, and Nuevo Leon, Mexico north to Alberta, Saskatchewan and Manitoba, Canada; east to Minnesota, Iowa, Kansas, Oklahoma, and Texas,; and west to coastal valleys in Washington and British Colombia. Disjunct populations occur in Missouri, northern British Columbia, and the Central Valley of California, and possibly Yukon and Alaska (Palmer 1988; England et al. 1997; Howell and Webb 1995).

22.3.2 Boreal Winter/Austral Summer Range

The winter range during the Austral summer in South America is primarily known to be northern Argentina, Paraguay, Uruguay, and southern Brazil (Palmer 1988; England et al. 1997). However, knowledge of South American distribution is incomplete. Human alteration of habitats (clearing of forests and subsequent increases in cattle pasture and cultivation) throughout South and Central America may provide suitable habitats that may now be utilized in areas not historically known to have Swainson's hawks. Orlog (*in* Smith 1980) and Jaramillo (1993) reported large concentrations of Swainson's hawks in Argentina where flocks were composed almost entirely of juveniles. This suggests that the population is segregated by age class on the wintering grounds and that the juveniles continue to the southern extreme of the winter range (Palmer 1988; Jaramillo 1993). Orlog (*in* Smith 1980) reports that locust swarms are being reduced by pesticides, and that this could be resulting in Swainson's hawks wintering further north.

22.3.3 Wintering in North America

Some migration dropouts and stragglers have been noted in Boreal winter in southern Florida where it is thought that they are primarily wayward juveniles that cannot manage the over-water crossing further south (Browning 1974). In addition, scattered winter records are noted from Mexico and Central America (Howell and Webb 1995). Observations and telemetry data (Bradbury et al. in prep) have recently documented the presence of a wintering population based primarily in western Mexico, southern Mexico and Central America. Also, a small population, never observed to exceed 30 individuals (Holt pers. obs.), has recently wintered in the Sacramento – San Joaquin River Delta of California (Herzog 1996). While the breeding origins of many Mexican-wintering Swainson's Hawks are now know to be the Central Valley of California, it is also thought that the Mexican wintering population is also comprised of Swainson's Hawks from other parts of the breeding range (Bradbury et al. in prep; Holt pers. obs.).

22.3.4 Wintering Locations of the Central Valley Breeding Population

The Swainson's hawk population which breeds in the Central Valley of California is now known to have significantly different wintering areas and migration routes than the main population (Bradbury et al. in prep.). In a study that successfully tracked 17 Central Valley-breeding Swainson's hawks with satellite telemetry devices, it was discovered that eight individuals spent the winter in Mexico, one wintered partly in Mexico and partly in Central America, three wintered in Colombia, four wintered in northern Argentina and southern Bolivia, and one wintered in northern Mexico and then returned to the Sacramento–San Joaquin River Delta in the Central Valley in mid-January (Bradbury et al. in prep.). Those birds that did go to northern Argentina/southern Bolivia were still well north of the known wintering areas of the main Swainson's hawk population (Jaramillo 1993; Woodbridge et al. 1997). Wintering in western Mexico (Sinaloa, Nayarit) should be considered to be a recent phenomenon as the areas where foraging now occurs have only been cleared for agricultural production in the past four decades and had previously been extensive thorn forest, a habitat that would not provide any opportunities for Swainson's hawk foraging (Bradbury et al. in prep.). It appears that the habitats in Central America and South America where Central Valley Swainson's hawks have been discovered to be wintering are likewise landscapes that have been altered by clearing and agricultural cultivation at least within the past century.

22.3.5 Nesting Distribution in the Central Valley

Swainson's hawk nesting data in California has been compiled by the CDFG since 1979. Data sources used by the CDFG include the following: 1) CNDDB (CDFG 2010), 2) records supplied by Ron Schlorff of the CDFG Non-Game Division, and 3) Swainson's hawk census data obtained by CDFG Region II biologists in 2002 and 2003 (Gifford pers.comm.). Nesting in the Central Valley occurs throughout the valley, extending from Tehama County in the north to Kern County in the south. However, the population is largely concentrated in the middle of the valley in a semi-circle around the Delta, primarily in Yolo, Solano, Sacramento, and San Joaquin counties. Roughly 60 to 65 percent of the statewide population and 70 to 75 percent of the Central Valley population occurs in this latter area. This distribution pattern conforms broadly to the distribution of agricultural habitats in the valley that are suitable for foraging. While alfalfa, irrigated pasture, mixed row, and field crops are found throughout the valley, they are broadly concentrated in those same areas where nesting Swainson's hawks are shown to be concentrated. Vineyards, cotton, orchards and dry native scrub dominate the landscape in the southern end of the valley, while rice and orchards are the dominant crops in the northern end of the valley.

22.3.6 Nesting Distribution in the Plan Area

In the Plan Area, there are 109 records documented in the CNDDB (CDFG 2010). This number includes some duplicate records of the same nesting territory in different years. There are an additional 49 nest-sites recorded in surveys conducted in 2002 and 2003 by CDFG Region II field biologists. This data has been collected as part of a larger census effort that samples randomly selected blocks throughout the entire Sacramento Valley. This data also includes some duplicates of previously recorded nesting territories. Finally, there is an additional set of seven nest-sites along Dry Creek on the County line that have been culled from Craig Swolgaard's study in 2002-2003. Compiled together, these data points depict the approximate nesting distribution of Swainson's hawk in the Plan Area. Figure SWHA-1 illustrates the distribution of known Swainson's hawk nest sites within Sacramento County as recorded in the CNDDB (CDFG 2010) as well as other sources (ebird.org 2005-2010; Estep 2006, 2007; Gill Ranch Survey 2003).

Swainson's hawk nest territories are aggregated in the south-central part of the county and river bottom lands associated with the Cosumnes River, Deer Creek, and Dry Creek. Swainson's hawks also nest in some urban areas and the dry annual grassland on the east side of the county, albeit in very low numbers.

22.4 Population Levels and Trends

22.4.1 Range Wide Population Estimate and Trend

Historical population estimates for Swainson's hawk are non-existent. However, comments from several observers mention that the Swainson's hawk was abundant in western North America in the nineteenth century (Palmer 1988; England et al. 1997). By the end of the nineteenth century and well into the twentieth century, observers were noting that Swainson's hawks were becoming less common (Palmer 1988; England et al. 1997). Serious declines in Swainson's hawk numbers continue to be reported in California (Grinnell and Miller 1944; Walton 1978; Bloom 1980), Nevada (Heron and Lucas 1978), southern Saskatchewan (Houston and Bechard 1983), and southeast Oregon (Littlefield et al. 1984).

Recent estimates of the total population of Swainson's hawks are widely disparate and range between 300,000 (Palmer 1988) and 1,000,000 (Clark and Wheeler 2003). England et al. (1997) state that no comprehensive estimate of population has been calculated for the species. Migration period counts over single points in Panama and eastern Mexico in the last 25 years vary from as high as 845,465 to as low as 175,644. Unfortunately, different count methodologies have been employed in different years, resulting in the inability to meaningfully compare the data (England et al. 1997).

In Canada, serious declines in reproductive success have been reported (Houston and Schmutz 1995). It is likely that differing pressures upon local populations in different regions of the species' range result in an uneven trend with regard to the species range wide population status.

22.4.2 California and Central Valley Population Estimates and Trend

Grinnell and Miller (1944) provide the following remark in regards to Swainson's hawks in California "Formerly abundant, but now (1943) greatly reduced in numbers and in extent of breeding range, as a result of human influences." Small (1994) states that a "drastic decline for the species in the far west began in the 1930's, accelerated through the 1940's, the 1950's and into the early 1960's. In the 1970's and 1980's, the population remained at a fairly constant but diminished level. Sporadic migratory flocks of 100 to 300 are still occasionally reported, and large summer feeding concentrations of non-breeders (numbering up to 150) have recently been found in the mid-Central Valley . . ." Bloom (1980) undertook an analysis of the Swainson's hawk in California. He reviewed historical records and egg collections in order to estimate the historical distribution, and found that the current range had been reduced drastically from its historical extent. Historical records indicate a past existence of breeding populations in appropriate habitat in most of California's bioregions, including the Southern Transverse Ranges, Central Coast Ranges, Central Valley, Great Basin, and Mojave-Colorado Desert. Small populations were documented to have been in Owens Valley, Shasta Valley, and Sonoma County. Unfortunately, historical records typically describe single nest trees and do not support conclusions about the size of local populations.

Bloom (1980) addressed this problem by extrapolating known densities per area of suitable habitat to larger unsurveyed areas. Thereby, he estimated a total statewide historical population to be between 4,284 to 17,136 breeding pairs. Bloom thought that the exact number probably fell somewhere in between those extremes. Bloom (1980) compared the minimum number with his 1979 statewide survey estimate of 375 pairs. Thus, a minimum 91 percent decline was calculated. Bloom (1980) also estimated an historical population in the Central Valley between 1,656 to 6,624 breeding pairs. Thus, using his 1979 population estimate of 280 breeding pairs for the Central Valley, the inferred decline for that region would be a minimum of 83.1 percent.

Hand in hand with the significant reduction in population, an enormous reduction in the former breeding range in California was documented (Bloom 1980). Historical populations have been extirpated from virtually all of Southern California, including: coastal valleys, the Mojave and Colorado Deserts, Transverse Ranges, and Santa Catalina Island. Coastal valleys of Central California (Livermore, Salinas, Sonoma) also no longer have breeding populations of Swainson's hawks. Bloom (1980) states that because of the Central Valley population size and distribution, it probably functions as the nucleus of recruitment into the other areas historically occupied in the state, with the probable exception of the Klamath Basin. Therefore, it is likely that recovery of populations in these areas outside of the Central valley is dependent upon a healthy Central Valley population.

Bloom's Central Valley population estimate of 280 pairs (Bloom 1980) was revised to 430 pairs in 1989 after further survey work (CDFG 1993, 1994). This increase in numbers was attributed to an increase in survey intensity rather than an increase in real numbers. Subsequent survey work in the Central Valley in the 1990's was never coordinated nor completely compiled. Therefore, no new calculation of population estimate was derived. The Swainson's Hawk Technical Advisory Committee (2000) estimates that there are as many as 900 pairs in the Central Valley. This is a reasonable guess; however, it is not possible to arrive at an accurate number without comprehensive surveys Nine hundred pairs are well short of Bloom's estimate of 1,656 to 6,624 historical pairs for the Central Valley. However, the reported increases in numbers could mean that the downward trend may have abated. Swainson's hawks are a relatively long-lived species. Thus, their longevity can have a masking effect on true population trends, particularly when relying on patchy and incomplete data. Therefore, estimates of current population trends are perhaps not prudent without more complete long-term data on population and reproduction.

22.4.3 Plan Area Population Estimates and Trend

In 1979, Bloom (1980) estimated the then current population between the Cities of Stockton and Sacramento, to be 75 pairs. In 1993, all of Sacramento County had 49 documented active pairs (CDFG Raptor Records Database). The CNDDB has 109 separate nesting records for Swainson's hawk in the Plan Area from the period between 1979 and 2010 (see Figure SWHA-1). This number is a compilation of data from several sources and does not reflect an accurate population estimate for the Plan Area. Earlier CNDDB records from 1979 through 1984 do not usually record a nest-site, but merely are an observation of a Swainson's hawk. Data from CDFG Region II census efforts in 2002 and 2003 accounts for 49 nest-sites, while Swolgaard's study in 2002-2003 of northern San Joaquin County includes seven nest sites along Dry Creek. Both of these efforts involve some duplication of records over the two-year periods. In addition, both studies surveyed only portions of the Plan Area. Therefore, it is not possible to estimate the number of nesting Swainson's hawk pairs is in the Plan Area based on the available data. Therefore, population trends for the area cannot be assessed at this time.

22.5 Threats to the Species

In general, settlement in both North and South America has brought with it a myriad of changes that have consequentially altered the environment that Swainson's hawks live in. To a large extent, vegetative cover types have undergone significant changes: clearing of land, cultivation of agriculture, new grazing regimes (fencing, sheep and cattle). These activities foster changes in plant species diversity and abundance (including invasive exotics) and subsequently affect prey-species composition and availability. Extirpations or extinctions of numerous prey species, such as the Rocky Mountain Locust, or the introduction of exotic prey species, such as house mouse, undoubtedly has affected Swainson's hawks in ways that will never be entirely known. The rangewide decline in Swainson's hawk numbers is something that was likely the result of a multitude of factors and will never be entirely understood.

Within California, Bloom (1980) documented a dramatic statewide decline in the Swainson's hawk population, and subsequent reduction of the breeding range. The reasons for this decline are again not completely understood. Bloom (1980) discussed habitat destruction, pesticide poisoning, and direct shooting as all contributing to the decline.

22.5.1 Elimination of Nesting Habitat

Smith (1977) estimated that 98.5 percent of the Central Valley's riparian forest had been eliminated largely by flood control and irrigation projects. Katibah (1981) estimated that 94 percent of riparian forest in the Central Valley had been removed and that the vast majority of the remaining habitat was disturbed, degraded or otherwise impacted by human activities. Schlorff and Bloom (1984) found 87 percent of all Swainson's hawk nests in the Central Valley to be associated with riparian systems. Estep (1989) found 78.1 percent of nest trees to be in riparian systems. With regard to this loss of nesting habitat, Schlorff and Bloom (1984) state that if "species such as the Swainson's hawk are to survive, the trend of destruction must be reversed."

Nest trees that are not in riparian systems such as roadside trees exist only in so far as they are "out of the way." With continued increases in vehicle traffic, roadways everywhere are being widened or otherwise improved. These projects often result in the removal of numerous trees that may be suitable nesting sites for Swainson's hawk. Some relict trees in lone agricultural fields die every year and are never replaced. Lone trees in grazing pastures are also disappearing. They are not being replaced when they die or are cut down. Recruitment of new trees is hampered by continued heavy grazing which removes seedlings. Also, lowered ground water levels, due to over-drafting of underground aquifers, can also hamper recruitment.

22.5.2 Elimination of Foraging Habitat

Loss of foraging habitat is perhaps the most serious threat to Swainson's hawks. Urbanization has removed large areas of historical habitat. Incompatible foraging crops (cotton, rice, orchards, vineyards, etc.) are dominant in much of the Central Valley. Large areas of former foraging habitat have been completely removed and are now highly urbanized landscapes. This is particularly true in Southern California where entire valleys no longer have any remaining suitable habitat.

Bloom (1980) notes that Swainson's hawks have also disappeared from areas (e.g., Central Coast Ranges) that have not been transformed by excessive urbanization. Therefore, he concludes that "habitat destruction, although a serious threat to the remaining population, does not appear to be the complete answer."

22.5.3 Poisoning

Bloom (1980) considered pesticide poisoning to be a threat to Swainson's hawks during migration passages or on their wintering grounds where pesticides use is not as well regulated. The Swainson's hawk's reliance on relatively short-lived terrestrial mammalian prey during the breeding season in North America, could induce a build up of pesticide residues to levels where eggshell thinning could affect reproduction (Henry and Kaiser 1979). Bloom thought that if Swainson's hawks from particular breeding areas all migrated via the same routes and all went to the same wintering areas, then they could all be vulnerable to the same threats during that journey. This could explain why Swainson's hawks are declining or have been extirpated from entire areas of their former breeding range.

Difficulties with insecticide poisoning in Argentina was suspected by Orlog (*in* Littlefield et al. 1984). The mass mortality of Swainson's hawks in Argentina resulting from direct organophosphate poisoning was discovered by Woodbridge et al. (1995b). Organophosphate chemicals were apparently being sprayed from tractors coursing across sunflower, corn, and alfalfa fields to control grasshoppers. Swainson's hawks, being attracted to the grasshoppers and field machinery, were found to have been mortally affected after being directly sprayed by the chemical or ingesting heavily contaminated insects. In 1996 approximately 5,000 dead Swainson's hawks were observed in Provincia de La Pampa with an estimated total kill of 16,000 to 20,000 (Goldstein et al. 1996). Additional mortality events of lower magnitude were reported in 1997 and 1998 (Woodbridge 1998; Rich et al. 2004). Education programs and restrictions on use of highly toxic pesticides have since dramatically reduced mortality of wintering Swainson's hawks (Woodbridge 1998).

Existing satellite telemetry data for Central Valley Swainson's hawks (Bradbury et al. in prep.) found no individuals wintering in areas where pesticide poisoning has been discovered. Also, band recoveries of deceased Swainson's hawks in Argentina did not include any from individuals banded in the Central Valley. The majority (13 of 17) of Central Valley Swainson's hawks that were tracked by satellite wintered north of the equator where the timing of farming operations (and assumedly pesticide applications) is different than in Argentina. The months when Swainson's hawks from the Central Valley are in Mexico is the winter season, a time when insecticides are generally not being applied (Bradbury pers. comm.; Holt pers. obs.). Therefore, the evidence indicates that Swainson's hawks from the Central Valley are not involved in the poisonings in Argentina. Furthermore, there is no evidence that Swainson's hawks from the Central Valley are involved in similar pesticide poisoning elsewhere.

22.5.4 Direct Shooting

Shooting of Swainson's hawks is something that has been widely reported in North America (Cameron 1913; Gabrielson and Jewett 1970; Palmer 1988) and in migration (Bloom 1980). Swainson's hawks were thought to be killers of chickens and even lambs and calves. Therefore, Swainson's hawks were routinely shot out of the air and at nest sites. Bloom (1980) points out that in California, in large areas of the Swainson's hawk's former range (Central Coast, Mojave Desert, southern San Joaquin Valley, etc.), red-tailed hawks and red-shouldered hawks continue to exist in fairly large numbers. Both of these species were persecuted as well by the same riflemen, however, both continue to exist in areas where Swainson's hawks no longer are found. Bloom (1980) reasoned that it is likely that shooting on the breeding grounds, therefore, is not the prime reason for the species' extirpation in those areas. Shooting could be a problem on migration routes or at winter roosts. Roost sites and mountain passes in particular are locations where Swainson's hawks are vulnerable to shooters. Information concerning Swainson's hawks in Central and South America is inadequate to assess the magnitude of this problem.

22.5.5 Threats within the Plan Area

Within the Plan Area, the loss of foraging and nesting habitat are the prime threats to the species. Loss of roadside nest trees and lone trees in agricultural fields and pastures, as mentioned above, should continue to be a challenge. Future flood control projects, spurred by increased human population, will pose threats to riparian nesting habitat. For instance, seven miles of trees along the south bank of the Mokelumne River (on the boundary of the Plan Area) were removed in the mid-1990's for flood control purposes. Mitigation for this long linear reach of nesting habitat, that undoubtedly held several nest trees was all placed in one 20-acre grove – a tree stand that would likely support only one nest territory. Urbanization threatens to remove both nesting habitat and foraging habitat. The Cities of Elk Grove, Galt, and Rancho Cordova, and the County of Sacramento are all expected to continue to grow and affect existing habitat for the species.

Agricultural conversions from one crop to another are not regulated and are difficult to track. Crops, be they compatible foraging habitat for Swainson's hawk or not, are planted on the basis of whether a farmer can profit from the activity. Cropping patterns from 50 years ago were likely different from what they are today. For example, major changes that have greatly affected Swainson's Hawks are the complete loss of sugar beets as a foraging habitat and the recent dramatic increase in vineyards. In Sacramento County, vineyards have increased in acreage by

263 percent in the period 1987 to 1997 (DWR 2002). This trend may have slowed, but there is no certainty in regards to what crops will be profitable to grow in the future.

Another matter of concern is the low reproductive success of Swainson's hawks in the Central Valley compared to other North American regions. Data from England et al. (1995), England et al. (1997), and Swolgaard (2004) compare multi-year studies of reproductive performance from differing regions of the Swainson's hawk's breeding range (**Table SWHA-2**). An average of 17.34 percent fewer chicks fledged from successful nests in studies that were done in the Central Valley versus the chicks fledged per successful nest in studies done in other areas of the Swainson's hawk's breeding range.

Table SWHA-2
Reproductive Performance of Swainson's Hawks in Various Populations

Location	Years of study	Number of nesting attempts	% successful nesting attempts	# chicks/ successful nest	Source
SE Washington	3	48	81.3%	1.85	Fitzner 1978
NE Colorado	3	119	54.6%	2.18	Olendorff 1973
SE Alberta, Canada	3	153	71.2%	1.98	Schmutz 1987
SE North Mexico	3	36	81.0%	1.94	Bednarz 1988
Saskatchewan, Canada	22	2031		1.91	Houston and Schmutz 1995
NE California	11	454	65.5%	2.24	Woodbridge et al. 1995a
Yolo County, California	5	492	82.1%	1.64	England et al. 1995
San Joaquin County, California	5	60	80.0%	1.73	England et al. 1995
Central Valley, California	2	69	83.5%	1.42	Estep 1989
Central Valley, California	2	31	54.8%	1.50	Holt *in*: Swolgaard 2004

Six studies outside of the Central Valley have a combined average of 1.96 chicks fledged per successful nest. While four combined studies within the Central Valley have an average of 1.62 chicks fledged per successful nest. This data is spread over a 28-year period, collected independently by differing investigators, and is sufficient to illuminate that there is a low rate of chicks fledged per successful nests for Central Valley Swainson's hawks. Nests with four chicks fledged are not unusual outside of the Central Valley (Brown and Amadon 1968; Palmer 1988; England et al. 1997), but in the Central Valley four chicks fledged in a nest is very rare. No such nest has been documented in the Plan Area, but at least one has been observed near Tracy, California in 1999 (Holt pers. obs.).

22.6 Data Gaps and Conservation Implications

A thorough understanding of the demographics of the population within the Plan Area would provide at least two important sources of information that could then be used to develop a more effective conservation strategy for the species: 1) age structure of the population; and 2) reproductive performance. This information would provide an opportunity to understand whether the species is still in decline in the area or has stabilized, albeit at a low population. The information might also provide insight into how much exchange is occurring with other adjacent populations outside the Plan Area. It could provide information on whether effective recruitment is occurring from the reproductive pairs that occur in the Plan Area (and if not…how that may be related to available habitat).

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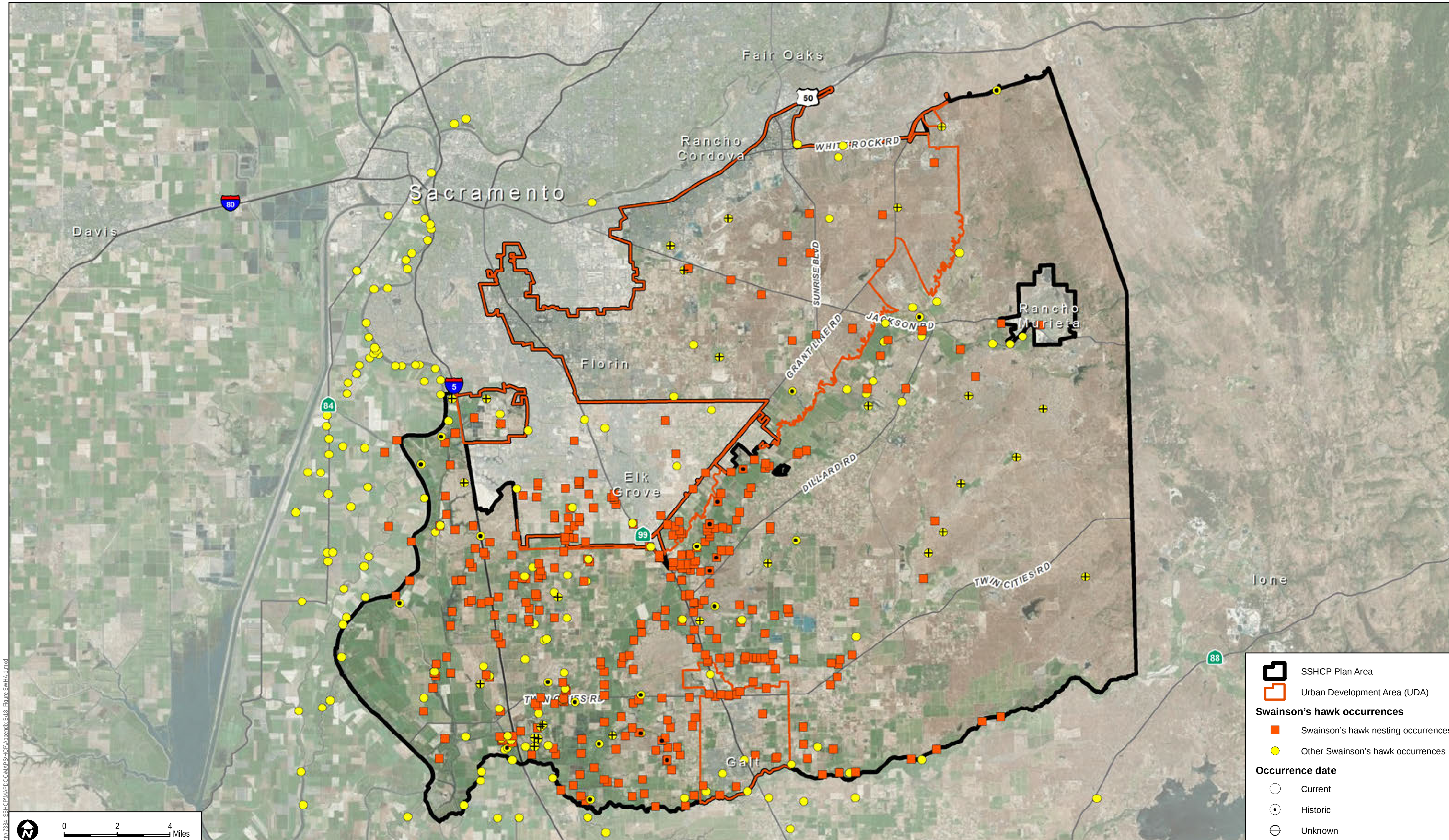

SOURCE: Bing Maps, County of Sacramento 2014, CDFG 2012, BIOS 2012, ESTEP Environmental 2006, ebird.org

FIGURE SWHA-1

Swainson's Hawk Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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23 NORTHERN HARRIER (NOHA)

Prepared by Henderson Ecology and Planning (Steve Henderson)

Northern Harrier (NOHA)

(Circus cyaneus)

Status USFWS: Bird of Conservation Concern

Status CDFG: Second Priority Bird of Special Concern

23.1 Legal Status

Northern harrier (*Circus cyaneus*) is legally protected under the federal Migratory Bird Treaty Act (16 U.S.C. 703-712) and California Fish and Game Code (Sections 3503.5 and 3800). This species is designated as a Second Priority Bird Species of Special Concern (BSSC) by the California Department of Fish and Game (CDFG) (Shuford and Gardali 2008) and a Bird of Conservation Concern (BCC) by the U.S. Fish and Wildlife Service (USFWS) (USFWS 2002).

23.2 Life History and Ecology

23.2.1 Species Description and Life History

23.2.1.1 Physical Description

Northern harrier is a long-winged, long-tailed hawk with a distinctive white rump patch in both sexes. Individuals have an "owlish" appearance in the face due to a facial ruff or disk. The male has a pale gray back, head, and breast, with black wing tips. Female and subadult northern harriers are brown on the back and are streaked on the breast. The juvenile coloring has a rusty tone. Northern harrier has a distinct flying style with its wings held in a shallow

"V." It is usually observed gliding unsteadily (e.g., tilting) and low over grasslands and marshes (MacWhirter and Bildstein 1996).

23.2.1.2 Taxonomy

Two subspecies of *C. cyaneus* are recognized: *C. c. hudsonius* and *C. c. cyaneus*. North American birds belong to *C. c. hudsonius*, a large subspecies (Cramp and Simmons 1980), while *C. c. cyaneus* occurs in Eurasia (MacWhirter and Bildstein 1996).

23.2.1.3 Reproduction

Northern Harriers are primarily monogamous; however, polygyny also occurs. The frequency of polygynous males is positively correlated with local prey abundance (Simmons et al. 1986; Ehrlich et al. 1988). Northern harriers reach sexual maturity at one to two years of age (Martin 1987), and females are more likely to breed during their first year than males; however, first-year males are more likely to breed in years when vole (*Microtus* spp.) abundance is high (Hamerstrom et al. 1985).

The breeding season for Northern harrier is generally late March through mid-September, although breeding is sometimes initiated earlier. Males arrive on the breeding grounds before females, typically in March or April. Pair formation likely occurs on the breeding grounds (Hamerstrom 1986). Courtship usually begins in March or April, followed by nest site selection and construction. Both sexes may select the nest site (Hamerstrom 1986; Simmons et al. 1987), and both sexes engage in nest construction. Adult northern harriers are primarily nomadic and exhibit low fidelity to breeding sites (Hamerstrom 1969; Burke 1979; MacWhirter and Bildstein 1996). When northern harriers do return to general nesting areas over consecutive years, they usually do not return to the same specific nest site (Breckenridge 1935; MacWhirter 1985).

Northern harriers nest on the ground in open, vegetated habitats such as grasslands, wetlands, and agricultural fields. Nests are typically built in dense, tall vegetation in areas that are undisturbed during the nesting period; and nest sites are often in wet areas. Nests are bowls or platforms constructed with vegetation (e.g., grasses, forbs). Northern harriers often construct platforms below the nest using sturdy vegetative material (e.g., cattails), to elevate the nest, particularly in wet areas. Nest construction typically lasts between seven to 14 days. Egg-laying can occur in early April through July, but peaks in late April through early July. The female lays four to nine eggs (five is normal); eggs are laid 2–3 days apart. The female incubates the eggs for 30 to 32 days, while the male delivers food to the female. Hatching usually occurs from April through June, and peaks in May–June. Fledging occurs 30 to 35 days later. Both parents feed the young (Hamerstrom et al. 1985, Ehrlich et al. 1988). Fledged juveniles remain near the nest site and are fed by the parents for approximately 2–4 weeks, when the family group disperses

(Bildstein 1992; MacWhirter 1994; MacWhirter and Bildstein 1996). Northern harriers typically produce one brood per season, but will produce a second brood if the first clutch fails during egg-laying or shortly thereafter (Simmons 1984).

Several studies have reported nest success (i.e., percentage of clutches with ≥ 1 young fledged) for northern harrier populations in North America. Nest success ranged from 18 to 79 percent in 12 studies (MacWhirter and Bildstein 1996). Loughman and McLandress (unpubl. data, *cited in* CPIF 2000) estimated nest success for four regions in California between 1987 and 1992. In the Sacramento Valley, San Joaquin Valley, Suisun Marsh, and northeastern California, nest success was 18 percent (n = 20), 28 percent (n = 40), 21 percent (n = 135), and 16 percent (n = 36), respectively.

23.2.1.4 Survival and Longevity

The maximum reported age of a northern harrier is 16.5 years (Bildstein 1988), while the average age at death among 114 banded birds was 1.4 years (Keran 1981 *cited in* MacWhirter and Bildstein 1996). First-year female and adult survivorship has been estimated at 40 percent and 72.4 percent respectively (Martin 1987). Bildstein (1988) estimated pre-1950s survival rates for first-year and adult harriers at 41 percent and 70 percent respectively.

23.2.1.5 Dispersal Patterns

There is little empirical information about natal and post-breeding dispersal of northern harriers, and further research on this subject is needed. Juveniles exhibit virtually no fidelity to their natal area, and fledged juveniles do not typically contribute to the breeding population in their natal area (Hamerstrom 1969; MacWhirter and Bildstein 1996). There is no information available on dispersal patterns and distances between natal and subsequent breeding sites. Adult northern harriers are primarily nomadic and exhibit low fidelity to breeding sites. When northern harriers do return to general nesting areas over consecutive years, they usually do not return to the same specific nest site (Breckenridge 1935; MacWhirter 1985).

23.2.1.6 Diet and Foraging

Northern harriers primarily eat voles (*Microtus* spp.) and other small mammals; however, they also eat birds, small reptiles, amphibians, and some insects (e.g., grasshoppers, beetles, crickets, and locusts) (MacWhirter and Bildstein 1996). In five studies conducted throughout North America, voles were the primary prey item (MacWhirter and Bildstein 1996). In California, in addition to *Microtus*, other important prey items were leporids (hares and rabbits), quail, finches, and blackbirds (red-winged blackbird and yellow-headed blackbird) (Selleck and Glading 1943).

Northern harriers hunt while flying and "patrolling" low above open ground. Harriers make low, quartering flights three to 30 feet (one to nine meters) above ground. Foraging individuals dive from flight or hover and pounce on prey. Northern Harriers have an "owlish" facial ruff or disk, which aids in the audible detection of prey (much in the same way as owls) (MacWhirter and Bildstein 1996).

Most aspects of northern harrier's population ecology are closely linked to prey availability, particularly local abundance and population cycles of small mammals (CPIF 2000). Rodent populations often experience population cycles between years. Because small mammals (e.g., voles) typically comprise the majority of the harrier's diet during the breeding season, northern harrier populations are sensitive to these cycles. For example, Northern harriers can experience increased nest densities, clutch sizes, nest success rates, and frequency of polygyny during peaks and increase phases in rodent cycles (Hamerstrom et al. 1985; Simmons et al. 1986; MacWhirter and Bildstein 1996).

Passerine birds, particularly nestlings and fledglings, are also important prey for northern harriers. Bernard et al. (1987) found that this prey group constituted the second most important diet for nesting northern harriers. Passerines have higher levels of calcium, iron, crude fat, and gross energy than grasshoppers and voles (Bird et al. 1982). Also, the timing of northern harrier nestling periods corresponded with passerine nestling periods, when young passerines were relatively abundant and available to foraging harriers (Bernard et al. 1987).

Northern harriers are generally opportunistic predators, and commonly shift their diets within a breeding season in response to prey availability and changes in local vegetation structure (MacWhirter 1985; Barnard et al. 1987). For example, Martin (1987) reported that northern harriers foraging in alfalfa fields preyed primarily on voles until vegetation height reached 18 inches (46 centimeters). Thereafter, harriers abandoned alfalfa and switched their diets to passerines and reptiles. After the alfalfa was cut, northern harriers switched their diet back to voles.

23.2.1.7 Movement and Migration Patterns

Northern harrier breeding populations in the northern portions of the species' range are more migratory than those at more southern latitudes (MacWhirter and Bildstein 1996). In the United States, migrating northern harriers depart their breeding grounds in August to December, and leave their wintering grounds in February to March. Migratory birds may winter in California, and some migrate south through Central and South America (MacWhirter and Bildstein 1996).

Many northern harrier populations breeding in California are residents; however, this species is nomadic and moves within and between seasons in response to prey availability (MacWhirter and Bildstein 1996). Northern harriers winter throughout California and typically occupy habitats similar to those used during the breeding season (MacWhirter and Bildstein 1996).

23.2.1.8 Territoriality, Home Range, and Spacing

Northern Harriers are not strongly territorial during the breeding season, except near the nest where both sexes defend the territory. Reported territory sizes for males have ranged from 2.0 to 271.8 acres (0.8 to 110 hectares). Females typically defend a smaller territory (Simmons 1983; Martin 1987). Territory sizes vary with habitat and prey availability (Martin 1987; Temeles 1987). Temeles (1987) showed that, in Yolo County, California, northern harriers adapted their territory sizes to maintain a consistent rate of prey capture. During winter, female territory size varies greatly. Temeles (1987, 1989) reported that female territory sizes in winter ranged from 9.6 to 308.6 acres (3.9 to 124.9 hectares) (mean = 83 acres [33.6 hectares]), and were inversely correlated with house mouse (*Mus musculus*) availability and pressure by intruders. In addition, prey availability was the only significant predictor of territory size in abundant food years. During winter, females defend territories and exclude non-territorial males. Females are approximately 12.5 percent larger and 50 percent heavier than males and dominate most aggressive interactions with males (MacWhirter and Bildstein 1996). Males are not considered territorial during winter.

During the breeding season, reported average home range sizes from eight studies were 420.1 to 37,066.5 acres (170 to 15,000 hectares); while the median size was 642.5 acres (260 hectares) (MacWhirter and Bildstein 1996 *citing* Smith and Murphy 1973, Rees 1976, Toland 1985, Martin 1987, Serrentino 1987). Females tend to hunt closer to the nest, and maintain smaller home ranges, than males (Martin 1987, Temeles 1987, MacWhirter and Bildstein 1996). Males reportedly will hunt ≥ 10 kilometers from the nest (Barnard 1983, Thompson-Hanson 1984). As the nestling period progresses, males and females can increase their home range by a factor of 2.5 or greater (MacWhirter and Bildstein 1996). In California, during the winter, males maintain considerably larger foraging ranges than females, presumably because they are non-territorial, or they use areas with lower prey densities or different prey composition than those favored by females (MacWhirter and Bildstein 1996).

Prey availability and habitat quality also affect northern harrier breeding densities, inter-nest distances, and spacing (MacWhirter and Bildstein 1996). Loughman and McLandress (unpubl. data, *cited in* CPIF 2000) estimated breeding densities of northern harrier in four regions of California. In the Sacramento Valley, San Joaquin Valley, Suisun Marsh, and northeastern California, nest densities (number of nests per square kilometer) were 4.2 to 5.7 (for 1987 - 1988), 5.0 to 6.7 (for 1987–1991), 3.3 to 24.8 (for 1987–1992), and 7.4 to 9.0 (for 1987–1989), respectively. The highest density reported, 24.8 nests per square kilometer at Suisun Marsh, occurred during an unusually high vole population year.

23.2.2 Habitat Requirements and Ecology

Northern harrier breeds in a variety of open grassland, wetland, and agricultural habitats. Open wetland habitats used for breeding include marshy meadows, wet and lightly grazed pastures, and freshwater and brackish marshes. Northern Harrier breeding habitat also includes dry upland habitats, including grasslands, croplands, drained marshlands, and shrub-steppe in cold deserts. Although Midwestern populations use wetland habitats more frequently, western populations tend to use upland habitats (e.g., grasslands) disproportionately. Northern harriers winter throughout California where suitable habitat occurs. Wintering habitat includes open areas dominated by herbaceous vegetation, including grasslands, pastures, croplands, coastal sand dunes, brackish and freshwater marsh, and estuaries. Northern harriers rarely occur in forested areas (Grinnel and Miller 1944; Martin 1987; MacWhirter and Bildstein 1996).

The quality of open nesting habitats for northern harrier appears to be a function of five primary factors: 1) vegetation composition and structure; 2) prey abundance; 3) levels of ground disturbance during the nesting season; 4) site moisture; and 5) predation. Successful nesting by northern harriers generally require open habitats with dense, tall vegetation, a high prey base and few predators (CPIF 2000), and no agricultural or other disturbances that destroy their nests. Also, northern harriers appear to prefer moist or wet sites; however they will nest in dry sites that support other elements of suitable habitat (e.g., dense, tall vegetation). These factors are discussed below.

Vegetation height and structure particularly affect northern harrier habitat quality, especially because this species is a ground-nester. Northern Harriers nest on the ground in open, vegetated habitats such as grasslands and wetlands. Harrier nests in upland fields are typically surrounded by grasses and forbs; whereas nests in wet sites are often surrounded by marsh grasses and cattails (Hamerstrom and Kopeny 1981; Simmons and Smith 1985; Loughman and McLandress unpubl. data, and LBWA unpubl. data *cited in* CPIF 2000). Nests are typically built in dense, tall vegetation in areas that are undisturbed during the nesting period; and nest sites are often in wet areas. Nests are bowls or platforms constructed with vegetation (e.g., grasses, forbs). Northern Harriers often construct platforms below the nest using sturdy vegetative material (e.g., cattails), to elevate the nest, particularly in wet areas.

Loughman and McLandress (unpubl. data, *cited in* CPIF 2000) reported the average vegetation height at nest sites in four regions of California (Sacramento Valley, San Joaquin Valley, Suisun Marsh, and Northeastern California). Vegetation height was lowest in the Suisun Marsh (12.6 to 24.1 inches [32.0 to 61.2 centimeters]) and greatest in the San Joaquin Valley (23.3 to 37.8 inches [59.2 to 96.0 centimeters]). Nest sites in Northeastern California were dominated by residual vegetation, while live vegetation was dominant in the other three study areas. Vegetation composition documented around northern harrier nests includes annual and perennial grasses

(Poaceae), rushes (*Carex* spp.), sedges (*Juncus* spp.), hemlock (*Conium* spp.), milk thistle (*Silybum* spp.), dock (*Rumex* spp.), mustard (*Brassica* spp.), clover (*Trifolium* spp.), and goldenrod (*Sildago* spp.) (Simmons and Smith 1985; Loughman and McLandress unpubl. data, and LBWA unpubl. data *cited in* CPIF 2000).

Northern harrier nest sites are characterized by partial or complete vegetation cover around the nest circumference (Loughman and McLandress unpubl. data, LBWA unpubl. data *cited in* CPIF 2000); however, the canopies directly above nests are typically open (i.e., the nests are not concealed). Simmons and Smith (1985) reported lower success of concealed nests. Loughman and McLandress (unpubl. data *cited in* CPIF 2000) reported that 71 percent of nests at Suisun Marsh and 93 percent of nests in northeastern California were characterized by no canopy cover. Also, 78 percent of nests located at Los Banos and Salt Slough Wildlife Areas were characterized by open canopies (LBWA unpubl. data *cited in* CPIF 2000). Northern Harrier nests on state and federal wildlife refuges in California were located in upland fields managed for waterfowl breeding (Loughman and McLandress unpubl. data). Nest sites were surrounded by tall annual or perennial grasses with no nest canopy cover.

Site moisture is also associated with the quality of northern harrier nesting habitat. In most nesting habitats, including dry uplands, a disproportionate number of nests are located in wet sites (Simmons and Smith 1985, Martin 1987, Grant et al. 1991). Simmons and Smith (1985) reported that northern harriers in Canada had higher nest success in wet sites (wetland fringe or wet meadows) than in dry sites; and wet sites were selected more than expected based on availability (Simmons and Smith 1985). Although both moisture and vegetation characteristics were correlated with nest success, moisture was the best predictor. Wet sites may be preferred due to reduced predation rates there (Simmons and Smith 1985; MacWhirter and Bildstein 1996). Also, moisture may be simply correlated with or affect other factors that directly determine habitat quality (e.g., vegetation structure and prey abundance).

Where agricultural lands provide suitable vegetation characteristics and prey availability, and are free of disturbances during the nesting period, these areas can provide important nesting habitat for northern harrier. Northern Harriers will attempt to nest in agricultural fields that support suitable vegetation characteristics and prey availability early in the nesting cycle. In Yolo County, California, harrier nests were found in three different upland types: uncultivated field of grasses and weeds, cultivated rice field, and cultivated field of clover (Temeles 1987). Also, in Yolo County, Hopkins (pers. comm.) reported nesting by northern harriers in hayfields. However, where northern harriers nest in agricultural lands, practices such as mowing, disking, and haying during the nesting cycle cause nest destruction (MacWhirter and Bildstein 1996); and these lands can function as population sinks. Because northern harriers are ground nesters with a long nesting period (approximately 75 days between nest construction and fledging young), nest success in croplands remains very sensitive to agricultural practices. Without landowner commitments to avoid nest destruction, the attractiveness of some croplands to northern harriers early in the nesting period can significantly threaten regional population dynamics, particularly in the Central Valley where agricultural lands are abundant.

Hamerstrom and Kopeny (1981) reported that northern harriers were very adaptive nesters, and continued nesting in marsh areas that were drained and converted to farmland or grasslands; however, it is unknown whether survival and reproduction vary between disturbed and natural habitats (CPIF 2000).

Some agricultural lands also provide high-quality foraging habitat for northern harrier. Agricultural lands that are suitable for foraging are those that support abundant rodent populations (e.g., alfalfa and irrigated pasture). Williams et al. (2000) compared winter use of croplands and rangelands by northern harrier and other raptors in eastern Kansas. Harrier densities were higher in croplands than in rangelands; and harriers generally preferred idle land. The authors hypothesized that the importance of cropland as winter foraging habitat was a function of high prey abundance, good visibility of prey in harvested fields, and a relatively high amount of suitable hunting habitat.

There is no empirical information on effects of habitat fragmentation and habitat patch size on the viability of northern harrier populations (CPIF 2000). The spatial requirements of northern harriers, and how reproductive success and long-term persistence varies with landscape-level parameters, are not known. Although these relationships are not documented, it is assumed that small and isolated habitat patches are less likely to sustain high reproductive success or long-term persistence than larger areas. Northern Harriers using isolated habitats may experience frequent disturbances from adjacent land uses (e.g., nest disturbance, habitat degradation, predation). Important biotic interactions between harriers and rodent populations may be disrupted, because some rodent populations may be sensitive to habitat area and surrounding land uses as well. For example, the availability of voles and other rodent prey may be limited in isolated habitats, and rodents may abandon or be eradicated from small parcels of habitat.

23.2.2.1 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for northern harrier are identified in Table NOHA-1 and have been derived from input from local species experts.

Table NOHA-1
Essential Habitat Elements for Northern Harrier

Essential Activities	Land Cover Types	Habitat Elements
Foraging	Blue oak savanna, cropland, irrigated pasture grassland, valley grassland, vernal impoundment, vernal pool, vernal swale, seasonal wetlands, seasonal impoundment, swale, and freshwater marsh.	Abundant rodent populations.
Nesting	Blue oak savanna, cropland, irrigated pasture grassland, and valley grassland.	Open habitats with dense, tall vegetation, a high prey base, and few predators. Nests are typically built in dense, tall vegetation in areas that are undisturbed during the nesting period; and nest sites are often in wet areas.

23.3 Species Distribution and Population Trends

23.3.1 Species Distribution

Breeding populations of northern harrier primarily occur throughout most of Canada and Alaska; central, coastal, and southwestern California into the Baja Peninsula, Mexico; and the west-central and northeastern United States. Northern harriers winter in most of the coterminous United States except portions of the northern-most states; Mexico and Central America; and Cuba and the Bahamas. Most wintering birds occur in the western and southern United States (MacWhirter and Bildstein 1996).

In California, northern harriers historically bred throughout the state except in deserts, woodlands, and forested mountains. Historical breeding localities included the interior from Siskiyou County south to western Riverside and San Bernardino Counties and coastal regions from Marin County to San Diego County (Grinnell and Miller 1944). The northern harrier's range also includes the Sierra Nevada foothills up to 3,600 feet elevation (CPIF 2000). Breeding populations were probably concentrated in most of the Central Valley, Sacramento-San Joaquin River Delta, Suisun Marsh, and portions of the San Francisco Bay (Zeiner et al. 1990). The northern harrier's present California breeding range is similar to its historical distribution; however, extensive local population declines continue as a result of habitat loss (Remsen 1978; Martin 1989; MacWhirter and Bildstein 1996; CPIF 2000).

23.3.2 Central Valley Distribution

Northern harrier's breeding range in California includes most of the Central Valley, where this species is a year-round resident (Zeiner et al. 1990;MacWhirter and Bildstein 1996).

23.3.3 Range Within the Plan Area

Northern harriers occur in suitable habitat within the Plan Area and are probably regular breeders (Trochet pers. comm.). Their overall distribution, abundance, and population structure are not well known. The CNDDB (CDFG 2010) reports no occurrences of northern harrier in Sacramento County, but this simply reflects the failure of local biologists to report records of the species since it is regularly observed in the area during the breeding season. Occurrences of northern harrier shown in Figure NOHA-1 are from various other sources (ebird.oeg 2005-2010; Klotz Property 2005). Land-cover types used by northern harriers, such as irrigated pasture-grassland, and valley grassland occur throughout much of the Central Valley and are well-represented in Sacramento County and the Plan Area.

Sacramento-area ornithologists C. Conard and J. Trochet provided additional occurrence and habitat distribution information, which is summarized below.

- Two nests have been documented at the Sacramento Regional County Sanitation District (SRCSD) Bufferlands. One nest was located in a hayfield approximately 50 to 60 acres in size. The other nest was in cropland (Conard pers. comm.).
- Nesting was documented approximately three years ago at The Nature Conservancy's Howard Ranch (Trochet pers. comm.).
- Approximately six nests have been documented at the Cosumnes River Preserve in the Lower Preserve area (Trochet pers. comm.). Additionally, in 2004, an immature male and an adult female were observed copulating at the Cosumnes River Preserve. This pair was observed there into early summer. The most suitable habitat at the preserve appears to occur in areas where water is drained away latest (Trochet pers. comm.).
- Other habitat identified as suitable for nesting northern harriers in the Plan Area includes areas along Scott and Latrobe Roads, in the eastern portion of the Plan Area (Trochet pers. comm.).

Because comprehensive surveys or monitoring efforts for northern harrier in the Plan Area have not been conducted, and because the existing data of known occurrences are based mostly on incidental observations or limited surveys (e.g., anecdotal records, surveys conducted within limited areas), the population size and nesting locations of this species in the Plan Area are not known. Nonetheless, for the purposes of the SSHCP, the species is considered to range throughout the Plan Area.

23.3.4 Population Levels and Trend

Northern harrier has experienced an overall population decline over its distribution during the 20th century (del Hoyo et al. 1995, MacWhirter and Bildstein 1996); however, specific population status and trends vary regionally. White (1994) considered harrier population trends variable, but possibly decreasing, in western North America. Furthermore, he cited habitat modification (particularly wetlands loss) as the most important cause of possible declines. Analysis of Breeding Bird Survey (BBS) data indicates an overall decline of northern harrier populations throughout the species breeding range, although trends vary regionally. In the Western BBS Region, BBS data indicate a population decrease between 1996 and 2003 (N = 408, $P < 0.01$), 1966–1979 (N = 123, $P = 0.14$), and 1980–2003 (N = 372, $P < 0.01$) (Sauer et al. 2004).

In California, northern harrier has experienced localized population declines (CPIF 2000). BBS data suggest a slight statewide (California) population increase between 1966 and 2003 (N = 56, $P = 0.36$), 1966 to 1979 (N = 31, $P = 0.15$), and 1980 to 2003 (N = 45, $P = 0.51$) (Sauer et al. 2004); although this trend is not considered statistically significant. The BBS trend for northern harrier in the Central Valley is similar to the statewide trend. Furthermore, based on Christmas Bird Count (CBC) data, the winter population as of 1990 was estimated at 13,200 birds (Johnsgard 1990).

23.4 Threats to the Species

The primary threat to northern harrier, particularly in California, is habitat loss and degradation as a result of urbanization, development, and agricultural conversion. North American populations of northern harrier have declined during the 20th century, mainly as a result of the extensive draining of wetlands, implementation of monoculture farming, and reforestation of open farmlands (MacWhirter and Bildstein 1996). White (1994) also cited habitat modification, particularly loss of wetlands, as the most important cause of possible population declines. In agricultural landscapes, overgrazing of pastures, fewer fencerows and larger croplands, and widespread use of insecticides and rodenticides have reduced prey availability for northern harriers (MacWhirter and Bildstein 1996).

Direct or indirect human disturbance of nesting activities, particularly in agricultural areas, threatens northern harrier populations. Where northern harriers nest in agricultural lands, practices such as early mowing, disking, and haying during the nesting cycle can cause nest destruction (MacWhirter and Bildstein 1996); and these lands can function as population sinks. Also, these activities near a nest can cause parents to abandon the nest (MacWhirter and Bildstein 1996). Because northern harriers are ground nesters with a long nesting period (approximately 75 days between nest construction and fledging young), nest success in croplands remains very sensitive to agricultural practices for a long duration.

Reproductive failure and declines in northern harrier populations in the mid-20th century have been linked to organochloride pesticide contamination, particularly dichlor-diphenylethylene (DDE), the major metabolite of Dichlorodiphenyltrichloroethane (DDT). However, these populations apparently recovered quickly after regulation of DDT in the early 1970s (Hamerstrom 1969, 1986; MacWhirter and Bildstein 1996).

In south Sacramento County, northern harrier is specifically threatened by habitat loss and fragmentation as a result of conversion of habitat to urban uses and agriculture, particularly the conversion of grasslands to vineyards. Also, the loss of suitable agricultural land to development has reduced the extent of suitable foraging habitat. It is possible that the use of rodenticides and insecticides have reduced prey populations, resulting in lowered survivorship and reproductive success.

23.5 Data Gaps and Conservation Implications

The ecology, status, and management of northern harriers have received considerable attention in recent years. There are several sources of uncertainty regarding northern harrier and its requirements in the Plan Area. These data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

23.5.1 Population and Habitat Distribution within the Plan Area

Northern harriers occur in suitable habitat within the Plan Area; however, their overall distribution, abundance, and population structure are not well known. Land-cover types used by northern harriers, such as grasslands, occur throughout much of the Central Valley and are well-represented in Sacramento County and the Plan Area. At most sites with these land-cover types, the status of northern harrier is not known.

Because comprehensive surveys for northern harrier in the Plan Area have not been conducted and because the existing occurrence data are based primarily on incidental observations (e.g., anecdotal records), the population size, nesting locations, and important wintering areas of this species throughout the Plan Area are not known. Although the distribution of grasslands is mapped and quantifiable, the quality of habitat for northern harriers within most of these areas is unknown.

Until this data gap is remedied, the conservation value of grassland and agricultural land-cover types for northern harrier will be considered relatively high in lands that support (or recently supported) known occurrences, are large in extent, and/or are adjacent to these areas.

23.5.2 Effectiveness of Grassland and Wetland Enhancement and Restoration Techniques in Creating Suitable Habitat Structure for Northern Harrier

Achieving the conservation goals and objectives for northern harrier will require successful enhancement and restoration of grassland and wetland habitats. The structure of these habitats (e.g., dense, tall vegetation) is an important factor for suitability of northern harrier. Whether restored or grasslands and wetlands can retain the structural attributes suitable for northern harrier is unknown.

If restoration and enhancement techniques cannot eventually create grassland and wetland habitats with structural characteristics suitable for northern harrier, then those lands would not support breeding pairs or contribute directly toward the conservation strategy for the species.

23.5.3 Landscape-level Habitat and Preserve Design Requirements for Viable Populations

The minimum habitat size and connectivity requirements for northern harrier are not well documented. This causes uncertainty in determining whether the preserve design will be effective in meeting the conservation goals for northern harrier.

23.5.4 Effectiveness of Mammalian Prey Population Enhancement Measures in Improving Foraging Habitat for Northern Harrier

Achieving the conservation goals and objectives for northern harrier may require successful enhancement of mammalian prey populations. Mammalian prey populations, particularly California vole, should be passively or actively promoted on all lands acquired and managed for northern harrier habitat. Whether these efforts will succeed at increasing the available prey base and enhancing habitat for northern harrier is unknown.

23.5.5 Other Data Gaps

Other data gaps that could be important for northern harrier conservation include: 1) responses of northern harrier populations to habitat management and enhancement techniques; 2) prey population dynamics and cycles; 3) variation in recruitment and survival between natural and disturbed habitats; 4) habitat use and nest success between wet and dry habitats; and 5) an appropriate livestock grazing and fire regime appropriate for northern harrier habitat management and enhancement.

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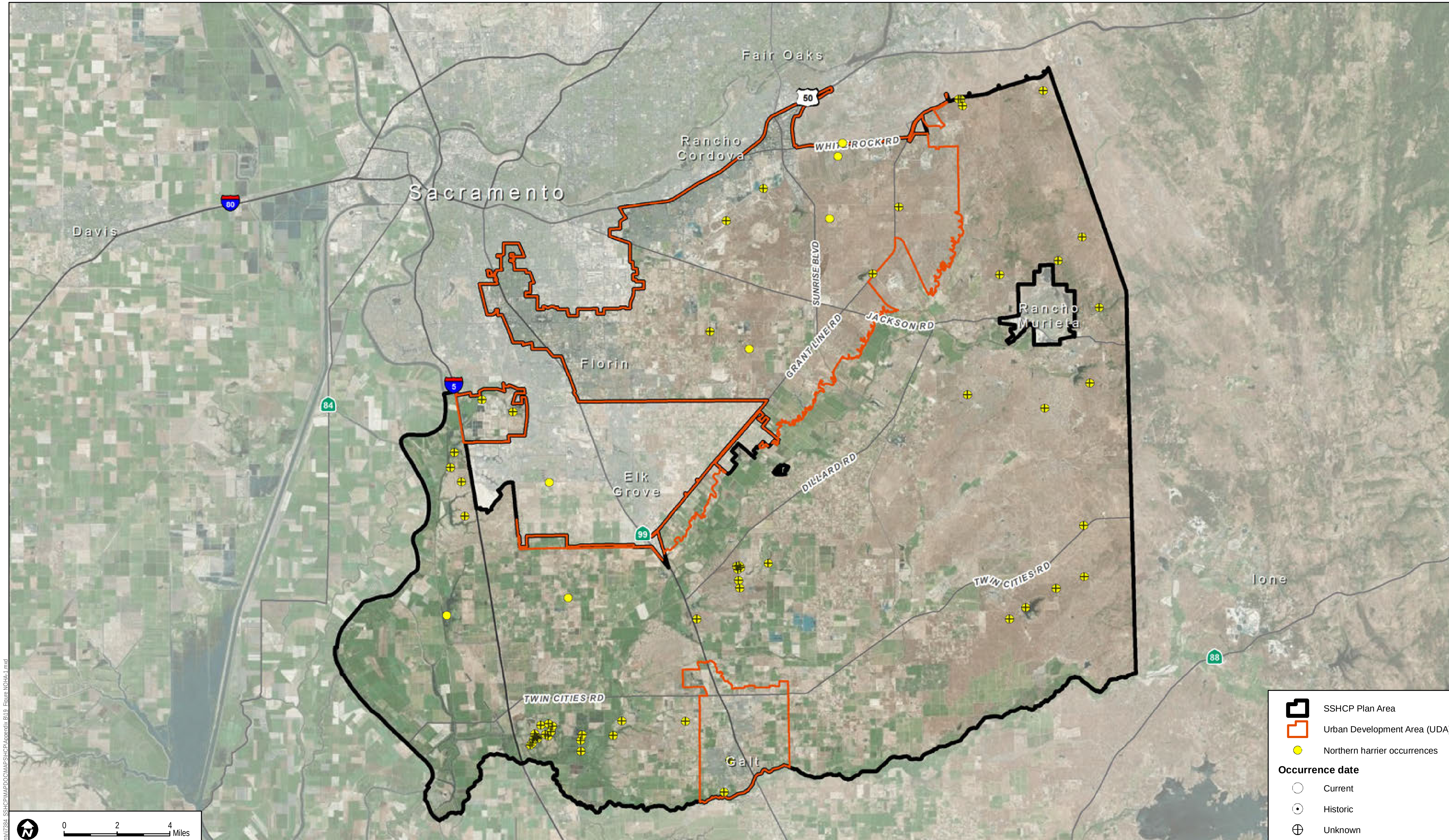

SOURCE: Bing Maps, County of Sacramento 2014, ebird.org

FIGURE NOHA-1

Northern Harrier Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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24 WHITE-TAILED KITE (WHKI)

Prepared by Todd Sloat Biological Consulting (Todd Sloat)

White-tailed Kite (WHKI)

(Elanus leucurus)

Status USFWS: None

Status CDFG: Fully Protected Species

Ron Wolf 2008

24.1 Legal Status

The white-tailed kite (*Elanus leucurus*) is legally protected under the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-7012). It is also protected under the California Fish and Game Code (Section 3503.5, 3513, and 3800) and is identified and protected as a California Fully Protected Species (Section 3511). White-tailed kite is not listed as a species of special concern by the California Department of Fish and Game (CDFG) (Shuford and Gardali 2008).

24.2 Life History and Ecology

24.2.1 Species Description and Life History

24.2.1.1 Physical Description

White-tailed kites are medium-sized hawks (total length 12.6 to 15 inches) with a long white tail and large, black shoulder patches. In adults, these features contrast with a gray back and white underparts. The sexes are similar is size, but females tend to have darker backs than males. Adults have red eyes and juveniles have yellow eyes. Juveniles have fluffy streaks on the breast and head, and gray and white-tipped feathers on the back. White-tailed kites are also recognized by their foraging behavior, frequently hovering in the air "kiting" while searching for prey (Sibley 2000; Sibley 2001).

24.2.1.2 Reproduction

White-tailed kites are monogamous and breed between February and October. Pairs select nest sites and build stick nests in trees, and are generally considered territorial to other kites and most large raptors (Dunk 1995; Henry 1983). Alternate nests are commonly built and may be used in subsequent breeding attempts (Waian 1973) even when first nest is successful and young are still dependent (Wright 1978). Most white-tailed kite nest studied by Erichsen (pers. comm.) failed during the first attempt due to factors including weather, predation or harassment (i.e. by Swainson's hawks [*Buteo swansonii*] or Corvids). Two broods are more common during periods of high prey abundance (Stendell 1972).

Nests are built by both sexes and the age at first breeding is unknown. Each sex gathers sticks to build nest and carries them in bill or with feet, although female places most of the sticks during nest construction (Dunk 1995). Most nests are located within the upper third of the tree and may be shaded or exposed to direct sunlight for long periods. The nests are primarily composed of small twigs and lined with grass, hay, or leaves and can take as long as 28 days to build (Dixon et al. 1957).

Females typically lay a clutch of four eggs and lay one egg every other day (Stendell 1972). Females incubate eggs exclusively (Dixon et al. 1957). Incubation begins after first or second egg is laid (Stendell 1972) and lasts for 30 to 32 days (Hawbecker 1942). Females take breaks from incubation to preen, stretch (Dixon et al. 1957), remove pellets which are dropped greater than 164 feet (50 meters) from the nest (Dunk 1995), and receive prey from the male.

Males continue to deliver prey to female when young hatch, although only female feeds prey to altricial young (Dixon et al. 1957). Prey are torn apart and fed to young until they are about 3.5 weeks old (Moore and Barr 1941). Although siblings attempt to monopolize food, females discourage aggressive young, and siblicide is not reported (Dixon et al. 1957; Dunk 1995). Young fledge around four to five weeks after hatching, and adults may teach young to fly by hovering over nest and fledglings (Waian 1973). Within two months of fledging, immature White-tailed kites are known to establish and hold territories (Dunk 1995).

24.2.1.3 Longevity, Survival, and Mortality

Little data is available for longevity and survival of white-tailed kites. The maximum life span recorded is five years and eleven months (Clapp et al. 1982). Mortality of white-tailed kites primarily occurs from natural causes (inclement weather and predation) (Stendell 1972). Predation by other large raptors is suspected from the remains of immature white-tailed kites found beneath larger raptor perches (Dunk 1995).

24.2.1.4 Dispersal Patterns

Little information is available for dispersal patterns of white-tailed kites. No evidence of natal philopatry exists, although one individual immature established a territory adjacent to natal territory (Dunk 1995).

24.2.1.5 Diet and Foraging

White-tailed kites may be observed in California hovering over grassland and ruderal habitat along the side of and in-between the Interstate 5 corridor. The species hunts almost exclusively by hovering at heights between five to 25 meters, often facing into the wind. A white-tailed kite will hover for longer periods (greater than one minute) in windy conditions, but will hover for a shorter duration until it attacks, flies to another hover location, soars, or flies to a perch (Dunk 1995; Jacsic et al. 1987). Hunting from a perch is rarely recorded (Dunk 1995). An attacking bird holds its wings nearly vertical and then drops straight down feet first. Once prey is captured, individuals fly to nearby perch to consume prey by first eviscerating, then decapitating and eating the head and body parts (Dunk 1995). During time periods when the male is feeding female or young, males fly to nest site with prey and exchange with female by perching side-by-side or by aerial exchange where female approaches hovering male from behind and grasps prey with talons from male (Dunk 1995; Waian 1973).

White-tailed kites predominantly feed on small mammals (greater than 95 percent), although a remarkable number of 10,959 different prey items have been reported from California (Dunk 1995). The species is considered a small mammal specialist, and several dietary studies (Hawbecker 1940, 1942; Dixon et al. 1957; Waian and Stendell 1970; Waian 1973; Wright 1978; Stendell 1972) from pellet analysis reveal that voles (*Microtus* spp.*)*, house mice (*Mus musculus)*, and harvest mice (*Reithrodontomys* spp.) are the most frequent prey species eaten. Vole is most frequently eaten and is a prey species known to dramatically fluctuate in abundance. Small mammals other than house and harvest mice are occasionally eaten (2.1 to 18 percent). White-tailed kites are not known to drink water, and pellet casting is related to timing of feeding (Stendell 1972).

24.2.1.6 Movement and Migration Patterns

White-tailed kites are generally thought of as resident species throughout their range although nomadism is suggested (Dunk 1995). White-tailed kites have expanded their range during the last 40 years (Waian and Stendell 1970; Eisenmann 1971; Pruett-Jones et al. 1980) and colonized San Clemente Island from mainland California, a distance of 50 miles (Scott 1994). Nomadism appears to be linked to low abundances of California voles (*Microtus californicus*). Individuals are reported moving prior to the breeding season (January through April) (Stendell 1972).

Individuals banded as nestlings were found 12 miles away from natal site in 8 months after banding, and 100 miles after two years (Dixon et al. 1957). Stendell (1972) recovered four nestlings that were banded. One individual was found one mile of the natal site, and the other three were found between 10 and 30 miles from the natal site.

24.2.1.7 Territoriality/Home Range

Territoriality of white-tailed kites during the nesting season likely varies by an order of magnitude throughout the species range (Dunk 1995). Competitors proximately regulate territoriality size, but ultimately prey numbers regulate territory size because they apparently control competitor's numbers (Dunk and Cooper 1994). Territory sizes estimated along the south coast of California near Long Beach ranged from 22 to 128 acres (nine to 52 hectares) (Waian 1973) and near San Diego from 42 to 217 acres (17 to 88 hectares) (Henry 1983).

Breeding densities of white-tailed kites vary with local prey abundance, ranging from one pair per 64 acres to one pair per 1,116 acres in occupied habitat (Stendell 1972). Winter densities along the north coast ranged from one white-tailed kite per 15 acres to one per 28 acres in occupied areas that supported large vole populations (Dunk and Cooper 1994).

White-tailed kites roost individually or communally during winter and often reuse roost sites annually, sometimes greater than 30 years (Erichsen pers. comm.). Communal roosts typically contain between 10 and 40 individuals (Waian 1973), and have supported more than 100 (Bolander and Arnold 1965). Communal roost sites are located in a variety of locations including woodlands and even large trees within urban areas (Erichsen pers. comm.). Human disturbance in urban areas has caused white-tailed kites to abandon some communal roost sites (Waian 1973; Dunk 1995), but in some instances, attempts to discourage communal roosting by kites are difficult and unsuccessful (Erichsen pers. comm.). White-tailed kites are known to travel over twenty miles to communally roost together (Erichsen pers. comm.).

24.2.1.8 Ecological Relationships

Predator-prey relationships are important for white-tailed kites, particularly because they are predators and affected by prey (small mammals) population cycles and abundance; and predation by other taxa is a source of mortality. Populations appear regulated by prey availability (Stendell 1972; Dunk and Cooper 1994), therefore availability of nesting and roosting sites may be important in areas where prey is abundant. Population distribution is also attributed to prey abundance (Dunk and Cooper 1994), as white-tailed kites have expanded their range during the last 40 years (Waian and Stendell 1970), even across ocean waters some 50 miles away to colonize San Clemente Island (Scott 1994).

Increased competition for nest sites with other raptors and corvids is suspected to negatively affect white-tailed kite populations (Dunk 1995). In areas where competitors occur, territory size is negatively influenced by competitor abundance (e.g. northern harriers [*Circus cyaneus*], red-tailed hawks [*Buteo jamaicensis*], red-shouldered hawks [*B. lineatus*], American kestrels [*Falco sparverius*], short-eared owls [*Asio flammeus*], and barn owls [*Tyto alba*]) (Dunk and Cooper 1994). Some competitors (red-tailed hawks, common ravens [Corvus *corax*]) are kleptoparasitic.

Suitable nesting substrates have declined in some regions where isolated trees have fallen and new regeneration is lacking.

24.2.2 Habitat Requirements and Ecology

White-tailed kites generally inhabit low-elevation grasslands, wetlands dominated by grasses, oak woodlands, and agricultural and riparian areas (Dunk 1995). Nests are built in trees that occur in isolation or in riparian areas. Other nesting raptor species as well as other conspecifics are known to compete for nest sites and territory size, but ultimately abundance of prey species is the primary factor that influences their numbers and distribution (Dunk 1995).

Nest tree selection has not been well studied. White-tailed kites have been found nesting in isolated trees and in trees within large stands (greater than 100 hectares) (Dunk 1995). Nests are built in several tree species and even in a few shrubs. These species include valley oak (*Quercus lobata*), interior live oak (*Q. wislizeni*), boxelder (*Acer negundo*), ornamental trees, cottonwood (*Populus* spp.), olive (*Olea* spp.), (CDFG 2010; Pickwell 1930; Hawbecker 1942; Dixon et al. 1957). The height of nest trees/shrubs ranges from 10 feet (three meters) [e.g., coyote-brush (*Baccharis* spp.*)* and saltbush (*Atriplex* spp.*)*] (Stendell 1972) to 164 feet (50 meters) [e.g. coast redwood (*Sequoia sempervirens)* and sitka spruce (*Picea sitchensis)*] (Dunk 1995). In the Central Valley, white-tailed kites have been observed nesting in valley oak, cottonwood, and pine (*Pinus* spp.) trees (Hopkins pers. comm.). White-tailed kites are territorial with conspecifics, and are known to nest at relatively close distances (e.g. 153 meters) (Dixon et al. 1957; Pickwell 1930; Hawbecker 1942). Erichsen (pers. comm.) reported that white-tailed kite nests in riparian areas were typically located within 0.25 miles of one another.

The size and structural diversity of woodlands supporting white-tailed kite nests has not been well documented. Nest sites are rarely found in isolated trees. They are usually located on the edge or riparian habitats, or in hedgerows and groups of trees, and are commonly found adjacent to natural vegetation, pasture crops (alfalfa) and sugar beets (Erichsen pers. comm.).

White-tailed kites use a variety of habitat types for foraging and the importance of these habitats is dependent on vegetation structure and prey abundance. Lightly grazed or ungrazed grasslands/pastures support larger prey populations and are thus considered more suitable, although intensively cultivated areas are also used (Dunk 1995). In cultivated areas, perennial crops such as alfalfa and sugar beets tend to support higher prey numbers, and White-tailed kite nest densities have been highly correlated with these two crops (Erichsen et al. 1994). Nesting studies conducted by Hawbecker (1942) showed that white-tailed kites foraged up to within 0.5 miles from the nest during the breeding season. During winter and the breeding season, Warner and Rudd (1975) found foraging from nest or perch sites extended up to 1.8 miles, but most were less than 0.6 miles. Foraging primarily occurred in two habitat types, riparian and irrigated cultivated land (e.g. alfalfa, tomatoes, sugar beets).

The occurrence and abundance of white-tailed kites during the breeding and non-breeding seasons are strongly affected by the dynamics of local rodent prey populations. Because rodent population cycles are often irruptive, and kite populations are sensitive to the availability of rodent prey, the suitability of an area and its occupancy by white-tailed kites may vary during certain years. Stendell (1972) found the density of voles at the onset of the breeding season affects the presence and abundance of nesting white-tailed kites. Winter densities of white-tailed kites are strongly correlated with the abundance of voles. The mean number of California Voles/territory was estimated at 1,483 for territories ranging from 3.9 to 53 acres (1.6 to 21.5 hectares) in northern California (Dunk and Cooper 1994). In other studies occurring in southern California (Waian 1973; Henry 1983), no prey abundances were reported with nesting territories.

Because white-tailed kites are highly dependent on voles, understanding habitat types optimal for prey species is of high importance. Many small mammal studies have been conducted including two studies in and adjacent to the Plan Area (Jones et al. 1999; Wyatt et al. 1991). The three most abundant species in both studies were the deer mouse (*Peromyscus maniculatus*), house mouse, and meadow vole (*Microtus californicus*). Jones et al. (1999) found the highest numbers of small mammals in perennial grassland, ruderal roadside vegetation, and restored riparian habitat when compared to alfalfa, annual grassland, and seasonal wetland. Abundance indices for these species varied by season and habitat type. When abundance indices for each of the three dominant species were combined for each season, the highest total index (1.47) occurred in perennial grassland habitat during spring.

The level of human disturbance that white-tailed kites can tolerate during the breeding season is unknown. The species generally avoids areas with regular human disturbance, although a small number of pairs appear to tolerate humans and nest at rural and urban margins (Erichsen pers. comm.). Communal roosts during the non-breeding season have been disturbed by humans and caused abandonment (Dunk 1995); however, if not disturbed, the species is known to roost communally in residential areas in cities for several consecutive years (Whisler pers. comm).

24.2.2.1 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for white-tailed kite are identified in Table WHKI-1 and have been derived from input from local species experts.

Table WHKI-1
Essential Habitat Elements for White-tailed Kite

Essential Activities	Land Cover Types	Habitat Elements
Foraging	Blue oak savanna, cropland, irrigated pasture grassland, valley grassland, vernal impoundment, vernal pool, seasonal wetlands, seasonal impoundment, and freshwater marsh.	White-tailed kites predominantly feed on small mammals (>95%). The occurrence and abundance of white-tailed kites during the breeding and non-breeding seasons are strongly affected by the dynamics of local rodent prey populations. Because rodent population cycles are often irruptive, and kite populations are sensitive to the availability of rodent prey, the suitability of an area and its occupancy by white-tailed kites may vary during certain years. CFP (2000) listed an objective of identifying habitat requirements of prey populations. In agricultural areas, prey populations vary, but perennial crops (ex. pasture, alfalfa) generally provide better foraging opportunities compared to annual crops (e.g. grains).
Nesting	Blue oak woodland, mixed riparian scrub, mine tailing riparian woodland, and mixed riparian woodland.	Nest tree or woodland nest site selection has not been well studied and may not be as important as prey abundance. Nests can be found in isolated trees, but are more often associated with small or medium size riparian woodlands with associated grasslands, irrigated pastures, or cultivated crops such as alfalfa and sugar beets. Dunk (1995) suggests that adding nest trees in open grasslands where there are few trees may be useful if White-tailed kites are limited by nest sites. A few white-tailed kites are known to nest in urban and suburban areas.

24.3 Species Distribution and Population Trends

24.3.1 Species Distribution

In the United States, the white-tailed kite breeds primarily in the Central Valley, coastal valleys and prairies of California. A few instances of breeding have been documented in Oregon and Washington. The white-tailed kite also commonly nests in southern Texas, and small nesting populations can be found in Florida. Outside the United States, white-tailed kites are found along the coastal areas of Mexico, Panama, the slope of the Caribbean, Colombia, Venezuela, Guyana, Brazil, Paraguay, Uruguay, and northern Argentina (Dunk 1995).

24.3.2 Central Valley Distribution

White-tailed kites can be found throughout the Central Valley where grasslands, vernal pool complexes, low-growing agriculture crops, and oak savannah and woodlands occur. No studies have documented the densities of breeding or wintering population numbers within the Central Valley.

24.3.3 Range WithIn Plan Area

White-tailed kites occur in suitable habitat throughout the Plan Area; their overall distribution, abundance, and population structure are not well known. Land cover types used by white-tailed kites, such as grasslands, vernal pool grasslands, riparian, oak savannah and woodlands, fallow agricultural fields, and cultivated agricultural fields occur throughout most of the Plan Area, particularly outside the Urban Development Area (UDA). At most sites within these land cover types, the presence and population status of white-tailed kites is not known.

No regularly occurring surveys have been conducted throughout the Plan Area, however, white-tailed kites are known to nest or forage throughout the Plan Area (Connard pers. comm.). These areas include Mather Lake (Conard pers. comm.), Mather Regional Park, Laguna Creek (Jones pers. comm.), and Morrison Creek and adjacent lands (Jones pers. comm.). They are also known to nest or forage in the Cosumnes River corridor, The Nature Conservancy's (TNC) Howard Ranch (Trochet pers. comm.), and suspected to nest at Stone Lakes National Wildlife Refuge (NWR) (Conard pers. comm.). The above areas constitute a subset of the potential habitat available for nesting and foraging white-tailed kites.

Some additional information on white-tailed kite distribution is also available from Swainson's hawks surveys conducted by the CDFG. These surveys are conducted throughout the Central Valley and include sixteen 3.1 square miles (five square kilometers) survey plots in the Plan Area. During the Swainson's hawk surveys, the presence of white-tailed kites were recorded if they were observed on any one of the three survey visits conducted during the Swainson's hawk breeding season. White-tailed kites were found in nine of the sixteen survey plots. The location of these survey plots where the kites were found primarily occurred in the southwestern portion of the Plan Area. Interestingly, no white-tailed kites were found in four study plots located in the central eastern portion of the county (i.e., near the area of Rancho Murrieta).

Because comprehensive surveys or monitoring efforts for the white-tailed kite in the Plan Area have not been conducted, and because the existing data of known occurrences are based mostly on incidental observations or limited surveys, the population size and nesting distribution of this species in the Plan Area are not well known. In the Plan Area, the CNDDB reports six occurrences inside the UDA, and four occurrences outside the UDA (CDFG 2010). These numbers do not provide an estimate of the distribution or population size of the kites because they are based on a very small number of surveys in a limited area. Figure WHKI-1 illustrates the distribution of occurrences of white-tailed kites within the Plan Area as recorded in the CNDDB (CDFG 2010) and from other sources (ebird.org 2005-2010; Estep 2007; Klotz Property 2005).

24.3.4 Population Levels and Trend

White-tailed kite populations have fluctuated greatly over the past century. According to Grinnel and Miller (1944), this species was common and widespread in the Central Valley and foothills before 1895 but was rare or entirely gone from many areas by the 1940's. The declines in California populations during this period have been attributed to a combination of habitat loss, shooting (kites were considered a pest species), and possibly egg collecting (Waian and Stendell 1970). From the 1940's to the early 1980's California populations increased dramatically (Fry 1966; Waian and Stendell 1970; Pruett-Jones et al. 1980), and their range expanded greatly (Dunk 1995). Factors that may have contributed significantly to this population increase include increased agricultural irrigation, reduced hunting, and the natural potential of the species for population growth.

Since the early 1980's, white-tailed kite populations have steadily decreased again throughout much of their range in California. The most significant declines have occurred in southern California grassland regions (i.e. 38.7 percent between 1982 and 1991) (Dunk 1995). No other values for percent declines in other regions were reported; however, ten of the remaining 13 regions showed declines. Factors possibly contributing to this decline include:

- The conversion of natural habitat or agricultural lands to urban development;
- Conversion of grassland, pastures, and agricultural fields to non-suitable crops such as vineyards;
- Increased disturbance of kites by human activities, farming techniques that remove vegetation along field margins that host prey species; and
- Increased competition for nesting sites with other raptors or with corvids (crows, ravens, and jays).

No population size or population trends have been specifically studied for the Central Valley or within the Plan Area. From Breeding Bird Surveys, Sauer et al. (1999) determined that overall numbers in California have increased, but increases were not statistically significant. Regional areas found to be decreasing included the Central Valley, southern California grasslands, and southern Pacific rainforests (CPF 2000). The California Natural Diversity Database (CNDDB) of the CDFG listed 10 occurrences in the Plan Area (CDFG 2010). These data are based on a small number of reports and do not represent an accurate measure of local population size. The actual population size in Plan Area is unknown and expected to be much larger than reported.

24.4 Threats to the Species

The white-tailed kite is threatened by habitat loss and alteration, and possibly from shooting, collisions with stationary/moving structure or objects, and disturbance at nest and communal roost sites. Few studies have good empirical data on population declines and because the species is known to vary in its nesting distribution, identifying whether once occupied habitat has become unsuitable is difficult. The following summarizes threats to white-tailed kite populations.

24.4.1 Habitat Loss and Alteration

Both nesting and foraging habitat for white-tailed kites has been lost to urbanization or converted to agricultural crops that do not support prey species or that are used for foraging. In addition, much of the grassland habitat used for foraging by white-tailed kite has been converted to other uses. DeHaven (2000) quantified changes in California cropping patterns and found that white-tailed kite “friendly” habitats such as rangelands, grassland, and pastures have decreased. These habitats have been replaced by a variety of other crops (e.g. fruit and nuts, cotton, and vineyards) that are not used by white-tailed kites, or by crops (e.g., vegetables and melons, tomatoes, beans, potatoes) that are suspected of lower quality than grassland habitats for foraging white-tailed kites.

Habitat loss and alteration also threatens white-tailed kites by fragmenting habitat, minimizing natural tree recruitment, and potentially lowering reproductive success by requiring kites to forage over longer distances. In fragmented habitat, increased foraging time theoretically also increases the time susceptible to predation and agonistic interactions with competitors. Fredrickson and Laubhan (1995) documented increasing fragmentation by urbanization, and in some areas, encroaching woody vegetation was decreasing grassland patch size. Some bird species are only found in grassland patches that are 100 times the size of an average territory of a given species (CDFG and PRBO 2003). In rangelands, natural tree recruitment has been minimized, and the decreased number of trees may limit nesting opportunities for white-tailed kites (Dunk 1995).

24.4.2 Shooting

White-tailed kites were once considered a pest species and were shot (Waian and Stendel 1970). No new research such as banding studies has been conducted that may prove that shooting still occurs. In general, white-tailed kites and other raptors are not regularly shot and this threat is not considered to seriously affect their populations (Hunt pers. comm.).

24.4.3 Disturbance at Nest and Communal Roost Sites

White-tailed kites are sensitive to human disturbance during communal roosting and nesting (Dunk 1995). They are known to travel greater than twenty miles during winter to roost together (Erichsen pers. comm.), most often in areas of little human disturbance, and nesting pairs are usually found in areas with minimal disturbance. Waian (1973) reported that white-tailed kites temporarily abandoned a communal roost site, although the type of disturbance and season was not reported. During this study, all terrain vehicles repeatedly disrupted a communal roost and the kites abandoned the site one day after the disturbance (Dunk 1995). Some individuals are known to tolerate disturbance of regular vehicle traffic and human activities, especially during winter. White-tailed kites are known roost communally in residential areas and also at urban fringes (Whisler pers. comm.). At one communal roost site in Davis, a landowner tried several measures to disturb greater than 100 kites communally roosting in pine trees. The white-tailed kites simply flew in at dark. Eventually, and landowner removed the tops of the trees to discourage their use by kites (Erichsen pers. comm.). Even during the nesting season, white-tailed kites have established nest sites in areas such as parks and areas at the urban fringe (CDFG 2010; Whisler pers. comm.), although one nest site monitored by Erichsen (pers. comm.) failed to produce young.

24.5 Data Gaps and Conservation Implications

Several researchers have documented many of the life history traits, habitat requirements, distribution, population trends, and threats to the species throughout its range. This information is important for the development of the white-tailed kite Conservation Strategy; however, the data gaps have implications for the species conservation.

24.5.1 Unknown Number of Undiscovered White-tailed Kite Nesting Territories/ Breeding Areas and Communal Roost Sites.

Additional unsurveyed and partially surveyed potentially suitable habitat exists within the Plan Area and elsewhere within the range of the species. In the Plan Area, discovery of nesting territories/breeding areas or communal roost sites of white-tailed kites may occur anywhere that suitable habitat is present.

24.5.2 Unknown Relationship Between Apparently Suitable Habitat Conditions but Unoccupied by Nesting Individuals

White-tailed kites do not currently occupy habitat that appears suitable (Jones pers. comm). Although specific habitat elements are present (i.e., nest trees), and general habitats such as fallow fields occur nearby, no active nest sites have been identified.

24.5.3 Pesticide and Herbicide Application

The use of pesticides and herbicides in agricultural areas and their impacts on prey items for white-tailed kite are unknown. Traditional efforts of rodent control may have impacts on white-tailed kite foraging opportunities.

24.5.4 Unknown Relationship between West Nile Virus and White-tailed Kites

West Nile Virus has only recently been reported in North America and has been found to primarily affect crows and other corvids by causing direct mortality. Many other birds species are also exposed, and owls appear to be a susceptible family of birds that develop both clinical signs and significant mortality (Fitzgerald et al. 2002). It is unknown if the virus can affect other raptors, such as the white-tailed kite, but some researchers believe that raptors may develop West Nile Virus by ingestion of infected prey such as smaller birds or mice, rather than direct transmission by biting mosquitoes (Garmendia et al. 2000).

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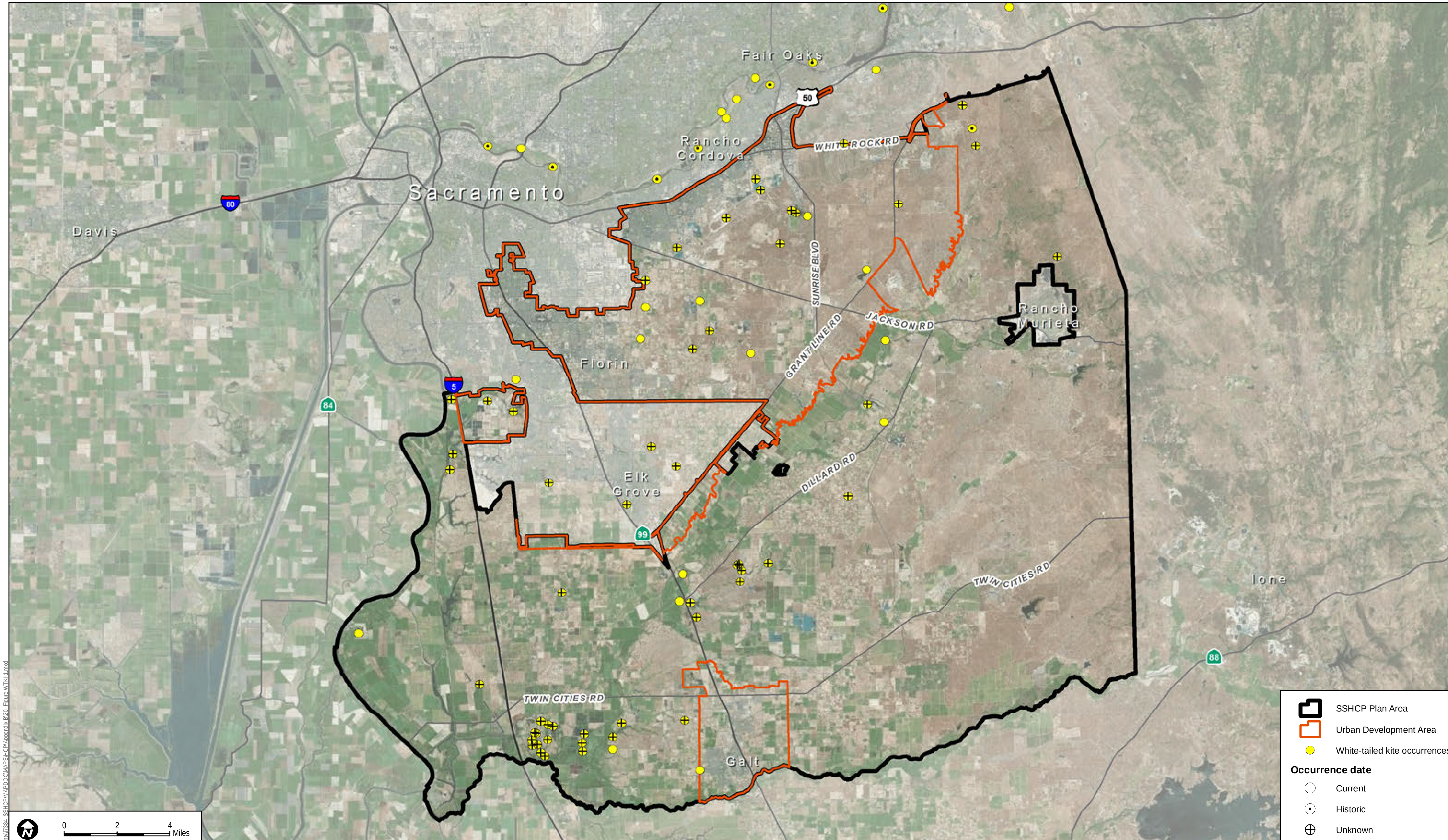

SOURCE: Bing Maps, County of Sacramento 2014, CDFG 2012, ESTEP 2006, ebird.org

FIGURE WHKI-1

White-Tailed Kite Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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25 GREATER SANDHILL CRANE (SACR)

Prepared by Todd Sloat Biological Consulting (Todd Sloat)

Greater Sandhill Crane (SACR)

(Grus candadensis tabida)

Status USFWS: None

Status CDFG: Threatened

25.1 Legal Status

Greater sandhill crane (*Grus canadensis tabida*) is listed as threatened under the California Endangered Species Act (CESA) and is legally protected under the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-7012) and the California Fish and Game Code (Section 3503.5 and 3800).

25.2 Life History and Ecology

25.2.1 Species Description and Life History

25.2.1.1 Physical Description

The greater sandhill crane is the largest of six subspecies occurring in North America. All sandhill cranes subspecies physically appear similar except for size. Adult sandhill cranes are gray overall with a dull red skin on their crown and lores. They have white colored feathers on the chin, throat, and cheek, and black colored primary feathers. The males and females are similar in plumage. Juveniles lack the dull red crown, and the gray colored body is irregularly mottled with brownish-red. Adults can also appear mottled brownish-red, but the color is from "stains" and not a true feather color.

25.2.2 Demography

25.2.2.1 Reproduction

In California, nesting greater sandhill cranes occur in Lassen, Modoc, Plumas, Shasta, Sierra, and Siskiyou Counties (Littlefield 1989; CDFG 1997).

Greater sandhill cranes nest in open areas of wet meadows. These areas are often interspersed with emergent marsh. Sandhill cranes usually build their nests over shallow water. Clutch size is typically two, and adults and young forage in emergent marsh and meadow habitat during the nesting season (CDFG 1997).

25.2.2.2 Longevity, Survival, and Mortality

The maximum age in the wild for any subspecies of sandhill crane is 21 years (Tacha et al. 1992), while in an eastern unhunted population of greater sandhill cranes, annual survival rates for post-juvenile males and females were 0.87 and 0.86 respectively. Ivey (pers. comm.) calculated survival rates for greater sandhill cranes nesting at Malheur National Wildlife Refuge (NWR) and Modoc NWR. For Malheur NWR, he found an annual survival rate of 0.9 (se=0.013) for adults and 0.66 (se=0.096) for juveniles. At Modoc NWR, annual survival rate was calculated to be 0.88 (se = 0.016) for the population.

Mortality can occur from a variety of factors. Greater sandhill cranes are not legally hunted in California and hunting is not considered a serious threat to the species. Collisions with transmission lines are known to cause crane mortality, especially in areas with high winds and fog (Tacha et al. 1992), while sandhill cranes also die from diseases such as avian botulism and cholera (Windingstad 1988).

Mortality from predation by foxes (*Vulpes* spp.), racoon (*procyon lotor*), coyote (*Canis latrans*), gray wolf (*C. lupus*), bobcat (*Lynx rufus*), common raven (*Corvus corax*), eagles, and owls typically occurs with eggs and young (Walkinshaw 1973).

25.2.2.3 Dispersal Patterns

Adults and young generally expand their range after breeding which leads to pre-migration staging (Tacha et al. 1992). Pairs and family groups consistently return to breeding areas and wintering sites if habitat conditions are suitable. Juveniles remain with adults during the first year in family groups and do not disperse until they return to the breeding areas the following year. Males are more philopatric to the natal site than females, although distances moved have not been reported (Tacha et al. 1992).

25.2.2.4 Diet and Foraging

Sandhill Cranes forage on a variety of food items by probing with their bills and gleaning food on the ground surface. They are considered omnivorous and have been reported to feed on cultivated grains, berries, small mammals, insects, snails, reptiles, amphibians, nestling birds, and seeds.

Studies by Ivey and Herziger (2003) show that within and adjacent to the Plan Area, wintering greater sandhill cranes feed in a variety of agriculture crop types; however, food items consumed in the study have not been documented.

25.2.2.5 Movement and Migration Patterns

Greater sandhill cranes are migratory and leave the northern breeding areas in mid-September. Cranes migrate in small groups (20 to 50 individuals) composed of pairs and family groups. By late October, most greater sandhill cranes have left their northern breeding or staging areas and have arrived on the wintering grounds. Once on the wintering grounds, greater sandhill cranes use traditional areas throughout the winter. Migration back to the breeding areas starts in February and is completed by mid-March (Ivey and Herziger 2003).

25.2.2.6 Territoriality/Home Range

Winter home ranges of greater sandhill cranes using the Staten Island area averaged 0.66 square miles (1.71 square kilometers), varying from 0.07-2.12 square miles (0.17-5.49 square kilometers). Cranes using other areas (e.g., Tyler Island, Cosumnes River Floodplain, and Sacramento-San Joaquin River Delta) were found to not travel far during winter. Only one of thirty-nine color marked greater sandhill cranes left the main winter use area. The rest remained in the main winter use area (Ivey and Herziger 2003).

Linear distances greater sandhill cranes traveled to forage from roost sites were also calculated by Ivey and Herzier (2003) and Pogson (1990). The average distance traveled was 0.88 mi (range 0.17-1.89 mi) (Ivey and Herziger 2003) and 1.74 miles (Pogson 1990) between roost sites and foraging areas.

25.2.3 Habitat Requirements and Ecology

Greater sandhill cranes wintering in and adjacent to the Plan Area use open agricultural habitats, natural vegetation communities, and seasonally managed wetlands. After the onset of winter rains, Sandhill Cranes begin foraging for invertebrates by probing soils in grassland habitats and overturning cattle dung. They also hunt for mice in taller grassland vegetation (Littlefield and Ivey 2000). They appear to avoid grassland habitats when vegetation exceeds 10 inches (25 centimeters). Invertebrates are also consumed in natural and managed seasonal wetlands.

Grain is also an important component to the sandhill crane's diet and as such agricultural habitat types are frequently utilized as foraging habitat. Common habitat types used for foraging include pastures, alfalfa, corn (chopped, disced, flooded, and stubble), tomatoes (flooded, ripped), and wheat (disced, ripped, flooded, stubble) (Ivey and Herziger 2003). Ivey (pers. comm.) rated agriculture crops in the Plan Area in order of importance. Rice and corn were rated the highest, followed by winter wheat and irrigated pasture. Alfalfa was the next highest rated crop, followed by hay, dryland pasture, and row crops. Sandhill Crane use in the above crop types occurs even though the crops are harvested for farming income. Allowing the crops to mature (e.g., corn) and serve as "food plots" for cranes has been successful in attracting cranes to refuges (Littlefield and Ivey 2000).

Habitats also important for greater sandhill cranes include flooded fields for roosting and rocky uplands (e.g., dirt and gravel roads) for collecting "grit." Roosting areas are located in shallowly flooded areas where cranes loaf during the day and seek protection from terrestrial predators at night. Although they will select sites with emergent vegetation along the periphery of the wetland, they rarely use roosts with heavy emergent vegetation (Littlefield and Ivey 2000). The size of roost sites is variable. Sandhill cranes roosting in Oregon used sites between 1-300 acres (0.5 to 120 hectares), with water depths averaging 4.5 inches (11.7 centimeters). Littlefield (1993) reported cranes abandoning roost sites when water depths reached eight to 11 inches (20 to 29 centimeters). He recommended roost sites should be at least 20 acres (8 hectares) in size, with water maintained from early September to mid-March. Collection of grit by cranes is important when their diet is composed of grain seeds. Grit collected in dirt and gravel roads can be essential when none is available near foraging sites. Sandhill Cranes in Sutter County have been reported flying up to five miles (eight kilometers) to obtain grit (Littlefield and Ivey 2000).

Greater sandhill cranes travel limited distances to foraging sites from night roost areas. Typically, the foraging areas are located within two miles of the night roost site. Most of the roost sites within the Plan Area are known.

Greater sandhill cranes are intolerant of excessive human disturbance and such disturbance may play an important role in habitat selection. Excessive disturbance has caused cranes to abandon foraging and roosting sites, and repeated disturbance affects their ability to feed and store energy needed for survival. Ivey and Herziger (2003) documented disturbance of greater sandhill cranes on Staten Island, a highly used area by cranes, and found that aircraft, vehicles, hunting, and recreational activities (e.g., birding, walking, horseback riding, bicycling, boating) can cause cranes to run or fly away. Ivey (pers. comm.) found that cranes generally avoid suitable agricultural foraging habitat near occupied dwellings, and foraging areas within 100 yards of human structures should not be considered suitable.

Greater sandhill cranes generally use open areas without significant distances of fencing. For example, the 9,200 acres on Staten Island contain virtually no fences. The only fencing on the entire island is located around a few residences. Sandhill cranes run and flap when initiating flight and this behavior prevents them from gaining altitude quickly and avoiding fences.

25.2.4 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment which are needed for survival and propagation of the species. The essential habitat elements for greater sandhill crane are identified in Table SACR-1 and have been derived from input from local species experts.

Table SACR-1
Essential Habitat Elements for Greater Sandhill Crane

Essential Activities	Land Cover Types	Habitat Elements
Foraging	Cropland, irrigated pasture grassland, valley grassland, freshwater marsh, and seasonal wetlands.	Open agricultural habitats (preferred without fencing). Foraging items (e.g. invertebrates or grains). Manage grassland habitats to not exceed 10 in height.
Roosting	Vernal impoundment, vernal pool, seasonal wetland, seasonal impoundment, and freshwater marsh.	Flooded fields with water maintained from early September to mid-March. Rocky uplands (e.g., dirt and gravel roads) for collecting “grit.” Cranes abandon roost sites when water depths reached 8-11 in. Cranes are intolerant of excessive human disturbance.

25.3 Species Distribution and Population Trends

25.3.1 Species Distribution

Greater sandhill cranes nest in the Great Lakes states, northwestern Minnesota, southeastern Manitoba; Rocky Mountain states; northeastern Nevada; southern British Columbia; southwestern Washington; central, eastern, and southeastern Oregon; and the Great Basin portion of California. Wintering sandhill cranes are found in southern Georgia and Florida, Texas Gulf Coast, New Mexico, southeastern Arizona, northern Mexico, southeastern California, and the Central Valley of California. In California, greater sandhill cranes nest in northeastern California and winter in the Central Valley, Sacramento-San Joaquin River Delta, southern Imperial County, Lake Havasu NWR, and the Colorado River Indian Reserve (Zeiner et al. 1990).

25.3.2 Central Valley Distribution

Greater sandhill cranes occur in limited locations in the Central Valley. A winter population estimate of 8,500 individuals was reported in January 1993. Of this estimate, 61 percent were using the Butte Basin, while the other two major areas used included the Cosumnes Floodplain and Delta. In the mid-1980’s, crane biologists believed 61 percent of the wintering greater sandhill cranes were found in the Delta, and the number of Cranes using the Cosumnes Floodplain increased from one percent in 1983 to 23 percent in 1984 (Littlefield and Ivey 2000). Apparently, Crane use of the Cosumnes Floodplain increases during flood years (Ivey pers. comm.).

Sandhill Cranes are counted each winter in the Central Valley during the "Mid-winter Waterfowl Survey Program" which is conducted from airplanes. No attempt is made to separate the species observed during the survey, but on occasion, ground surveys have been conducted concurrently with aerial surveys in order to determine relative proportions of Greater and Lesser Sandhill Cranes. Hoffman (pers. comm.) found that in the Sacramento Valley, most of the cranes observed were greater sandhill cranes, while those in the Sacramento-San Joaquin River Delta had a more even distribution of Greater and lesser sandhill cranes. The mid-winter waterfowl count conducted January 3rd to 6th, 2005 found 7,786 sandhill cranes in the Sacramento Valley, 2,611 in the Sacramento-San Joaquin River Delta, and 1,335 in the San Joaquin Valley.

The nearest greater sandhill crane use outside of the Plan Area occurs on the Stone Lakes NWR where several hundred greater sandhill cranes occur each winter. Crane use on the NWR and adjacent agriculture land occurs in wetland and irrigated pasture (Harvey pers. comm.). Greater sandhill crane use adjacent to the refuge has decreased from agriculture conversion.

25.3.3 Range within the Plan Area

Greater sandhill crane use in the Plan Area principally occurs in the Cosumnes River Floodplain. During the 1970's, few cranes were found in the Cosumnes River Floodplain, but by 1984, an estimated 24 percent of the wintering population was found using the flooded meadows and pastures of this latter area in late January (Littlefield and Ivey 2000). Pogsen and Lindstedt (1988) recorded a peak of 1,631 greater sandhill cranes during the 1983/84 winter along the Cosumnes River Foodplain and between the preserve and State Highway 99. Apparently, greater sandhill cranes use the Sacramento-San Joaquin River Delta in early winter. When local duck clubs dewater fields after hunting season (i.e., early January), these cranes move to the Cosumnes River Floodplain. Surveys in 1999 suggest crane use in the Sacramento-San Joaquin River Delta and Cosumnes River Floodplain is similar to that found in the mid-1980's (Littlefield and Ivey 2000).

Greater sandhill cranes that are foraging and roosting at the Cosumnes River Preserve tend to be concentrated in the roadless area south of Desmond Road, one to two miles east of Franklin Boulevard, and north of the Cosumnes River (Figure SACR-1) (Ivey and Herziger 2003). Greater sandhill cranes also use the area immediately west of the Plan Area south of Lambert Road (Harvey pers. comm.).

For the purposes of the SSHCP, the range of wintering greater sandhill crane is that area identified as use areas in the *Conservation Assessment for Greater Sandhill Crane Wintering on the Cosumnes River Floodplain and Delta Region* (Littlefield and Ivey 2000); however, this area was extended to include recorded occurrences (ebird.org 2005-2010) and all suitable habitat within a two-mile buffer of the occurrence location. In coordination with USFWS and CDFG the range was extended to include other adjacent habitat that is otherwise consistent with that previously defined. Figure SACR-1 shows the reported locations of sandhill crane sightings as reported by local birders on ebird.org (2005-2010) as well as the estimated range of the species within the Plan Area. There are no records for greater sandhill crane in the California Natural Diversity Data Base (CNDDB) (CDFG 2010).

25.3.4 Population Levels and Trend

Market hunting between 1880 and 1915 has been cited as having a severe impact on greater sandhill cranes (Littlefield and Ivey 2000). In the 1920's, Dawson (1923 *in* Littlefield and Ivey 2000) reported there were no more than six nesting pairs left in California. Two decades later, in 1944, Walkinshaw (1949 *in* Littlefield and Ivey 2000) estimated only three to five nesting pairs in California. In 1988, 276 pairs were reported and by 2000, 465 pairs were recorded at 127 sites (i.e., an increase of 68 percent).

Although population estimates have been regularly recorded on the breeding grounds in northern California, solid population data is not available for greater sandhill cranes wintering in California. The last detailed winter estimate was conducted in the Central Valley in January 1984. Surveyors found 6,000 greater sandhill cranes. Surveys in 1991 to 1993 estimated 8,500 individuals. During the mid-1980's, 23 percent (1,380) of the sandhill cranes occurred in the Cosumnes River Floodplain (Pogson 1990 *in* Littlefield and Ivey 2000). No recent detailed winter estimates are available for the Cosumnes River Floodplain. Ivey (pers. comm.) estimated that around 1,000 individuals used the area during the 2002/03 winter, while approximately 1,500 were documented using nearby Staten Island.

25.4 Threats to the Species

Historic threats to the species included market hunting, agricultural expansion, and wetland drainage. Although sandhill cranes are no longer hunted in California, agricultural expansion and wetland impacts still occur and affect the species. These and other threats are described below.

25.4.1 Habitat Loss and Alteration

Foraging and roosting habitat for the greater sandhill crane has been lost to urbanization or converted to agricultural crops that do not provide habitat for the species (i.e., vineyards, orchards). Conversion of grassland habitats to urban and agricultural uses proportionately exceeds the conversion of any other habitat type in California (Ewing et al. 1988; Moore et al. 1990 *in* Hunting 2001). Much of the grassland and grassland/vernal pool habitat used by foraging cranes has been converted to other uses. Some of these uses, including agricultural crops such as rice, corn, winter wheat, and irrigated pasture provide high quality habitat for cranes. However, many of these crops have been recently replaced by a variety of other crops (e.g., fruit and nuts, and vineyards) (DeHaven 2000) that are not used by greater sandhill cranes, or by crops (e.g., cotton, potatoes, tomatoes) that are rarely used or are of lower quality than grassland habitats (Ivey and Herziger 2003).

Recent habitat loss in the area of Stone Lakes NWR near the Plan Area has affected greater sandhill cranes. Greater Sandhill Cranes have been displaced from suitable habitat associated with the East Franklin Project (roughly 3,000 acres). Similarly, the conversion of approximately 1,200 acres of suitable habitat to vineyards at the Circle K Ranch has displaced cranes. Additional future expansion in the area (i.e., City of Elk Grove) could impact even more crane habitat.

Decreasing patch size of natural habitats and agriculture crops has been found to reduce habitat suitability for many bird species (including sandhill cranes). Ivey (pers. comm.) found that greater sandhill cranes generally will not use suitable foraging areas that are within 100 yards of a human dwelling. Cranes also flush and are disturbed when automobiles approach within such distances. When larger, more continuous tracks of lands are split and made smaller for other crops, vehicle traffic from farming operations often increases, and this increase in human activity negatively affects crane use.

25.4.2 Collision with Transmission Lines, Fences, and Television/Radio Towers

Greater Sandhill Crane collisions with distribution lines have been reported by several authors (Pogson et al. 1988; Tacha et al. 1978; Walkinshaw 1956; Wheeler 1966; Drewien 1973; Lewis 1974; Nesbitt and Gilbert 1976 *in* California Energy Commission 1995). These collisions typically occur in foggy and windy conditions and result in mortality (Tacha et al. 1978; Lewis 1974; Nesbitt and Gilbert 1976; Littlefield and Ivey 2000). It is unknown if these collisions occur frequently enough to be considered a threat to the overall population. Drewien (1973) found that collisions with power lines accounted for 37 percent of the observed Sandhill Crane mortality in his study population, while Pogson et al. (1988) concluded that power line collisions seem to be the largest source of unnatural mortality for California's Central Valley Sandhill Crane population. In one incident in Texas (i.e., one day), 52 sandhill cranes were found dead or dying from collision with distribution lines (Tacha et al. 1978). Limiting distribution lines in areas where Sandhill Cranes forage and roost during the breeding season is considered an effective means of minimizing mortality (Ludwig pers. comm.)

25.4.3 Disturbance of Foraging and Roosting Areas

Greater Sandhill Cranes do not tolerate regular disturbances. Types of disturbances that are detrimental to the subspecies include hunting, birding, photography, operating equipment for habitat management, boating, and aircraft. Disturbance forces them to expend unnecessary energy that is needed for survival during winter and migration. Disturbance during pre-dawn hours, such as hunting activities has caused cranes to leave roosts in darkness, increasing their risk for collisions with transmission lines or other obstructions. Only one pre-dawn disruption is usually necessary before cranes abandon a site (Littlefield and Ivey 2000).

Aircraft were found to affect the greatest numbers of greater sandhill cranes using Staten Island (Ivey and Herziger 2003). Aircraft disturbance documented during the study occurred from planes assessing water levels for mosquito abatement, weeds, levee integrity, as well as flying for recreational reasons. While aircraft have the ability to affect more cranes because they can cover large areas quickly, the most frequent disturbance type occurred from vehicles, including all-terrain vehicles (ATV's) (Ivey and Herziger 2003). Cars and trucks disturb cranes less than ATV's, providing the drivers stay inside the vehicle. This study also showed cranes are more tolerant to vehicles during mid-day compared to pre-dawn. Slow moving farm equipment only slightly disturbed cranes.

Disturbance from hunting also poses a serious threat to greater sandhill cranes. Hunters accessing hunt areas during pre-dawn hours flush cranes from their roosts and hunter presence can keep cranes from roosting or foraging in an area (Ivey and Herziger 2003). Because of hunting-related disturbances to cranes, Staten Island implemented a crane friendly hunting program. This program has been considered successful at minimizing disturbances and increasing crane use of the island. Ivey and Herziger (2003) noted that the number of greater sandhill cranes roosting on Staten Island more than doubled after the opening day of waterfowl season. This increase in crane numbers was attributed to the disturbance of cranes in nearby crane use areas (i.e., adjacent Delta Islands).

Waterfowl hunting may impact cranes less that pheasant hunting if hunters are limited to using blinds. During pheasant hunting, hunters and dogs who are on foot are more disruptive to cranes than waterfowl hunters sitting concealed in blinds (Ivey and Herziger 2003).

25.4.4 Epizootic Events

Like other waterfowl, sandhill cranes are limited by the low availability of wetland roost areas. For example, less than twenty salt lakes in western Texas provide roost areas for up to 80 percent of the mid-continent population during winter. Thus, greater numbers of Sandhill Cranes are "forced" to use these limited roost areas and are more susceptible to epizootic events such as cholera, avian botulism, aspergillosis, salmonella, and avian tuberculosis. Each of the above diseases has been documented to kill Sandhill Cranes (Tacha et al. 1992).

Avian cholera has resulted in greater sandhill crane mortality in San Joaquin County (S. Lindstedt pers. comm. with G. Ivey). Although no details were reported with this event, it is assumed to have only affected a small number of Sandhill Cranes. Several years of data collected from waterfowl surveys may support this assumption. Sandhill Cranes have been observed roosting in areas where thousands of dead waterfowl were being recovered due to death from avian cholera (Gifford pers. comm.). During an avian cholera abatement program from the mid-1970's to 2000 in the Sacramento-San Joaquin River Delta and Yolo Bypass area, two greater sandhill cranes were documented to succumb to avian cholera. In addition, another 32 records of sandhill cranes (subspecies unknown) were reported dead over a period of 20 years (Gifford pers. comm.). These numbers appear low, but may be important from a population perspective given there are fewer than 10,000 greater sandhill cranes wintering in California.

25.5 Data Gaps and Conservation Implications

Several researchers have documented the life history traits, habitat requirements, distribution, population trends, and threats to the subspecies throughout its range. This information is important for the development of the greater sandhill crane Conservation Strategy. The discovery of new information, considered here as data gaps, has additional implications for the species conservation. These topics are discussed below.

25.5.1 Population and Habitat Distribution within the Plan Area

Greater Sandhill Cranes occur in suitable habitat within the Plan Area. Greater Sandhill Cranes are not known to utilize many other apparently suitable lands within the study area. Until this data gap is remedied, the conservation value of grassland, seasonal wetlands, vernal pools, and suitable agricultural land-cover types for greater sandhill crane will be considered relatively high in lands that support (or recently supported) known occurrences, are large in extent, or are adjacent to these areas.

25.5.2 Amount of Wintering Habitat

Most of the greater sandhill crane wintering population within the Plan Area is assumed to occur in the Cosumnes River Floodplain. However, in severe winters where the amount of flooded area is greatly expanded, suitable foraging habitat may be limited if preserve boundaries have not included enough land.

25.5.3 Pesticide and Herbicide Application

The use of pesticides and herbicides in agricultural areas and their direct and indirect impacts (i.e., through effects on prey species) on greater sandhill cranes are unknown. Traditional methods for controlling invertebrates may cause toxicitiy effects or reduce foraging opportunities.

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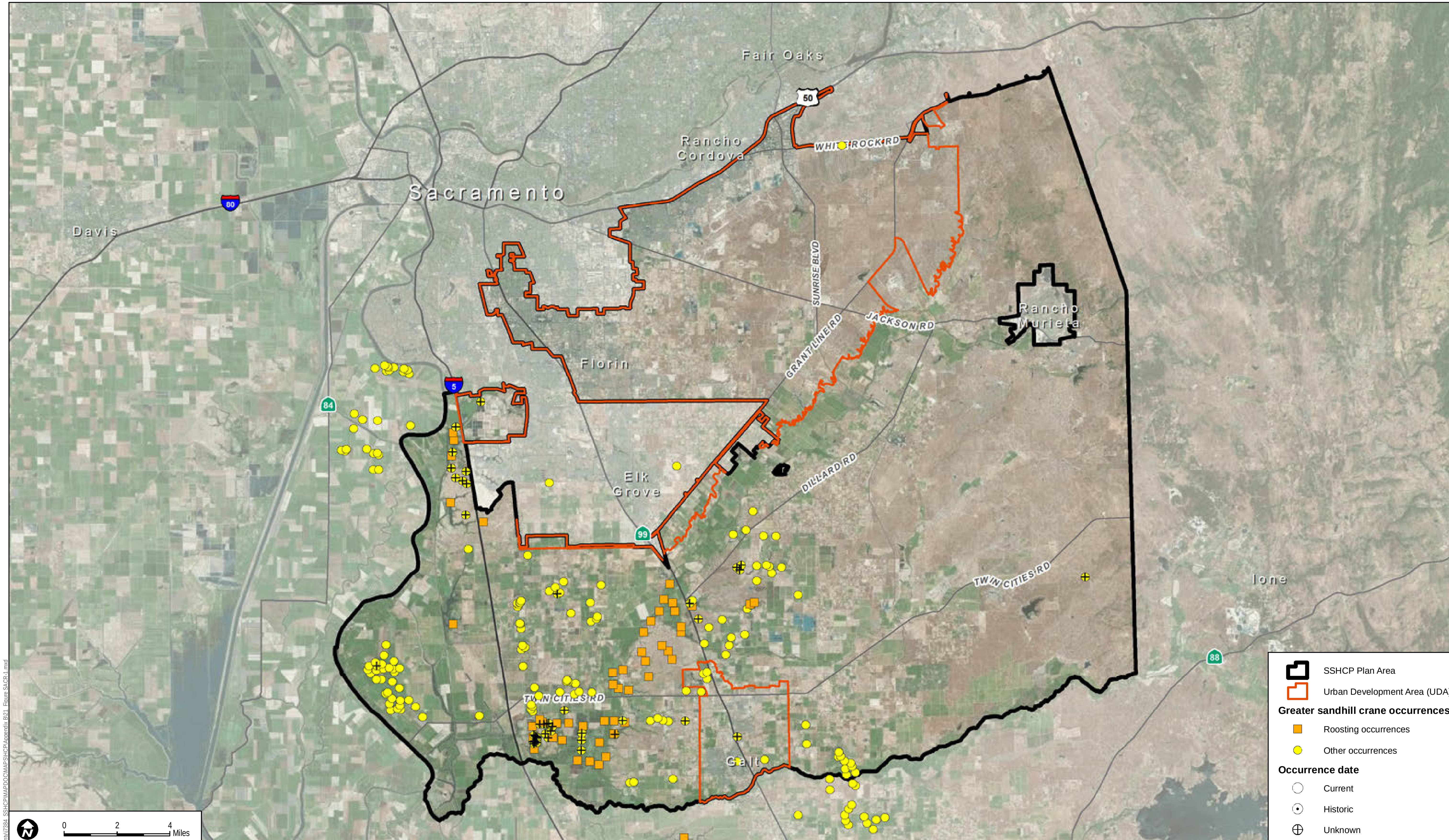

SOURCE: Bing Maps, County of Sacramento 2014, TNC 2000, Ivey 2003, Pogson & Lindstedt 2005, ebird.org, ICF 2013

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

FIGURE SACR-1

Greater Sandhill Crane Documented Occurrences

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

Path: Z:\Projects\Sacramento_County\17384_SSHCP\MAPDOC\MAPS\HCP\Appendix B\21_Figure SACR-1.mxd

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26 LOGGERHEAD SHRIKE (LOSH)

Prepared by Henderson Ecology and Planning (Steve Henderson)

Loggerhead Shrike (LOSH)
(Lanius ludovicianus)
Status USFWS: Bird of Conservation Concern

Status CDFG: Second Priority Bird of Special Concern

26.1 Legal Status

Loggerhead shrike (*Lanius ludovicianus*) is legally protected under the federal Migratory Bird Treaty Act (16 U.S.C. 703-712) and the California Fish and Game Code (Section 3800). This species is designated as a Second Priority Bird Species of Special Concern (BSSC) by the California Department of Fish and Game (CDFG) (Shuford and Gardali 2008); and a Bird of Conservation Concern (BCC) by the U.S. Fish and Wildlife Service (USFWS) (USFWS 2002).

26.2 Life History and Ecology

26.2.1 Species Description and Life History

26.2.1.1 Physical Description

Loggerhead shrike is a medium-sized (7.9 to 9.8 inches [20 to 25 centimeters]), large-headed Passerine with dark gray on the back and white on the breast. Its distinguishing feature is a black face mask that extends over the bill (Yosef 1996).

26.2.1.2 Taxonomy

There is considerable geographic variation in plumage and morphometrics within *Lanius ludovicianus.* The current systematics (Clements 2000) recognize 11 subspecies of *L. ludovicianus*. Five subspecies occur in California: *L. l gambeli*, *L. l. excubitorides, L. l. mearnsi, L. l. anthonyi,* and *L. l. grinnelli*. *L. l. gambeli* breeds from Washington south to southwestern California, including the Plan Area; *L. l. grinnelli* breeds from San Diego County south to north-central Baja California, Mexico. *L. l. excubitorides* breeds in southeast California, east *of L. l* *gambeli*; *L. l. mearnsi* is a resident on San Clemente Island; and, *L. l. anthonyi* is a resident on Santa Cruz, Santa Rosa, and Santa Catalina Islands (Yosef 1996).

26.2.1.3 Reproduction

The breeding season for loggerhead shrike generally begins before most other sympatric Passerine species (in late January or early February), and extends to July. In non-migratory populations, shrikes remain paired during the winter. Territory establishment probably begins between February and March. There is no information available about the specific timing of nest construction; however, it probably begins soon after territory establishment. Nest construction lasts approximately six to 11 days. Loggerhead shrikes build open cup nests, placing them in well-hidden microsites on a tree or shrub. Eggs are typically laid between March and June. Females normally lay five to six eggs and incubate for 15 to 17 days. The female usually feeds the nestlings until they fledge at 16 to 20 days after hatching; however, the male will feed the nestlings if the female is absent from the nest for extended periods. During the nestling period, the male provides the brooding female with food and participates in nest sanitation (e.g., removing fecal matter and regurgitated pellets) (Yosef 1996).

26.2.1.4 Survival and Longevity

There are no reliable juvenile or adult survival estimates for loggerhead shrike.

26.2.1.5 Dispersal Patterns

Banding studies indicate that adult loggerhead shrikes exhibit some site fidelity, and juveniles disperse widely. Recapture rates of loggerhead shrikes banded as juveniles are low. In Alberta, the average distance of juvenile dispersal was 4.2 mi (6.7 kilometers). Over the period of three years since the time of banding, shrikes dispersed up to 43.5 miles (70 kilometers) from their natal site. The rates of breeding adults returning to breeding sites between selected years were 73 percent in Idaho, 68 percent in Indiana, 60 percent in Virginia, 54 percent in Missouri, 57 percent in Iowa, and 41 percent and 59 percent in Minnesota. On San Clemente Island, California, return rates between years were 30 to 90 percent between 1985 and 1988. In other areas, (e.g., Alberta and North Dakota) return rates of breeding adults were lower (Yosef 1996).

26.2.1.6 Diet and Foraging

Loggerhead shrikes eat small to medium-sized animal matter, including arthropods, birds, amphibians, reptiles, and small mammals. They also eat roadkills and carrion. Shrikes forage primarily on large ground-dwelling insects that require little to no water (Miller and Stebbins 1964). A loggerhead shrike is able to carry prey as heavy as its own mass with its feet. It can carry smaller items in its bill. Hunting perches are especially important for loggerhead shrike foraging (Brooks and Temple 1990; Yosef and Grubb 1994). Loggerhead shrikes hunt from perches such as fences, shrubs, trees, utility lines, and poles. Shrikes kill their vertebrate prey by attacking the nape and tearing the cerebral vertebrae. They often impale their prey on barbed wire and other sharp objects. Loggerhead shrikes forage primarily in the morning (Yosef 1996).

26.2.1.7 Movement and Migration Patterns

Migration in loggerhead shrikes is poorly understood. Northern populations of loggerhead shrike are migratory. They migrate annually between their breeding and wintering grounds. Their spring migration to the breeding grounds begins in January and extends to March, peaking between February and March. Fall migration to the wintering grounds generally begins in August and extends through November, peaking between September and November. Birds apparently migrate individually during the day (Yosef 1996.) Although not explicitly reported, Loggerhead shrike populations in Sacramento County are presumably resident and non-migratory.

26.2.1.8 Territoriality/Home Range

Loggerhead shrikes are territorial and aggressive during the breeding season. They maintain relatively large territories, and all activities associated with reproduction (i.e., mating, foraging, brooding) occur within the territory. In mainland California, the average size of territories averaged 21 acres (8.5 hectares) and ranged between 10.9 acres (4.4 hectares) and 39.5 acres (16 hectares) (Yosef 1996). In areas of year-round residence (such as much of lowland California) members of a pair are known to defend adjoining territories during the non-breeding season and then defend a single nesting territory comprised of the adjoining winter territories during the breeding season (Lefranc 1997).

26.2.1.9 Ecological Relationships

There is little data available on predation of loggerhead shrike. Nest predators have included feral cats, black-billed magpies (*Pica pica hudsonia*), weasels (*Mustela* spp.), raccoons (*Procyon lotor*), and snakes. Potential nest predators are often mobbed by shrikes. These species include American crow (*Corvus brachyrhynchos*), red-tailed hawk (*Buteo jamaicensis*), and northern harrier (*Circus cyaneus*) (Yosef 1996).

Prior to nesting, loggerhead shrikes engage in "group meetings," where neighboring shrikes convene to call and display. This behavior is thought to facilitate familiarity among neighboring territorial shrikes and minimize agonistic behavior among them during breeding activities. Shrikes interact with, and appear to dominate, many species that share their habitat. Nest parasitism of loggerhead shrike by Brown-headed Cowbird was first documented in Iowa in 1991. Shrikes readily chase cowbirds that approach nests containing eggs (Yosef 1996). The extent and intensity of cowbird nest parasitism on loggerhead shrike is unknown.

26.2.2 Habitat Requirements and Ecology

Loggerhead shrikes occur in dry, open habitats including grasslands, pastures with fence rows, agricultural fields, open woodlands (savannahs), scrub, and riparian areas. Suitable breeding habitat has the following characteristics: 1) short, sparse vegetation; 2) scattered or isolated low trees or large shrubs for nest sites; and 3) available hunting perches with an open view (Yosef 1996; Cade and Woods 1997). Loggerhead shrikes typically avoid completely treeless and shrubless areas (Cade and Woods 1997), as well as urbanized and densely wooded areas (Grinnell and Miller 1944). Winter foraging habitat is similar to summer breeding and foraging habitat, however, shrikes also use idle pastures and hayfields during the winter (Bartgis 1992).

In many areas, loggerhead shrike abundance is correlated with the amount of pastureland and available perches (Gawlik and Bildstein 1993; Yosef 1996). Hunting perches are especially important for loggerhead shrike foraging (Brooks and Temple 1990; Yosef and Grubb 1994). Loggerhead shrikes hunt from perches such as fences, shrubs, trees, utility lines, and poles. Yosef and Grubb (1994) experimentally added wooden posts (averaging 53 inches tall) to loggerhead shrike territories. They found that productivity increased and territory size decreased in territories where perches were added compared to control sites. The authors concluded that habitats managed for loggerhead shrikes should include abundant hunting perches, as well as an adequate prey base and nest sites.

Loggerhead shrikes may also forage in areas where vegetation is tall and dense, although these areas are considered suboptimal. Foraging success in these areas may be similar to that in more open and sparse areas, but involves more hovering, more flights, and increased perch-switching (Yosef and Grubb 1993).

26.2.2.1 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for loggerhead shrike are identified in Table LOSH-1 and have been derived from input from local species experts.

Table LOSH-1
Essential Habitat Elements for Loggerhead Shrike

Essential Activities	Land Cover Types	Habitat Elements
Foraging	Blue oak savanna, cropland, irrigated pasture/grassland, and valley grassland.	Open habitats with abundant, large arthropods (e.g., grasshoppers) and numerous hunting perches.
Nesting	Blue oak woodland, blue oak savanna, mine tailing riparian woodlands, mixed riparian scrub, and orchards.	Structurally diverse woodland habitats that dense vegetation for siting nests.

26.3 Species Distribution and Population Trends

26.3.1 Species Distribution

The breeding range of loggerhead shrike is extensive. It includes Alberta, Saskatchewan, and Manitoba in Canada; most of the United States with the exception of the Pacific Northwest and most of the northeastern states; and most of Mexico. Northern populations of loggerhead shrike are migratory. Their winter distribution includes northern California, northern Nevada, northern Utah, central Colorado, Kansas, western Missouri, northern Kentucky, and northern Virginia south through the southern United States and Mexico (Yosef 1996). Loggerhead shrike has apparently always been more frequent throughout the western and southern portions of its range than other areas of its distribution (Cade and Woods 1997).

In California, loggerhead shrike is a year-round resident throughout the foothill and lowland regions in the central to southern portion of the state. Although it does not breed or winter in the north coast region of California, winter migrants occur there (Zeiner et al. 1990).

26.3.2 Central Valley Distribution

Loggerhead shrike is a resident in the Central Valley where there is suitable habitat. The Central Valley may have historically functioned as a core area for interior populations of loggerhead shrike in California. Although shrikes occur in successional habitats, the Central Valley supported abundant breeding habitat that is considered more permanent or stable, such as perennial grasslands and open savannahs (Cade and Woods 1997).

26.3.3 Range Within Plan Area

Loggerhead shrikes occur year-round in suitable habitat throughout the Plan Area. They are probably regular breeders in the Plan Area in low densities (Trochet pers. comm.); however, their overall distribution, abundance, and population structure are not well known. The CNDDB (CDFG 2010) reports no occurrences of loggerhead shrike in Sacramento County. There are occurrences from other sources (Ebird.org 2005-2010) that report the species throughout the Plan Area. Figure LOSH-1 shows the occurrences of loggerhead shrike within the Plan Area.

Land cover types used by loggerhead shrikes, such as irrigated pasture-grassland, cropland, blue oak savanna, blue oak woodland, orchards, and valley grassland occur throughout much of the Central Valley and are well-represented in Sacramento County and the Plan Area; however, at most sites within these land-cover types, the presence of loggerhead shrike is not known.

Sacramento-area ornithologists C. Conard and J. Trochet provided occurrence and habitat distribution information, which is summarized below.

- At the Sacramento Regional County Sanitation District (SRCSD) Bufferlands (and at nearby Stone Lakes National Wildlife Refuge), approximately two to three shrike nests are located each year. Loggerhead shrikes occur regularly throughout the agricultural lands and grasslands where suitable habitat features exist (Conard pers. comm.).
- Loggerhead shrikes occur regularly during summer at The Nature Conservancy's Howard Ranch; although their abundance is not high. Also, a nest that produced two young was documented there in 2001 (Trochet pers. comm.).
- At the Consumes River Preserve, shrikes nested successfully from 1995–1997 north of the Tall Forest. This area supports pastureland with scattered small trees and shrubs, and was considered the most reliable location to observe shrikes during all seasons. The area has since been converted to rice fields and no longer supports loggerhead shrikes during the breeding season (Trochet pers. comm.).
- On County land northeast of the Tall Forest, shrikes nested successfully near pasture and fallow rice fields (Trochet pers. comm.). Also, along Bruceville Road, 0.2 to 0.3 miles south of Twin Cities Road, adult shrikes with four young were observed over a period of time (Trochet pers. comm.).
- Nesting has not been documented at Valensin Ranch, although some locations there provide suitable breeding habitat.
- Loggerhead shrikes have been documented at least twice during the breeding season at the Schneider property, along Meiss Road approximately 1.75 miles from Ione Road, although nesting has not been documented there. This property may not support suitable nest sites (small trees or shrubs). Nesting could have occurred in the adjacent dredge spoils area that supports small trees or shrubs; however this area has not been searched (Trochet pers. comm.).
- In general, loggerhead shrikes occur regularly during the breeding season throughout south Sacramento County, in open country with elevated perches and appropriate vegetation for breeding. They are probably regular, low-density breeders throughout the entire southern portion of the County where suitable habitat exists (Trochet pers. comm.).

Because comprehensive surveys or monitoring efforts for loggerhead shrike in the Plan Area have not been conducted, and because the known occurrences are based mostly on incidental observations or limited surveys (e.g., anecdotal records, surveys conducted over a limited area), the population size and nesting locations of this species in the Plan Area are not well known.

26.3.4 Population Levels and Trend

Prior to the mid-1900s, loggerhead shrike was considered widespread and abundant (Yosef 1996; Cade and Woods 1997); however, loggerhead shrike populations have been declining rangewide since that time, and it has been extirpated locally throughout the species' range (Cade and Woods 1997). Much of the evidence for population declines has come from analysis of Breeding Bird Survey (BBS) data. Loggerhead shrike is one of the few species that show a significant decline (based on BBS data) in most states.

Analysis of Breeding Bird Survey (BBS) data indicates an overall decline of loggerhead shrike populations throughout the species breeding range, although trends vary regionally (Sauer et al. 2004). In California, loggerhead shrike has experienced extensive local population declines. BBS data suggest a significant statewide (California) population decrease between 1966 and 2003 (N = 108, $P = 0.01$). The BBS trend for loggerhead shrike in the Central Valley is similar to the statewide trend.

26.4 Threats to the Species

The primary cause of loggerhead shrike population declines is breeding habitat loss and degradation as a result of urbanization, development, and agricultural conversion (Morrison 1981; Yosef 1996; Cade and Woods 1997). Another important cause of population declines is related to pesticides that are ingested with the species' prey (Yosef 1996).

Shooting of perched shrikes due to dislike of their raptor-like habits contributed to the species decline in the past century (Yosef 1996), but is not likely to be a significant source of mortality in current populations. Road kills and increased predation of young and eggs by common raven, domestic cats, and foxes may also be factors in the species decline.

26.5 Data Gaps and Conservation Implications

There are several sources of uncertainty regarding loggerhead shrikes and their requirements in the Plan Area. These data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

26.5.1 Population and Habitat Distribution within the Plan Area

Loggerhead shrikes occur in suitable habitat within the Plan Area; however, their overall distribution, abundance, and population structure are not well known. Land-cover types used by shrikes, such as grasslands and pastureland, occur throughout much of the Central Valley and are well-represented in Sacramento County and the Plan Area. At most sites with these land cover types, the presence of loggerhead shrike is not known.

Because comprehensive surveys for loggerhead shrike in the Plan Area have not been conducted and because the existing occurrence data are based primarily on incidental observations (e.g., anecdotal records), the population size, nesting locations, and important wintering areas of this species throughout the Plan Area are not known. Although the distribution of grasslands and other open habitats is mapped and quantifiable, the quality of habitat for shrikes within most of these areas is unknown.

These information gaps limit our ability to identify the best lands available for preserving loggerhead shrike habitat and accurately estimate the impacts resulting from covered activities. Until this data gap is remedied, the conservation value of valley grassland, blue oak savannah, and pasture land-cover types for loggerhead shrike will be considered relatively high in lands that support (or recently supported) known occurrences, are large in extent, or are adjacent to these areas.

26.5.2 Effectiveness of Habitat Enhancement Techniques in Creating Suitable Nest and Perch Sites for Loggerhead Shrike

Achieving the conservation goal and objectives for loggerhead shrike will require successful enhancement of grassland and other habitats. The structure of these habitats (e.g., short, sparse vegetation), and presence of nest and perch sites, are important factors for suitability. Whether enhancement and management can retain the elements suitable for loggerhead shrike is unknown.

If restoration techniques cannot eventually create grassland and other habitats with characteristics suitable for nesting shrikes, then those lands would not support breeding pairs or wintering individuals.

It is assumed that careful design and implementation of grassland enhancement plans could create suitable loggerhead shrike breeding habitat. Habitat enhancement and restoration efforts to achieve conservation objectives for loggerhead shrike will incorporate habitat requirements into their objectives, designs, and performance standards. Also, restoration and enhancement projects will be established as working experiments. It is expected that enhancement and management efforts aimed at burrowing owl conservation will also benefit loggerhead shrike.

26.5.3 Landscape-level Habitat and Preserve Design Requirements for Viable Populations

The minimum habitat size and connectivity requirements for loggerhead shrike are not understood. This causes uncertainty in determining whether the preserve design will be effective in meeting the conservation goal for loggerhead shrike. The criteria for designing preserves will be based on the best available information on or inferences about spatial requirements for all covered species. The minimum size and connectivity requirements of preserves will be expected to meet or exceed requirements to maintain loggerhead shrike populations.

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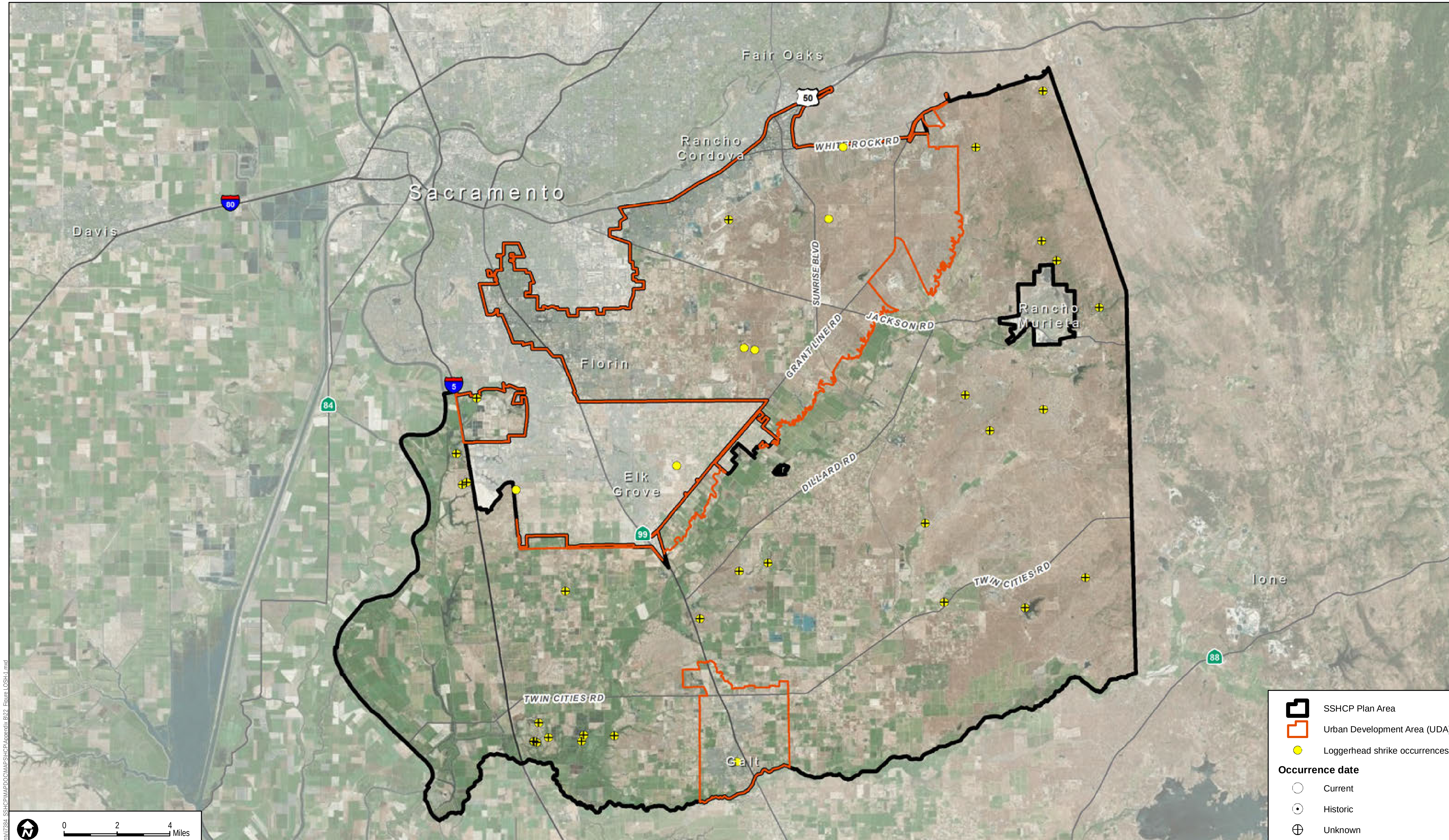

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SSHCP South Sacramento Habitat Conservation Plan

SOURCE: Bing Maps, County of Sacramento 2012

FIGURE LOSH-1

Loggerhead Shrike Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

NOTE: Historic occurrences are observations prior to 1990. CNDDB points are centroids of CNDDB polygons of variable certainty.

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27 WESTERN RED BAT (WRB)

Prepared by Heather L. Johnson

Western Red Bat (WRB)
(Lasiurus blossevillii)
Status USFWS: None
Status CDFG: Species of Special Concern

27.1 Legal Status

The western red bat (*Lasiurus blossevillii*) is considered a special animal by the California Department of Fish and Game (CDFG) (Bolster 1998). This status is based largely on the findings of the Western Bat Working Group (WBWG), which rates management concern for the western red bat as high priority, indicating that this species is imperiled or at high risk of imperilment (WBWG 1998).

27.2 Life History and Ecology

27.2.1 Species Description and Life History

The western red bat is a member of the taxonomic Order Chiroptera and Family Vespertilionidae, the largest of the three bat families present in California. The generic name *Lasiurus* may be translated as "hairy-tailed." Until 1988 the western red bat was considered a subspecies of *Lasiurus borealis* and was known as *L. b. teliotis* (Shump and Shump 1982). Current taxonomy recognizes the eastern red bat (*L. borealis*) and the western red bat (*L. blossevillii*; Baker et al. 1988) as full species.

27.2.1.1 Identification

This species is a medium-sized bat (six to 13 grams in the Sacramento Valley, Johnson unpubl. data) with long pointed wings (forearm 35 to 45 mm, Pierson et al. 2002) and a wingspan of 28 to 32 centimeters (Harvey et al. 1999). As its name suggests it is a distinctive rusty reddish color washed with white. The underparts are slightly paler. Color can vary from "a very distinct red to a yellow-brown" (Pierson et al. 2002). The wing membranes are black with orange demarcations along the fingers and the interfemoral membrane is heavily furred (bat species outside this genus usually have naked or partially furred tail membranes). Barbour and

Davis (1969) state that the tail is long and extends straight out in flight, which gives this bat a distinctive silhouette against the sky as compared to other species with shorter tails. The western red bat has short, broad, and rounded ears that do not extend much above the dorsal fur line (Barbour and Davis 1969). The tragus is triangular. The nose is plain and short. The feet are small, slender, and furred and there is fur on the wrists.

The western red bat is not likely to be confused with other species known to occur in Sacramento County due to its distinctive coloration; however, two congeners occur in California: the yellow bat (*L. xanthinus*) and hoary bat (*L. cinereus*). The northernmost known occurrences for the yellow bat are in Los Angeles and San Bernardino Counties (Constantine 1998). Therefore, this species is not expected to occur in Sacramento County. The hoary bat may occur in Sacramento County, but it is a larger bat (forearm 46 to 58 millimeters, Pierson et al. 2002), its fur is generally dark gray with whitish hair tips giving it a frosty appearance, and it has yellow fur around the face with black rimmed ears. Although *L. blossevillii* can appear somewhat frosted and have a yellowish tinge to its fur, it is never as dark nor as frosted as *L. cinereus*, nor as yellow as *L. xanthinus* (Pierson et al. 2002).

27.2.1.2 Life History

The life history of the western red bat centers on reproduction and meeting the energetic demands of a small insectivorous mammal. Several aspects of this species' life history are uncommon among bats in northern California, namely its roosting, social, reproductive, and migratory habits. The western red bat is solitary and roosts in foliage. During the day, it shelters on the underside of overhanging leaves. It most often roosts individually; however, females with dependent young roost together and multiple individuals are sometimes found in clusters during migration (e.g., roosting in the same tree). The western red bat uses torpor to conserve energy during the day when it is inactive (Shump and Shump 1982; Willis and Brigham 2001). It hangs by one foot in a compact position and it is thought that the furred tail membrane acts as a blanket. The fur on its feet and wrists and the overall thickness of the fur are adaptations to the greater exposure of its chosen roost sites.

This species makes north-south migrations in spring and fall that may be hundreds of miles. Cryan (2003) studied seasonal dispersal of the western red bat on a continental scale and stated that seasonal dispersal from California is apparently limited, and it is unclear if California populations mix with others to the south and east. During migration western red bats may form small groups (Constantine 1959), though males and females may travel separately (Barclay 1984). Western red bats may be year-round residents in the Bay Area (Orr 1950). During winter cold snaps the eastern red bat extends torpor (hibernates) and the western red bat may do so as well. Most of the life history traits of the eastern red bat and western red bat are assumed to be shared.

Pups are born from late spring to early summer (Pierson et al. 2002). Three pups are usual in a litter, but there may be as many as five (Allen 1939; Pierson et al. 2002). It is thought that red bats have more young than other bat species because their roosting habits in foliage expose them to greater predation. The literature contains numerous accounts of birds attacking red bats and their young (Allan 1947; Constantine 1959; Downing and Baldwin 1961; Elwell 1962; Hoffmeister and Downes 1964; Wilks and Laughlin 1961). The large number of pups seem especially burdensome to females because grounded mothers have often been found unable to fly due to the weight of the clinging pups (Allan 1947; Pearson pers. comm. 2004; Stains 1965). Western red bat pups are weaned between six to eight weeks of age when they have grown to adult size and are thus able to fly.

The only longevity record known for the western red bat is two years for an individual in captivity; however, this species does not adapt well to captivity (Pearson pers. comm. 2004). Potential predators of this species include jays (Allan 1947; Constantine 1959; Elwell 1962; Hoffmeister and Downes 1964), American crows (*Corvus brachyrhynchos*), American kestrels (*Falco sparverius*), hawks (*Buteo* spp.), owls (*Bubo* spp., *Asio* spp.) (Allen 1939), opossums (Sperry 1933), skunks (*Mephitis* spp.), weasels (*Mustela* spp.), rats (*Rattus* spp.), snakes (Allen 1939), and cats. Terrestrial predators may capture bats roosting in low-growing branches. Western red bats, like all mammals, can also contract the rabies virus. In addition, infected bats may be a vector for the disease before they die.

27.2.2 Habitat Requirements and Ecology

The western red bat occurs primarily in the low and middle elevations in broadleaf tree communities (Pierson et al. 1999). It is less abundant in mixed conifer forests. This species roosts in the foliage of large shrubs and trees in habitats bordering forests, rivers, agricultural areas, and urban areas (Harvey et al. 1999). Roosts are commonly in edge habitats adjacent to streams or open fields, in orchards, and sometimes in urban areas with mature trees (WBWG 1998).

Pierson et al. (1999) describe roosting habitat as large diameter riparian cottonwoods and sycamores, and older orchard trees (particularly walnuts). Constantine (1958, 1959, 1966) studied red bats in California, Georgia, and Iowa. He found that roosts have the following attributes: protection from view from all directions except below; no obstructions below allowing the bat to drop downward to begin flight; no lower perches from which predatory birds or mammals can see or reach the bat; dark ground cover minimizing the reflection of sunlight; sufficient adjacent vegetation to break up wind currents and retard the distribution of dust; location on the south or southwest side of the tree; and height usually four to 10 feet above ground. The western red bat usually hangs from the leaf petiole, but occasionally hangs from a twig or branch (Barbour and Davis 1969). Hanging from one foot it closely resembles a dead leaf and the wing markings are thought to add to the camouflage.

Foraging occurs in and amongst vegetation and regularly occurs over the same territory (Allen 1939). Foraging has been noted in habitats such as mature orchards, oak woodland, low elevation conifer forest, and non-native trees in urban and rural residential areas. In addition, this species may forage in habitats adjacent to streams and rivers that do not provide roosting habitat. No dietary information is available for western red bats in California (Pierson et al. 2002); however, eastern red bats prey on moths, flies, beetles, and tiny wasps (WBWG 1998). Western red bats may forage all night (perhaps males and nonreproductive females), but there is often an initial foraging period after sunset and a minor secondary activity period before sunrise that corresponds to periods of increased insect activity (WBWG 1998).

Habitat requirements in Sacramento County may include open water for drinking and foraging, undisturbed foliage roost sites that provide protection from predators, and structurally diverse vegetation that supports a diversity of insect prey. Water features are a vital habitat component because bats often drink immediately after emergence and water is an important source of concentrated insects. Studies by Pierson et al. (1999) comparing mature riparian habitat extending greater than 50 meters back from the Sacramento River to areas with less extensive or degraded habitat suggest that this species prefers the mature, extensive riparian habitat. Mature orchards with dense canopies provide alternate roosting sites and may provide foraging habitat (Pierson et al. 1999).

27.2.2.1 Essential Habitat Elements

Essential habitat elements are those basic aspects of the environment, which are needed for survival and propagation of the species. The essential habitat elements for western red bat are identified in Table WRB-1 and have been derived from input from local species experts.

Table WRB-1
Essential Habitat Elements for Western Red Bat

Essential Activities	Land Cover Types	Habitat Elements
Foraging	Blue oak woodland, blue oak savanna, mine tailing riparian woodlands, valley oak riparian woodlands, mixed riparian woodland, orchards, mixed riparian scrub, vernal impoundment, vernal pool, seasonal wetlands, seasonal impoundment, freshwater marsh, open water, and streams/creeks.	A variety of habitats including oak woodland and savanna, grassland, riparian areas, and wetlands are suitable foraging habitat. Nearby water features are a vital habitat component because bats typically have high water needs. Furthermore, water features are an important source of concentrated insects.

Table WRB-1
Essential Habitat Elements for Western Red Bat

Essential Activities	Land Cover Types	Habitat Elements
Roosting	Blue oak woodland, blue oak savanna, mine tailing riparian woodlands, valley oak riparian woodlands, and mixed riparian woodland.	Roosts are provided by the foliage of large shrubs and trees in habitats bordering forests, rivers, agricultural areas, and urban areas Roosts have the following attributes: protection from view from all directions except below; no obstructions below allowing the bat to drop downward to begin flight; no lower perches from which predatory birds or mammals could see or reach the bat; dark ground cover minimizing the reflection of sunlight; sufficient adjacent vegetation to break up wind currents and retard the distribution of dust; location on the south or southwest side of the tree; and height usually 4-10 feet above ground.

27.3 Species Distribution and Population Trends

Anecdotal observations suggest that the historical abundance of eastern red bat and western red bat was likely much greater than at present (O'Shea et al. 2003). Carter et al. (2003) concluded that quantitative information concerning long-term population trends of solitary foliage roosting bats cannot be drawn from existing data because of the lack of standardized reporting and inability to determine the proportion of total population sampled. Carter et al. (2003) noted that indices of abundance such as submissions to health agencies for rabies testing and trends in habitat are the only present means to indirectly assess population trend.

27.3.1 Range Wide Distribution

The western red bat ranges from southern British Columbia south to Baja California and Mexico, and east to Wyoming (Hall 1981). This species regularly occurs in California, Arizona, New Mexico, and throughout western and central Mexico to South America (Baker et al. 1988; Cryan 2003; Hall 1981). The only known region where both red bat species overlap is in west Texas (WBWG 1998).

27.3.2 Central Valley Distribution

The western red bat occurs throughout the Central Valley in suitable habitat. Although its range includes much of western North America, the only areas with multiple records for breeding females are California river valleys west of the Sierra Nevada crest (Pierson et al. 1999). Breeding females appear to be highly associated with lower elevation riparian habitats, particularly relatively intact stands of cottonwood and sycamore in the Central Valley (Pierson et al. in review, 2002). Cryan (2003) summarized capture data from California as follows "Males and females are together at lower elevations in California during winter (Grinnell 1918, Orr 1950) but segregate during spring and summer; females remain in lowland areas, whereas males apparently move to higher elevations (Grinnell 1918; Shump and Shump 1982)." Sutter County capture data is consistent with these findings (Johnson 2000).

The Museum of Vertebrate Zoology (MVZ) at the University of California Berkeley has museum specimens from Tehama, Sutter, Butte, Yolo, Yuba, Sacramento, Solano, San Joaquin, Merced, Madera, Fresno, Tulare, Kings, and Kern Counties. Specimens have also been collected in San Joaquin County in 1950 and 1987 and deposited in the California Academy of Sciences. Johnson (2000) captured western red bats in blue oak woodland in the Sutter Buttes, Sutter County. Roost sites have been found in orange and apricot orchards near Esparto and Rumsey, Yolo County (Constantine 1959).

The four MVZ records for Sacramento County are from the following locations: (1) Eddinger–Johnson Ranch south of Sacramento, (2) two miles northwest of Folsom, and (3) Sacramento (two specimens taken in 1952 and in 1990). A dead western red bat was found on a sidewalk in downtown Sacramento in 1995 (Johnson pers. obs.). In addition, from 1977 to 2002 at least 56 western red bats were submitted to the Sacramento County Public Health Laboratory (Constantine unpubl. data 2004). Though the California Natural Diversity Database (CNDDB) does not contain records for this species in Sacramento County (CDFG 2010), the CNDDB does provide scattered occurrence records for western red bat throughout California.

27.3.3 Range within the Plan Area

Western red bat records were obtained from the numerous bat specimens annually submitted for rabies testing to the Sacramento County Public Health Laboratory. Fifty-six records for the western red bat (1977 to 2002) varied in location precision from "Sacramento County" to "Sacramento" to an actual address (CDFG 2010). Over 30 western red bats were from localities reported as the City of Sacramento, Folsom, Rancho Cordova, Wilton, Elk Grove, or Galt (Constantine unpubl. data 2004). These specimens included females and immature individuals indicating the presence of a reproductive population. Further details are unavailable on most of the occurrence localities, but seven addresses were given for locations inside the Plan Area. Though a bat monitoring project conducted at the Cosumnes River Preserve has also detected western red bats, there has been no area-wide assessment of whether available habitats within the Plan Area provide appropriate roosting and foraging habitat for the species.

27.3.4 Population Levels and Trends

Estimates of historic and current population levels for the western red bat are currently unavailable; however, detailed information on the species, including population trends, should be available when a report on the distribution and status of the western red bat in California becomes available (Pierson et al. in review). More information may also become available as a result of the release of the revised Mammal Species of Special Concern by the CDFG (Brylski et al. in review).

In order to assess the trend of the species, long-term monitoring of both roosting and foraging habitat conducted over multiple years is needed. Biologists recognize that "most efforts at monitoring bat populations involve use of indices that are uncalibrated in relation to population size, do not incorporate measures of variation or detectability, are discontinuous in time and space, and sometimes lack standard protocols" (O'Shea et al. 2003). Roost count indices are typically used to monitor bat populations; however, aspects of the life history of the western red bat (i.e., roosting individually or in small groups in inconspicuous locations) make it especially difficult to study. Ball (2002) proposed that if land uses and bat habitat can be monitored simultaneously, patterns in the availability and condition of bat habitat will emerge to guide their management.

O'Shea et al. (2003) states that current estimates of the relative abundance of low density foliage roosting species come primarily from capture and echolocation-detector index measures. Pierson and Rainey (Stillwater Sciences et al. 2003) were able to infer western red bat roost locations, as well as migratory and foraging activity by observing riparian woodland at sunset and visually and acoustically monitoring bats as they emerged. Though the USGS has a report in press that may suggest improved methods for estimating numbers of bats with this type of life history (O'Shea and Bogan 2003), acoustic monitoring of foraging activity may be the primary available means of monitoring this species and assessing habitat condition.

27.4 Threats to the Species

Potential threats to the western red bat in the Plan Area include habitat removal, direct mortality, and increased predation. Furthermore, roosting habitat in riparian cottonwood and sycamore stands may be lost as result of reduced regeneration due to hydrological alteration of watersheds (WBWG 1998). Direct mortality may occur from pesticide use in orchards (WBWG 1998). Pierson et al. (2002) state "the intensive use of pesticides in fruit orchards may constitute a threat to roosting bats and may significantly reduce the amount of insect prey available." Although western red bats occur in urban and agricultural habitats, they may suffer higher levels of predation from the unnaturally high numbers of urban-tolerant species such as jays, crows, opossums, and domestic cats that occur in and are concentrated in these habitats (Pierson et al. 2002; Johnson pers. obs.).

27.5 Data Gaps and Conservation

The ecology, status, and management of the western red bat have received increased attention in recent years; however, there are several sources of uncertainty regarding western red bat and its requirements in the Plan Area. The primary data gaps, their implications for the success of the conservation strategy, and current operating assumptions are summarized below.

27.5.1 Population and Habitat Distribution within the Plan Area

Western red bats occur in suitable habitat within the Plan Area. However, their overall distribution, abundance, and population structure are not well known. Land cover types used by western red bats occur throughout much of the Central Valley and are well represented in Sacramento County and the Plan Area.

Because comprehensive surveys for western red bat in the Plan Area have not been conducted and the existing occurrence data are based primarily on incidental observations (e.g., CNDDB, anecdotal records), the population size and distribution of the species throughout the Plan Area are not known. In addition, though the distribution of different land cover types is mapped and quantifiable, the quality of habitat for western red bat within most of these areas is unknown. These information gaps limit our ability to identify the best lands available for preserving western red bat habitat and accurately estimate the impacts resulting from covered activities.

Until this data gap is remedied, the conservation value for western red bat will be considered relatively high in lands that support (or recently supported) known occurrences (particularly roost sites) or are adjacent to these areas.

27.5.2 Determining Threat Severity

Although it is unknown if western red bats have declined rangewide, most bats for which there is good data have shown population declines (particularly those species with limited roost sites and special roost site requirements). Activities that directly remove or replace suitable habitat (particularly roost sites) with incompatible land uses are more easily quantifiable than factors that indirectly affect an area or population. Therefore, to improve conservation planning efforts for western red bat in the Plan Area and elsewhere, additional empirical data are needed, specifically when analyzing factors that indirectly affect known populations and their habitats.

27.5.3 Effectiveness of Habitat Enhancement and Restoration Techniques in Creating Suitable Habitat for Western Red Bat

Achieving the conservation goals and objectives for western red bat will require successful enhancement and restoration of suitable habitat that functions as both roosting and foraging habitat; however, whether restored or enhanced habitats can retain the structural attributes suitable for western red bat is unknown.

If habitat restoration and enhancement techniques cannot eventually create habitats with functional characteristics suitable for western red bat, then those lands would not support sustainable populations.

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28 AMERICAN BADGER (AMB)

Prepared by Henderson Ecology and Planning (Steve Henderson)

American Badger (AMB)
(Taxidea taxus)
Status USFWS: None
Status CDFG: Species of Special Concern

28.1 Legal Status

American Badger (*Taxidea taxus*) is designated as a species of special concern by the California Department of Fish and Game (CDFG) (Williams 1986).

28.2 Life History and Ecology

28.2.1 Species Description and Life History

28.2.1.1 Physical Description

American Badgers are heavy-bodied, short-legged, grayish mammals that have a white medial stripe from the nose over the top of the head and down the back. Badgers have a black nose, white cheeks, and a black spot in front of each ear. Their feet are black with extremely long front claws. The belly and the short tail are yellowish (Burt and Grossenheider 1980).

28.2.1.2 Taxonomy

There are four described extant subspecies of *T. taxus* (Long 1973); two of these occur in California: *T. t. jeffersonii and T. t. berlandieri*. Long (1972) noted that some of these specimens from the Central Valley exhibit intermediate characters, suggesting intergradation (Williams 1986). According to Long (1973), Sacramento County is within the estimated range of *T. t. jeffersonii;* however, Kyle et al. (2004) shows Sacramento County within the range of *T. t. berlandieri.*

Generally *T. t. jeffersonii* occurs in the Coast Ranges, Sierra Nevada and northeast into Oregon, Washington, northern Nevada, Idaho, Colorado, Montana, and into Canada (Long 1973; Kyle et al. 2004). *T. t. jeffersonii* (Harlan) generally ranges in the better-watered areas of

California, including coastal areas, most of the Sierra Nevada, and most of the Great Basin Province (Williams 1986). This subspecies is generally larger and darker-colored and occurs in cooler, moister areas (Williams 1986). *T. t. berlandieri* ranges throughout the Central Valley and southern California, and east through Arizona, New Mexico, southern Nevada, and Texas (Kyle et al. 2004). *T. t. berlandieri* Baird ranges through the hotter, drier desert and grassland associations of southeastern California and the Central Valley and are generally smaller and lighter-colored.

28.2.1.3 Reproduction

Badgers mate in summer and early fall. Young are born in March to early April in burrows, and are raised by the female (Long 1973; Minta 1993). Natal burrows are dug typically in dry, sandy soil in areas with sparse overstory cover (Zeiner et al. 1990). Juveniles disperse approximately three to four months following birth (Minta 1993).

28.2.1.4 Survival and Longevity

In captivity, the typical and maximum reported longevity of badgers is 11 and 15.5 years, respectively (Long 1973). There are no known survival rates reported for badger populations.

28.2.1.5 Diet and Foraging

Badgers are mostly carnivorous and prey primarily on fossorial (i.e., digging) mammals, especially ground squirrels and pocket gophers (Whitaker 1989). Badgers dig their prey out of burrows. They also prey on reptiles, insects, worms, eggs, birds, and carrion. Badgers shift their diet seasonally and annually in response to prey availability (Zeiner et al. 1990).

28.2.1.6 Movement and Migration Patterns

American Badgers are nocturnal and diurnal, active year-round, and non-migratory (Long 1973; Zeiner et al. 1990). Dispersing young females may move greater than 32 miles, whereas males may move greater than 63 miles (Messick and Hornocker 1981).

28.2.1.7 Territoriality/Home Range

Badgers are solitary and exhibit a simple social structure (Lindzey 1982; Messick 1987; Minta 1993). Olfactory communication is well-developed in this species. Badgers mark their territories with urine, feces, and scent glands. Males appear more territorial than females (Minta 1993). Female and male home range sizes in Utah have been estimated at 338 to 751 acres and 1,327 to 1,549 acres, respectively (Lindzey 1978). In Idaho, female and male badger home ranges averaged 400 acres and 600 acres, respectively (Messick and Hornocker 1981). Minimum patch size is 25 acres (Laudenslayer and Parisi 2007). Above 100 acres, area alone does not increase habitat suitability for an individual badger (Laudenslayer and Parisi 2007).

28.2.2 Habitat Requirements and Ecology

American Badger occurs in a variety of open habitats, including grasslands, shrublands, savannahs, and meadows. Factors that positively affect habitat suitability for badgers are food availability, presence of friable soils, and uncultivated ground (Williams 1986). Badgers dig their own burrows, and excavate their prey in friable soils. Badgers prey primarily on fossorial rodents, particularly ground squirrels. In Wyoming, badger density was correlated with ground squirrel density (Minta 1993). Accordingly, it is assumed that the quality of badger habitat in the Plan Area is closely and positively related to the occurrence and population viability of California ground squirrel (*Spermophilus beechyi*) in an area.

28.3 Species Distribution and Population Trends

28.3.1 Species Distribution

American Badger is distributed in North America from the south-central Canadian provinces south throughout the western and central United States, and south to central Mexico (Williams 1986). Its distribution does not include the eastern or southeastern United States.

28.3.2 Central Valley Distribution

In California, American Badger's range includes open habitat throughout the state, including the Central Valley. This species does not occur in the humid forests of northwestern California in Del Norte and northwestern Humboldt Counties (Williams 1986).

28.3.3 Range Within The Plan Area

The Plan Area is positioned within American Badger's range in California. American Badgers have been documented in the northeastern portion of the Plan Area (Figure AB-1); however, their overall distribution, abundance, and population structure are not well known. Land-cover types used by badgers, including cropland (foraging), blue oak savanna, and valley grassland, occur throughout the Central Valley and are represented in Sacramento County and the Plan Area, particularly outside the Urban Development Area (UDA). Within suitable habitat in the Plan Area, the presence of badgers has not been established by extensive surveys. It is assumed that most of this habitat is not occupied.

There are few occurrence records of badger in Sacramento County and the Plan Area. There are four CNDDB records and one additional occurrence record (Trochet pers.comm.) within

Sacramento County, two of which are within the UDA (CDFG 2010). One occurrence record is within the City of Sacramento, south of Jackson Highway (State Hwy 16) near Power Inn Road and is presumed extant (CDFG 2010). Of the four occurrence records within the Plan Area, only one that is located in southeastern Rancho Cordova is extirpated (CDFG 2010). Trochet (pers. comm.) observed a badger at Valensin Ranch, Cosumnes River Preserve, in approximately 1997–1998. There is also a 1938 CNDDB record located north of Hood recorded within the Museum of Vertebrate Zoology (CDFG 2010; also reported in Williams 1986). Both of these occurrences are inside the Plan Area and outside the urban services boundary (USB). These records do not provide an estimate of the distribution or population size of American Badger, because they are based on a very small number of surveys in a limited area.

28.3.4 Population Levels and Trend

Although there is very little empirical information about American Badger population status and trends in California, badger populations have clearly declined or were extirpated in several areas of California (Williams 1986). Badger populations in some parts of the State may be stable; however, in the middle Central Valley, the population size and number of locations occupied by badgers have declined. The overall population decline and local extirpations in the middle Central Valley are probably greater than in any other portion of California (Larsen 1987).

28.4 Threats to the Species

The American badger is threatened by habitat conversion to urban and agricultural uses, farming operations, shooting and trapping, poisoning, and reduction of prey base as a result of rodent control activities (Williams 1986). Loss of prey species (through poisoning), fur harvesting, and mortality from vehicles are other likely contributors to the downward trend of this species (Apps et al. 2002; Newhouse and Kinley 2000; Scobie 2002). Furthermore, badgers have a history of persecution, and are often perceived by humans as a pest species, for which they are shot or poisoned (Rahme et al. 1995). Shooting and trapping may have been important factors in population declines historically (Williams 1986).

In California, the primary threat to American Badger is habitat loss and degradation as a result of urbanization, development, and agricultural conversion (Williams 1986; Neal and Cheeseman 1996). The conversion of pasture and grasslands to farmland has led to a decline in the number of badgers as suitable foraging and denning habitat is reduced.

Predator control with the usage of indiscriminate trapping and poisons have caused extensive loss (Ahlborn 2005). In some parts of the USA and Canada, badger numbers have declined because of indiscriminate "pest control" activities (traps set for coyotes, and poisons meant for other predators), unregulated sport hunting, and trapping (some 50,000 badgers were taken every year for their fur in the 1970's, though this number fell to 20,000 in the 1980's) (Jackson 2010).

Vehicular accidents are also a major cause of badger mortality (USFS 2008). A peak in the number of road casualties occurs in February through March. According to the University of California at Davis California Roadkill Observation System (CROS), there were approximately 15 observed roadkills of American Badger reported in California between 2009 and 2010, out of approximately 4,000 reports of medium-sized mammals (i.e., skunks, raccoons, coyotes, jackrabbits, and foxes) (CROS 2010).

28.5 Data Gaps

Little research or monitoring has been conducted on the populations of the American Badger in California. As a result, many knowledge gaps exist with regard to the abundance, distribution and population trends of this species, as well as its behavior, habitat requirements, prey species, mortality factors and ecological role. The primary data gap for American Badger is lack of distributional data for the species within the Plan Area and throughout California. It is not feasible economically or temporally to survey the entire Plan Area. Some specific areas will need to be physically verified as to whether they support badger habitat and species presence. In addition, quantitative bioassessment may be necessary to determine the ecological functions and values of selected preserve areas to assess their suitability and value as preservation habitats for this species.

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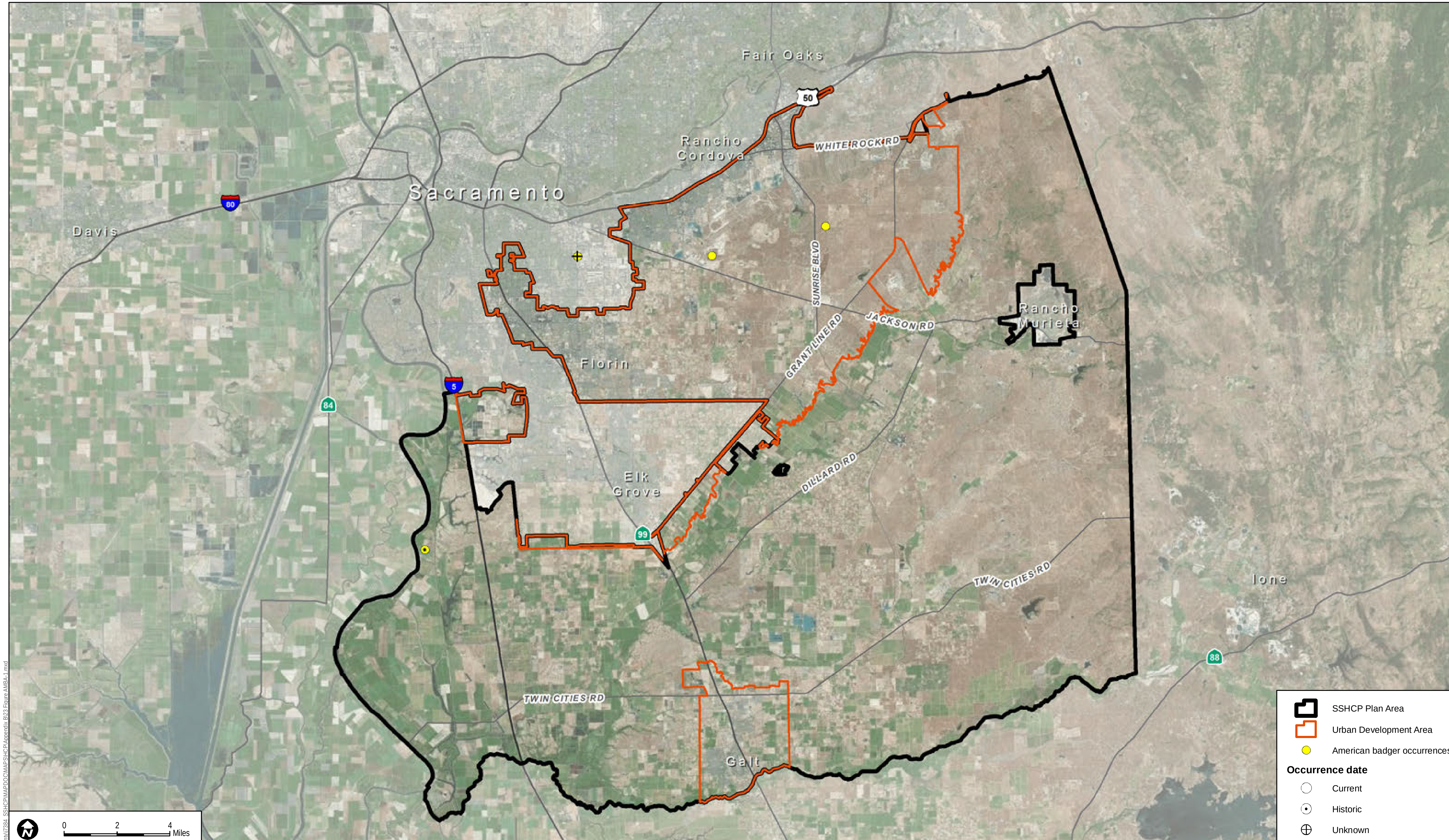

Path: Z:\Projects\Sacramento_County\07384_SSHCP\MAPDOC\MAPS\SHCP\Appendix B\23 Figure AMBA-1.mxd

SOURCE: Bing Maps, County of Sacramento 2014, CDFG 2012

FIGURE AMBA-1

American Badger Documented Occurrences

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

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APPENDIX C

Implementing Agreement

FINAL

IMPLEMENTING AGREEMENT

for the

HABITAT CONSERVATION PLAN

for

SOUTH SACRAMENTO COUNTY

January 2018

1.0 PARTIES

The Parties to this Implementing Agreement are the County of Sacramento, City of Galt, City of Rancho Cordova, Sacramento County Water Agency, the Southeast Connector Joint Powers Authority and the SSHCP Implementing Entity (collectively the "Plan Permittees"), and the United States Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW) (collectively the "Parties").

2.0 RECITALS AND PURPOSE

2.1 Recitals.

2.1.1 The Plan Area, and in particular the Preserve System, has been determined to provide, or potentially provide, habitat for the Covered Species as defined in Section 3.

2.1.2 The Plan Area is currently used for a variety of purposes including the potential for development. Plan Permittees are desirous of undertaking a number of activities, including public, residential, commercial and industrial development activities as summarized in Section 5 within the Plan Area in a manner that is designed to avoid or minimize adverse impacts to the Covered Species. Additionally, Plan Permittees wish to undertake actions that would be beneficial to and contribute to the conservation of the Covered Species.

2.1.3 Plan Permittees have developed a series of measures, described in the South Sacramento Habitat Conservation Plan ("SSHCP", "Plan" or "HCP"), to minimize and mitigate to the maximum extent practicable the effects of Take of Covered Species incidental to Plan Permittees' Covered Activities.

2.2 Purpose. The purpose of this Agreement is to clarify the provisions of the SSHCP and the processes the Parties intend to follow to ensure successful implementation of the SSHCP in accordance with the Permit and applicable law.

3.0 DEFINITIONS

The following terms as used in this Agreement will have the meanings set forth below. Additional terms and acronyms are contained in Appendix A of the SSHCP:

3.1 Terms defined in Endangered Species Act or Implementing Regulations. Terms used in this Agreement and specifically defined in the Endangered Species Act ("ESA") or in regulations adopted by the USFWS under the ESA have the same meaning as in the ESA and those implementing regulations, unless this Agreement expressly provides otherwise.

3.2 Certificate of Inclusion. means a document other than a Development Authorization, executed by a Plan Permittee and a third party that extends the incidental Take authorization granted to Plan Permittees to such third party for the purpose of carrying out a

Covered Activity in the Plan Area. Execution of a Certificate of Inclusion by the third party places such third Party under the legal control of that Plan Permittee for purposes of enforcing and implementing the Permit, including the SSHCP and this Agreement. A Certificate of Inclusion template is attached to this agreement as Exhibit "C".

3.3 Changed Circumstances. means as defined in the "No Surprises" rule at 50 C.F.R. Section 17.3, means changes in circumstances affecting a Covered Species or the Plan Area covered by the SSHCP that can reasonably be anticipated by the Parties and that can reasonably be planned for in the SSHCP (e.g. the listing of a new species, or a fire or other natural catastrophic event in areas prone to such event.) Changed Circumstances and the planned responses to those circumstances are described in Chapter 11 of the SSHCP. Changed Circumstances are not Unforeseen Circumstances.

3.4 Covered Activities. means certain activities carried out by Plan Permittees in the Plan Area that may result in incidental Take of Covered Species that is authorized under the Permit. Covered Activities means the activities analyzed in detail in Chapter 5 of the SSHCP provided that these activities are otherwise lawful.

3.5 Covered Entity. means the recipient of a Development Authorization or a Certificate of Inclusion issued pursuant to the governmental powers of Plan Permittees.

3.6 Covered Species. means those 28 species within the Plan Area, each of which the SSHCP addresses in a manner sufficient to meet all of the criteria for issuing an incidental Take permit under ESA § 10(a)(1)(B). These species are discussed in Appendix B of the HCP and listed in Exhibit "A" to this Agreement.

3.7 Development Authorization. means a permit, lease, license, contract or similar written authorization issued pursuant to the governmental powers of Plan Permittees, under which the recipient has the right to engage in a Covered Activity and against whom Plan Permittees have the legal authority and has committed to enforce applicable terms of the Permit, including the SSHCP and this Agreement.

3.8 Effective Date. means the date following execution of this Agreement by the Parties, on which the Permit is issued. Any Plan Permittees executing this Agreement after the Effective Date shall, upon execution, become a Party to this Agreement, with all rights and obligations of Parties defined herein, and this Agreement shall be enforceable between each later executing Plan Permittees and all prior signing Parties.

3.9 HCP, Plan or SSHCP. means the South Sacramento Habitat Conservation Plan prepared by Plan Permittees as depicted on Figure 1-1 attached to the SSHCP.

3.10 Land Use Authority Permittee. means the County of Sacramento, and the Cities of Galt and Rancho Cordova.

3.11 Listed Species. means a species (including a subspecies, or a distinct population segment of a vertebrate species) that is listed as endangered or threatened under the ESA.

3.12 Permit. means the incidental take permit issued by the USFWS to Plan Permittees pursuant to Section 10(a)(1)(B) of the ESA for Take of the Covered Species incidental to Covered Activities within the Plan Area, as it may be amended from time to time.

3.13 Plan Area. means the area in which all conservation actions will be implemented and generally where the Plan Permittees have Take Authorization for Covered Species and species habitat resulting from Covered Activities.

3.14 Plan Permittees. means the County of Sacramento ("County"), City of Galt ("Galt"), City of Rancho Cordova ("Rancho Cordova"), Sacramento County Water Agency ("SCWA"), the Southeast Connector Joint Powers Authority ("JPA") and the SSHCP Implementing Entity.

3.15 SSHCP Implementing Entity. means joint powers authority formed by the County and Cities to provide primary policy direction for implementation of the SSHCP, as set forth in Chapter 9 of the SSHCP.

3.16 Take. means as defined in the ESA and implementing regulations means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any listed or unlisted animal Covered Species. Harm means an act that actually kills or injures a Covered Species, including an act that causes significant habitat modification or degradation where it actually kills or injures a Covered Species by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Take of plant species is not prohibited under the ESA; however, the plant species identified in Chapter 1 of the HCP and in Exhibit A of this Agreement are listed on the Permit as Covered Species in recognition of the conservation measures provided for such species under the plan and receive No Surprises Assurances under the Permit. For purposes of determining any outstanding mitigation owed upon termination of the Permit under Section 6 herein, Take includes impacts to Covered plant species.

3.17 Unforeseen Circumstances. means as defined in the "No Surprises" rule at 50 C.F.R. section 17.3 means changes in circumstances affecting a Covered Species or geographic area covered by the SSHCP that could not reasonably have been anticipated by Plan Permittees and the USFWS at the time of the SSHCP's negotiation and development, and that result in a substantial and adverse change in the status of the Covered Species as addressed in Chapter 11 of the HCP.

3.18 Unlisted Species. means a species (including a subspecies, or a distinct population segment of a vertebrate species) that is not listed as endangered or threatened under the ESA.

3.19 Other Terms. means any other capitalized term not otherwise defined herein shall carry the same meaning and definition as that term is used and defined in the SSHCP.

4.0 INCORPORATION OF HCP

Subject to Section 15.11 herein, the SSHCP and each of its provisions are intended to be, and by this reference are, incorporated herein. Notwithstanding such incorporation, it is acknowledged by the Parties that the HCP was drafted by the Plan Permittees and submitted to USFWS in support of the application for the Permit. Characterizations, analyses, and representations in the HCP, and in particular, characterizations, analyses and representations in the HCP of Federal or State laws, regulations and policies, represent the views of the Plan Permittees and shall not control the administration of the Permit by USFWS in accordance with Federal and State laws, regulations and policies. In the event of any inconsistency between the HCP and this Agreement, the provisions of the Agreement control. Similarly, in the event of any inconsistency between the HCP or Agreement and the Permit, the Permit controls.

5.0 OBLIGATIONS OF THE PARTIES

5.1 Obligations of Plan Permittees. Plan Permittees will fully and faithfully implement the Take minimization, mitigation and other requirements of the HCP, this Agreement and the Permit.

5.1.1 Mitigation Obligations. Plan Permittees will implement and fulfill the obligations described in Chapters 5 [Covered Activities], 7 [Conservation Strategy], 8 [Monitoring and Management], 9 [Implementation], 10 [Permit Application Process] and 12 [HCP Funding Program] of the SSHCP.

5.1.2 Interim Obligations upon a Finding of Unforeseen Circumstances. If the USFWS makes a finding of Unforeseen Circumstances, during the period necessary to determine the nature and location of additional or modified mitigation, Plan Permittees will avoid contributing to appreciably reducing the likelihood of the survival and recovery of the affected Covered Species.

5.1.3 Duty to enforce. Plan Permittees shall undertake all necessary actions to enforce all applicable terms of the HCP, this Agreement and the Permit as to itself, and any entity or individual for which a Development Authorization or Special Participating Entity approval has been issued over which Plan Permittees have committed to enforce the terms of the HCP, this Agreement and the Permit. Any substantial non-compliance by Plan Permittees, or any entity or individual for which a Development Authorization or Special Participating Entity approval has been issued may be deemed by USFWS a violation of the Permit by Plan Permittees. In addition, any failure by Plan Permittees to enforce the applicable provisions of the HCP, this Agreement or the Permit against itself, or any entity or individual for which a Development Authorization or Special Participating Entity approval has been issued may be deemed by USFWS a non-compliance by Plan Permittees with the HCP, this Agreement or the Permit and a violation of the Permit by

Plan Permittees. USFWS shall take into account all efforts undertaken by Plan Permittees to enforce the terms of the HCP, this Agreement and the Permit as to itself, any entity or individual for which a Development Authorization or Special Participating Entity approval has been issued and all actions taken by Plan Permittees to redress the effects of such non-compliance, particularly the enforcement efforts and redress actions specifically described in the HCP.

5.1.4 Changed Circumstances. Plan Permittees shall undertake all appropriate measures provided in Chapter 11 of the SSHCP to respond to Changed Circumstances.

5.1.5 Transfer of Preserve System. As set forth in more detail in Chapter 9, Plan Permittees may not transfer ownership or control, including fee title or a conservation easement, of any portion of the Preserve System, that is intended to stay within the Preserve System, to a third party, other than an agency of the Federal government, unless a conservation easement or equivalent legal protection, in a form approved by USFWS and which names USFWS as a third-party beneficiary, has been recorded. Nothing herein prohibits the sale of Preserve System land to a third party for non-conservation purposes if the USFWS and the SSHCP Implementing Entity find that the land is not supporting the Preserve System.

5.2 Obligations of the USFWS. Upon execution of this Agreement by each Party, and satisfaction of all other applicable legal requirements, the USFWS will issue Plan Permittees a permit under Section 10(a)(1)(B) of the ESA, authorizing incidental Take by Plan Permittees of each listed wildlife Covered Species resulting from Covered Activities in the Plan Area. The Permit will be conditioned on compliance with all terms and conditions of the Permit, including the HCP, this Agreement and applicable law.

5.2.1 Permit coverage. The Permit will identify all Covered Species. The Permit will take effect for listed Covered Species at the time the Permit is issued. Subject to compliance with all other terms of this Agreement, the Permit will take effect for an unlisted Covered Species upon the listing of such species. Any reference in this Agreement or in the HCP to incidental Take or Take of Covered Species shall, for the purpose of Covered plant Species include loss or impacts to Covered plant Species identified in the Permit.

5.2.2 "No surprises" assurances. Upon issuance of the Permit, Plan Permittees shall receive regulatory assurances pursuant to the "No Surprises" regulations at 50 C.F.R. 17.22(b) (5) and 17.32(b) (5). Pursuant to the "No Surprises" regulations, as long as Plan Permittees have complied with their obligations under the HCP, this Agreement, and the Permit, USFWS shall not require additional conservation and mitigation measures that involve the commitment of additional land, water, or financial compensation or additional restrictions on the use of land water or other natural resources otherwise available for development or use under the original terms of the HCP without the consent of Plan Permittees.

5.2.3 USFWS Cooperation and Assistance. USFWS shall cooperate and provide, to the extent appropriated funds are available for that purpose, technical assistance to the

Plan Permittees. Nothing in this Agreement shall require the USFWS to act in a manner contrary to the requirements of the Anti-Deficiency Act.

5.2.4 Assurances Regarding SSHCP. After opportunity for public review and comment, based on the best available current scientific and commercial data, the USFWS has found that the SSHCP, as implemented by this Agreement: 1) is consistent with and will complement other applicable conservation planning and regulatory programs and efforts addressing wildlife within the region, 2) minimizes and mitigates the potential significant adverse impacts of the Covered Activities on the Covered Species, 3) will ensure that the measures agreed upon by the Plan Permittees and the USFWS will be met, and 4) will be implemented. The USFWS shall not take a position inconsistent with the acknowledgments set forth in this section, including, without limitation, in the form of comments offered by the USFWS in the context of any CEQA or NEPA process associated with approvals for Covered Activities with regard to effects on Covered Species.

5.2.5 Take Authorization for Newly Regulated Covered Species; Savings Provision. Subject to compliance with all other terms of this Agreement, the Section 10(a) Permit will automatically become effective for each unlisted Covered Species upon the listing of such species as endangered or threatened under FESA. If it is judicially determined that the USFWS was not authorized to cause the Section 10(a) Permit to become effective automatically as to Covered Species as they become listed pursuant to FESA, the USFWS shall accept the minimization and mitigation measures in the SSHCP and this Agreement as the basis for an application for a Section 10(a) amendment or separate Section 10(a) Permits, Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 703-712) ("MBTA") Permits, and/or other Take Authorizations. The USFWS shall use reasonable efforts to review and process the application expeditiously so as to ensure, provided the Permit amendment or application meets the requirements of the ESA and other applicable federal laws, that the Take Authorization is effective concurrently with the listing of the Covered Species under FESA. In issuing such Permits, amendments and/or Take Authorizations, and to the extent that such judicial determination creating the circumstances requiring such additional review and processing allows, the USFWS shall not request, impose, recommend or require further mitigation, conservation, compensation, enhancement or other protection for such Covered Species except as expressly provided in this Agreement.

5.2.6 Changes in the Environmental Laws. It is acknowledged and agreed by the USFWS that the Permittees are agreeing to perform substantial avoidance, minimization, mitigation, conservation and management measures as set forth in this Agreement. If a change in, or an addition to, any federal law governing or regulating the impacts of the Covered Activities on land, water or biological resources as they relate to Covered Species, including, but not limited to, ESA and NEPA, the USFWS shall give due consideration to the measures required under the SSHCP in applying the new laws and regulations to the Plan Permittees.

5.2.7 Section 7 Consultations. The USFWS will evaluate the direct, indirect, and cumulative effects of the Covered Activities in their internal ESA biological opinion issued in connection with the SSHCP and issuance of the Section 10(a) Permit. As a result, and to the maximum extent allowable, in any consultation under Section 7 of ESA subsequent to the Effective Date involving the Plan Permittee(s) or any entity or individual for which a Development Authorization or Special Participating Entity has been issued with regard to Covered Species and Covered Activities, the USFWS shall ensure that the ESA biological opinion issued in connection with the proposed project that is the subject of the consultation is consistent with the internal ESA biological opinion. Such project must be consistent with the terms and conditions of the SSHCP and this Agreement. Any reasonable and prudent measures included under the terms and conditions of an ESA biological opinion issued subsequent to the Effective Date with regard to the Covered Species and Covered Activities shall, to the maximum extent appropriate, be consistent with the implementation measures of the SSHCP and this Agreement. The USFWS shall not impose measures in excess of those that have been or will be required by the Plan Permittee(s) pursuant to the SSHCP and this Agreement. The USFWS shall process subsequent ESA consultations for Covered Activities in accordance with the process and time periods set forth in 50 Code of Federal Regulations, section 402.14. The Parties agree that this section does not create an independent cause of action.

5.2.8 Future Recovery Plans. Recovery plans under ESA delineate actions necessary to recover and protect federally listed species. These plans frequently include information, or may lead to the development of information, that can contribute to the development of an adaptive management program. However, recovery plans do not obligate any Plan Permittee, individual or entity to undertake specific tasks.

The Parties acknowledge that ESA recovery plans have no effect on the implementation of this SSHCP, except to the extent that they may contribute information to, or assist in achieving the goals of, the Plan’s Adaptive Management provisions. Any recovery plan applicable to any Covered Species within the SSHCP Plan Area that is developed after the Effective Date shall:

A. Not require any additional land or financial compensation by Permittees;

B. Be finalized only after the USFWS has consulted with and requested input from the SSHCP Implementing Entity on the preparation of the recovery plan; and

C. Not in any way diminish the Take Authorization for Covered Species granted to Plan Permittees pursuant to the SSHCP, this Agreement, or the Section 10(a) Permit.

5.2.9 Migratory Bird Treaty Act. The Section 10(a) Permit shall constitute a Special Purpose Permit under 50 Code of Federal Regulations section 21.27, for the Take of

Covered Species Adequately Conserved listed under ESA and which are also listed under the MBTA, in the amount and/or number specified in the SSHCP, subject to the terms and conditions specified in the Section 10(a) Permit. Any such Take will not be in violation of the MBTA. The MBTA Special Purpose Permit will extend to Covered Species listed under ESA and also under the MBTA after the Effective Date of the Section 10(a) Permit. This Special Purpose Permit shall be valid for a period of three (3) years from its Effective Date, provided the Section 10(a) Permit remains in effect for such period. The Special Purpose Permit shall be renewed pursuant to the requirements of the MBTA, provided the Permittees remain in compliance with the terms of this Agreement and the Section 10(a) Permit. Each such renewal shall be valid for a period of three (3) years, provided that the Section 10(a) Permit remains in effect for such period.

6.0 TERM

6.1 Initial Term. This Agreement, the HCP, and the Permit will remain in effect for a period of fifty (50) years from the Effective Date of the original Permit. Notwithstanding the stated term, the Parties agree that preservation of the Preserve System shall be permanent.

6.2 Permit Renewal. Upon agreement of the Parties and in compliance with all applicable laws, the USFWS may extend the Permit beyond the initial term under the applicable regulations in force on the date of such extension. If the Plan Permittees desire to extend the Permit, they will so notify the USFWS at least four (4) months before the then-current term is scheduled to expire. Extension of the Permit constitutes extension of the SSHCP and this Agreement for the same amount of time, subject to any modifications agreed to by the Parties at the time of extension.

6.3 Surrender of the Permit. Any one or combination of Plan Permittees may withdraw from the Permit by surrendering the Permit to the USFWS in accordance with the regulations of the USFWS in force on the date of such surrender. (These regulations are currently codified at 50 CFR 17.22(b)(7) and 17.32(b)(7) and by their express terms apply in place of 50 CFR 13.26 to the extent of any conflict.

6.4 Procedure Applicable to Early Surrender of the Permit. If anyone or a combination of Plan Permittees elects to surrender the Permit before expiration of the full term, then in addition to surrendering the Permit, relevant Plan Permittees will provide a status report detailing the nature and amount of any incidental Take of the Covered Species, the minimization and mitigation measures provided for Take up through the date of early surrender, and the status of compliance with all other terms of the HCP. Within 90 days after receiving the surrendered Permit and a status report meeting the requirements of this paragraph, USFWS will use reasonable efforts to give written notice to the relevant Plan Permittees identifying all required outstanding mitigation and minimization measures.

6.5 Effect of Early Surrender. Upon the relevant Plan Permittee(s)' surrender of the Permit in accordance with Section 6.3, no further Take by relevant Plan Permittee(s) or any entity or individual for which a Development Authorization has been issued by that Plan Permittee(s) shall be authorized under the terms of the Permit. Notwithstanding early surrender of the Permit, the relevant Plan Permittees shall implement each of the post-termination mitigation and minimization measures identified by USFWS in their written notice under Section 6.3, for any incidental Take of a Covered Species resulting from Covered Activities carried out in accordance with the Permit prior to the date of surrender, provided, however, that the post-termination mitigation and minimization measures identified by USFWS are subject to the voluntary dispute resolution procedure outlined in Section 14.2 herein. USFWS will only cancel the Permit upon determination that all applicable post-termination mitigation and minimization measures have been implemented. If prior to termination of the Permit, USFWS has approved the transfer of a portion of the Permit in accordance with all applicable statutory and regulatory requirements, then the transferred portion of the Permit shall remain in effect notwithstanding termination of the remaining portion.

7.0 SUSPENSION OR REVOCATION OF THE PERMIT

USFWS may suspend or revoke the Permit for cause in accordance with the laws and regulations in force at the time of such suspension or revocation. (The regulations governing permit suspension and revocation are currently codified at 50 CFR 13.27 (suspension) and 50 CFR 13.28, 17.22(b)(8) and 17.32(b)(8) (revocation). Suspension or revocation may apply to the entire Permit, or only to specified Covered Species, portions of the Plan Area or Covered Activities. Except where USFWS determines emergency action is necessary to avoid irreparable harm to a Covered Species, it will not suspend the Permit without first requesting the Plan Permittees to take appropriate remedial actions, if any such actions are available, and providing the Plan Permittees with written notice of the facts or conduct which may warrant the suspension, and an adequate and reasonable opportunity, including, where appropriate, use of the voluntary dispute resolution procedure outlined in Section 14.2, to demonstrate why suspension is not warranted.

7.1 Continuing Liability for Outstanding Mitigation. Notwithstanding revocation of the Permit, Plan Permittees affected by the suspension will remain liable for all incidental Take of Covered Species that occurred prior to revocation and shall fully implement all measures required under the HCP to minimize and mitigate for such Take. USFWS shall use their reasonable efforts to notify Plan Permittees in writing of all required outstanding minimization and mitigation measures within 90 days of permit revocation.

7.2 Other Rights and Authorities Not Affected. Nothing in this Section 7 prevents Plan Permittees from seeking review by a court of competent jurisdiction of any decision of the USFWS to revoke the Permit. Likewise, nothing in this Section affects or circumscribes the authority of USFWS to carry out their enforcement and other responsibilities under the ESA.

8.0 FUNDING

Plan Permittees warrant that they will expend SSHCP program funds as may be necessary to fulfill their obligations under the HCP. Plan Permittees will promptly notify the USFWS of any material change in Plan Permittees' financial ability to fulfill its obligations. The funding program is set forth in detail in Chapter 12 of the SSHCP.

9.0 MONITORING AND REPORTING

9.1 Planned Periodic Reports. As described in the HCP, the SSHCP Implementing Entity will submit periodic reports describing their activities and results of the monitoring program provided for in the SSHCP. In accordance with Chapters 8 and 9 of the SSHCP, the SSHCP Implementing Entity will submit an annual report by April 1 of each year that describes for the reporting period the status of Covered Activities, the results of the required monitoring, any instances of noncompliance with the provisions of the HCP, actions taken to rectify the non-compliance, any problems under the HCP, and all other of the reporting requirements set forth in Chapters 8 and 9 of the SSHCP.

9.2 Other Reports. The SSHCP Implementing Entity, Plan Permittees, or both, as relevant, will provide, within 30 days of being requested by the USFWS if feasible, any additional information in their possession or control related to implementation of the SSHCP that is requested by the USFWS for the purpose of assessing whether the terms and conditions of the Permit, including the HCP, are being fully implemented.

9.3 Certification of Reports. All reports will include the following certification from a responsible company official who supervised or directed preparation of the report:

> I certify under penalty of law, to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparation of this report, the information submitted is true, accurate, and complete.

9.4 Monitoring by USFWS. Plan Permittees acknowledge the necessity for USFWS to monitor compliance with the Permit and will cooperate fully in such monitoring. USFWS may conduct inspections and monitoring in connection with the Permit in accordance with its regulations. (See 50 C.F.R. § 13.21(e)(2))

10.0 CHANGED CIRCUMSTANCES

10.1 Plan Permittees-Initiated Response to Changed Circumstances. Plan Permittees will give notice to the USFWS after learning that any of the Changed Circumstances listed in Chapter 11 of the HCP have occurred. As soon as practicable thereafter, Plan Permittees will use best efforts to modify their activities in the manner described in Chapter 11 of the HCP, to the extent necessary to mitigate the effects of the Changed Circumstances on Covered Species, and will report to the USFWS on their actions. Plan Permittees will make such modifications without awaiting notice from the USFWS.

10.2 Service-Initiated Response to Changed Circumstances. If the USFWS determines that Changed Circumstances have occurred and that Plan Permittees have not responded in accordance with Chapter 11 of the HCP, the USFWS will so notify Plan Permittees and will direct Plan Permittees to make the required changes. Within 30 days after receiving such notice, Plan Permittees will make the required changes and report to the USFWS on their actions. If such actions are not feasible within this time frame, or if the Plan Permittees disagree with the direction from the USFWS, the SSHCP Implementing Entity will meet and confer with the USFWS. USFWS and the SSHCP Implementing Entity will use best efforts to develop a mutually agreeable action plan and schedule. Such changes are provided for in the HCP, and hence do not constitute Unforeseen Circumstances or require amendment of the Permit or HCP.

11.0 ADAPTIVE MANAGEMENT

11.1 Plan Permittees-Initiated Adaptive Management. Plan Permittees will implement the adaptive management provisions in Chapter 8 of the SSHCP, when changes in management practices are necessary to achieve the SSHCP's biological objectives, or to respond to monitoring results or new scientific information. Plan Permittees will make such changes without awaiting notice from the USFWS, and will report to the USFWS on any actions taken pursuant to this section.

11.2 Service-Initiated Adaptive Management. If the USFWS determines that one or more of the adaptive management provisions in the HCP have been triggered and that Plan Permittees have not changed their management practices in accordance with Chapter 8 of the SSHCP, the USFWS will so notify Plan Permittees and will direct Plan Permittees to make the required changes. Unless Plan Permittees invoke the voluntary dispute resolution procedure outlined in Section 14.2 to demonstrate why the required adaptive management changes are not warranted, Plan Permittees will make the required changes and report to the USFWS on their actions within 60 days after receiving such notice. Such changes are provided for in the HCP, and hence do not constitute Unforeseen Circumstances or require amendment of the Permit or HCP, except as provided in this section.

11.3 Reductions in Mitigation. Plan Permittees will not implement adaptive management changes that may result in less mitigation than provided for Covered Species under the original terms of the SSHCP, unless the USFWS first provides written approval. Plan Permittees may propose any such adaptive management changes by notice to the USFWS, specifying the adaptive management modifications proposed, the basis for them, including supporting data, and the anticipated effects on Covered Species, and other environmental impacts. Within 60 days of receiving such a notice, the USFWS will either approve the proposed adaptive management changes, approve them as modified by the USFWS, or notify Plan Permittees that the proposed changes constitute permit amendments that must be reviewed under Section 13.2 of this Agreement. If the USFWS has not responded within the 60 day period, the proposed adaptive management changes will be deemed approved.

11.4 No Increase in Take. This section does not authorize any modifications that would result in an increase in the amount and nature of Take, or increase the impacts of Take, on Covered Species beyond that analyzed under the original SSHCP and any amendments thereto. Any such modification must be reviewed as a permit amendment under Section 13.2 of this Agreement.

12.0 LAND TRANSACTIONS

12.1 Acquisition of Preserve System Lands. Land for the Preserve System will be acquired pursuant to Chapter 9 of the SSHCP.

12.2 Transfer of Preserve System Lands. Plan Permittees may not transfer ownership or control, including fee title or a conservation easement, of any portion of the Preserve System that is intended to stay within the Preserve System, to a third party, other than an agency of the Federal government, unless a conservation easement or equivalent legal protection, in a form approved by USFWS and which names USFWS as a third-party beneficiary, has been recorded pursuant to Section 5, above. Plan Permittees may transfer all or a portion of the Preserve System to an agency of the Federal government if, prior to the transfer, the USFWS determines in writing that the transfer will not compromise the effectiveness of the SSHCP based on adequate commitments by that agency regarding management of such land. Transfers of all or portions of the Preserve System under this section may be processed as minor modifications to the SSHCP in accordance with Section 13.1. Nothing herein prohibits the sale of Preserve System land to a third party for non-conservation purposes if the USFWS and the SSHCP Implementing Entity find that the land is not supporting the Preserve System.

13.0 MODIFICATIONS AND AMENDMENTS

13.1 Minor modifications.

13.1.1 Procedure. Either Plan Permittees or USFWS may propose minor modifications to the HCP or this Agreement by providing notice to all Parties. Such notice shall include a statement of the reason for the proposed modification and an analysis of its environmental effects, if any, including the effects of the proposed modification on operations under the SSHCP and on Covered Species. The other Parties will use reasonable efforts to respond to proposed modifications within 30 days of receipt of such notice. Proposed modifications will become effective upon the other Parties' written approval or shall be deemed approved by a Party if no response is received within 30 days of receipt of such notice. If USFWS determines that such modifications would result in operations under the SSHCP that are significantly different from those analyzed in connection with the SSHCP, adverse effects on the environment that are new or significantly different from those analyzed in connection with the SSHCP, or additional Take not analyzed in connection with the SSHCP, it may be processed as an amendment of the Permit in accordance with Section 13.2 of this Agreement. Parties may also institute the Dispute Resolution process set forth in Section 14.2 of this Agreement to resolve the objection.

13.1.2 Subject Matter of Minor Modifications. Subject to Section 13.1.1, Minor modifications to the HCP and Agreement processed pursuant to this subsection may include but are not limited to Chapter 9.10.2 of the SSHCP.

13.1.3 Other Proposed Changes to HCP or Agreement. Except for Administrative Revisions described in Chapter 9.10.1 of the SSHCP, any other proposed modifications to the SSHCP or Agreement will be processed as amendments of the Permit in accordance with Section 13.2 of this Agreement.

13.2 Amendment of the Permit. The Permit may be amended in accordance with all applicable legal requirements, including but not limited to the ESA, the National Environmental Policy Act, and the USFWS' permit regulations. In addition, the Party seeking to amend the Permit shall provide a statement of the reasons for the amendment and an analysis of its environmental effects, including its effects on operations under the HCP and on Covered Species. The Party seeking to amend the Permit shall follow the procedures outlined in Chapter 9 of the SSHCP.

13.3 Amendment of this Agreement. In addition to other approval requirements identified in this Section that may apply, this Agreement may only be amended consistent with the ESA and with the written consent of each Party.

14.0 ENFORCEMENT OF PERMIT AND DISPUTE RESOLUTION

14.1 General Authorities and Legal Rights. Nothing contained in this Agreement is intended to, or shall, limit the authority of the United States government to seek civil or criminal penalties or otherwise fulfill its enforcement and other responsibilities under the ESA or other applicable federal law. Nothing contained in this Agreement limits the rights of the Plan Permittees under applicable federal or state law to seek redress against the USFWS as otherwise permitted by law.

14.2 Dispute Resolution. The Parties recognize that disputes concerning implementation of, compliance with, or termination of the Permit, including the SSHCP and this Agreement may arise from time to time. The Parties will work together in good faith to resolve such disputes, and may use the informal dispute resolution procedures set forth in Section 14.2.1, or such other procedures upon which the Parties may adopt. However, if at any time, any Party determines that circumstances so warrant, it may seek any available administrative or judicial remedy without engaging in or waiting to complete informal dispute resolution.

14.2.1 Informal Dispute Resolution Process. Unless the Parties elect another dispute resolution process, or unless a Party has initiated administrative proceedings or suit in Federal court, the Parties may use the following process to attempt to resolve disputes:

(a) The USFWS will notify the Plan Permittees of the alleged non-compliance with, or violation of the Permit, including the HCP and this Agreement, the basis for contending that the non-compliance or violation has occurred, and the remedies the USFWS proposes to correct the alleged non-compliance or violation. Where Plan Permittees allege that USFWS's alleged reasons for non-compliance or violation of the Permit, including HCP implementation, is inconsistent with the terms of the SSHCP, this Agreement and/or the Permit, Plan Permittees will notify USFWS of their objection, the basis for the objection and the manner in which Plan Permittees believe the SSHCP, Agreement and/or Permit should be interpreted and implemented.

(b) The notified Party will have 60 days, or such other time as may be agreed to by the Parties, to respond. During this time either Party may seek clarification of the information provided in the initial notice. The Parties will use reasonable efforts to provide any information then available that may be responsive to such inquiries.

(c) Within 30 days after such response is provided or is due, representatives from each Party will meet and negotiate in good faith toward a solution satisfactory to both Parties, or will establish a specific process and timetable to seek such a solution.

(d) If any issues cannot be resolved through such negotiations, the Parties may consider non-binding mediation and other alternative dispute resolution processes and, if a dispute resolution process is agreed upon, will make good faith efforts to resolve all remaining issues through that process.

15.0 MISCELLANEOUS PROVISIONS

15.1 No Partnership. Neither this Agreement nor the HCP shall make or be deemed to make any Party to this Agreement the agent for or the partner of any other Party.

15.2 Notices. Any notice permitted or required by this Agreement shall be in writing, delivered personally, or by overnight mail, to the persons listed below, or shall be deemed given five (5) days after deposit in the United States mail, certified and postage prepaid, return receipt requested and addressed as follows, or at such other address as any Party may from time to time specify to the other Party in writing. Notices may be delivered by facsimile or other electronic means, provided that they are also delivered personally or by overnight or certified mail. Notices shall be transmitted so that they are received within the specified deadlines.

Deputy Manager
United States Fish and Wildlife Service
California/Nevada Operations Office
2800 Cottage Way, Room W-2606
Sacramento, California 95825
Telephone: 916-414-6464
Telefax: 916-414-6486

California Department of Fish and Wildlife Service
[Plan Permittees Address]
Telephone:
Telefax:

County of Sacramento
[Plan Permittees Address]
Telephone:
Telefax:

City of Galt
[Plan Permittees Address]
Telephone:
Telefax:

City of Rancho Cordova
[Plan Permittees Address]
Telephone:
Telefax:

Sacramento County Water Agency
[Plan Permittees Address]
Telephone:
Telefax:

Southeast Connector Joint Powers Authority
[Plan Permittees Address]
Telephone:
Telefax:

SSHCP Implementing Entity
[Plan Permittees Address]
Telephone:
Telefax:

15.3 Availability of Funds. Implementation of this Agreement and the HCP by the USFWS is subject to the requirements of the Anti-Deficiency Act and the availability of appropriated funds. Nothing in this Agreement will be construed by the Parties to require the obligation, appropriation, or expenditure of any money from the U.S. Treasury. The Parties acknowledge that the USFWS will not be required under this Agreement to expend any federal agency's appropriated funds unless and until an authorized official of that agency affirmatively acts to commit to such expenditures as evidenced in writing.

15.4 Duplicate Originals. This Agreement may be executed in any number of duplicate originals. Each Party shall maintain in their records a complete original of this Agreement.

15.5 No Third-Party Beneficiaries. Without limiting the applicability of rights granted to the public pursuant to the ESA or other federal law, this Agreement shall not create any right or interest in the public, or any member thereof, as a third-Party beneficiary hereof, nor shall this Agreement be construed to authorize anyone to maintain a suit for personal injuries or damages or any other cause of action pursuant to the provisions of this Agreement. The duties, obligations, and responsibilities of the Parties to this Agreement with respect to third parties shall remain as imposed under existing law.

15.6 Relationship to the ESA and Other Authorities. The terms of this Agreement shall be construed in accordance with the ESA and applicable federal law. Nothing in this Agreement is intended to limit or diminish the legal obligations and responsibilities of the USFWS as an agency of the federal government.

15.7 References to Regulations. Any reference in this Agreement, the HCP, or the Permit to any regulation or rule of the USFWS shall be deemed to be a reference to such regulation or rule in existence at the time an action is taken.

15.8 Applicable Laws. All activities undertaken pursuant to this Agreement, the HCP, or the Permit must be in compliance with all applicable state and federal laws and regulations.

15.9 Successors and Assigns. This Agreement shall be incorporated as a term and condition of the Permit. Assignment or other transfer of the Permit shall be governed by the USFWS' regulations in force at the time.

15.10 Permit Renewal. The Permit may be extended or renewed in accordance with all applicable laws and regulations in force at the time such action is initiated.

15.11 Agreement not an Enforceable Contract. Notwithstanding any language to the contrary in this Agreement, this Agreement is not intended to create, and shall not be construed to create an enforceable contract between the USFWS and Plan Permittees under the law with regard to the Permit or otherwise and none of the Parties to this Agreement shall be liable in damages to any other Party or any other third party or person for any performance or failure to perform any obligation identified in this Agreement. The sole purposes of this Agreement as between the USFWS and Plan Permittees are to clarify the provisions of the HCP and the processes the Parties intend to follow to ensure the successful implementation of the HCP in accordance with the Permit and applicable Federal law.

15.12 Compliance with the California Environmental Quality Act (CEQA). The Parties agree that the Plan provides extensive analysis and mitigation for the protection of Covered Species. For this reason, the Parties agree that compliance with the SSHCP constitutes full mitigation for impacts to Covered Species under the California Environmental Quality Act (CEQA) for Covered Activities. Nothing in this Section negates the requirement for full compliance with CEQA for Covered Activities, as determined by the applicable Plan Permittee.

15.13 Annexation and Deannexation of Lands. Each of the Plan Permittees shall enforce the terms of the Plan, the Permit, and this Agreement as to all individuals or entities subject to its jurisdiction, including lands in the Plan Area annexed into the Plan Permittees' jurisdictions after the Effective Date of this Agreement provided the Minor Modification requirements of Section 13.1 of this Agreement have been met. Any land annexed into the Plan Area shall receive Take Authorization pursuant to the Permit provided the Minor Modification requirements of Section 13.1 of this Agreement have been met. If the Minor Modification requirements cannot be met, a Permit Amendment will be required.

In the event of the annexation or deannexation of any land within the Plan Area to another jurisdiction that is not a Plan Permittee, the Parties shall seek to enter into an agreement between the Plan Permittees, the Local Agency Formation Commission ("LAFCO"), the annexing or deannexing jurisdiction and the USFWS as part of the annexation process to ensure that any development of the annexed lands proceeds in accordance with the conservation goals of the SSHCP. If an agreement can be reached, that jurisdiction shall become a Plan Permittee after executing an addendum to this Agreement and complying with Section 9.10.3 of the SSHCP.. If an agreement cannot be reached, or if the SSHCP requirements are not imposed as a condition of annexation by LAFCO, then the annexed or deannexed land will not receive Take Authorization pursuant to the Permit, the SSHCP or this Agreement. Additionally, such annexation or deannexation may result in the revocation or suspension of the Permits pursuant to Section 7.0 of this Agreement. Parties within such annexed or deannexed land that qualify as Participating Special Entities may receive Take Authorization.

15.14 Incorporation of New Cities within SSHCP Boundaries. During the term of the SSHCP, and after the Effective Date, one or more new cities may be incorporated within the Plan Area. Such newly incorporated cities, upon execution of an Implementing Agreement with the USFWS substantially similar in form to this Agreement, shall receive Take Authorization pursuant to the Permit and all other rights and obligations granted by the Permit, the SSHCP and this Agreement. Incorporation of a new city within the Plan Area shall constitute a Minor Modification and shall be processed as such pursuant to Section 13.1 of this Agreement. In the event a newly incorporated city fails to participate in the SSHCP, the Permit may be revoked or suspended as set forth in Section 7.0 of this Agreement.

IN WITNESS WHEREOF, THE PARTIES HERETO have executed this Implementing Agreement.

BY ____ Date ______________

[insert USFWS official who will sign the permit]
Deputy Manager
United States Fish and Wildlife Service, Region 8
Sacramento, California

BY ____ Date _______________
Deputy Director
Habitat Conservation Division
California Department of Fish and Wildlife
Sacramento, California

BY ____ Date_______________
[Name], Chair]
County of Sacramento

BY ____ Date_______________
[Name], Mayor
City of Galt

BY ____ Date_______________
[Name], Mayor
City of Rancho Cordova

BY ____ Date_______________
[Name], Chair
Sacramento County Water Agency

BY ____ Date_______________
[Name], Chair
Southeast Connector Joint Powers Authority

BY ____ Date_______________
[Name], Chair
SSHCP Implementing Entity

Exhibit A
Covered Species and Listing Status

Scientific Name Common Name	Status		
	Federal	*State*	*CRPR*
Invertebrates			
Lepidurus packardi Vernal pool tadpole shrimp	E*	—	—
Branchinecta lynchi Vernal pool fairy shrimp	T*	—	—
Branchinecta mesovallensis Mid-valley fairy shrimp	—	—	—
Desmocerus californicus dimorphus Valley elderberry longhorn beetle	T	—	—
Hydrochara rickseckeri Ricksecker's water scavenger beetle	—	—	—
Amphibians			
Ambystoma californiense California tiger salamander, (Central Valley population)	T*	T	—
Spea hammondii Western spadefoot	—	CSC	—
Reptiles			
Actinemys marmorata Western pond turtle	—	CSC	—
Thamnophis gigas Giant gartersnake	T	T	—
Birds			
Accipiter cooperii Cooper's hawk	—	WL	—
Agelaius tricolor Tricolored blackbird	BCC	T (Emergency Listed)	—
Athene cunicularia hypugea Western burrowing owl	BCC	CSC	—
Buteo regalis Ferruginous hawk	BCC	—	—
Buteo swainsoni Swainson's hawk	BCC	T	—
Circus cyaneus Northern harrier	—	CSC	—
Elanus leucurus White-tailed kite	—	CFP	—
Grus canadensis tabida Greater sandhill crane	—	T; CFP	—
Lanius ludovicianus Loggerhead shrike	BCC	CSC	—
Mammals			
Lasiurus blossevillii Western red bat	—	CSC	—
Taxidea taxus American badger	—	CSC	—

Exhibit A
Covered Species and Listing Status

Scientific Name Common Name	Status		
	Federal	*State*	*CRPR*
	Plants		
Downingia pusilla Dwarf downingia	—	—	2.2
Gratiola heterosepala Boggs Lake hedge-hyssop	—	E	1B.2
Juncus leiospemus var. *ahartii* Ahart's dwarf rush	—	—	1B.2
Legenere limosa Legenere	—	—	1B.1
Navarretia myserii Pincushion navarretia	—	—	1B.1
Orcuttia tenuis Slender Orcutt grass	T*	E	1B.1
Orcuttia viscida Sacramento Orcutt grass	E*	E	1B.1
Sagittaria sanfordii Sanford's arrowhead	—	—	1B.2

Status Definitions

Federal:

E = Listed as endangered under the federal ESA
T = Listed as threatened under the federal ESA
* = Species has designated Critical Habitat located within the Plan Area.
— = No federal ESA listing
BCC = Bird of Conservation Concern, USFWS 2008.

State:

E = Listed as endangered under CESA
T = Listed as threatened under CESA
CFP = Fully protected under the California Fish and Game Code
CSC = Species of special concern in California
WL = Watch List
— = No state status

California Rare Plant Rank (CRPR)

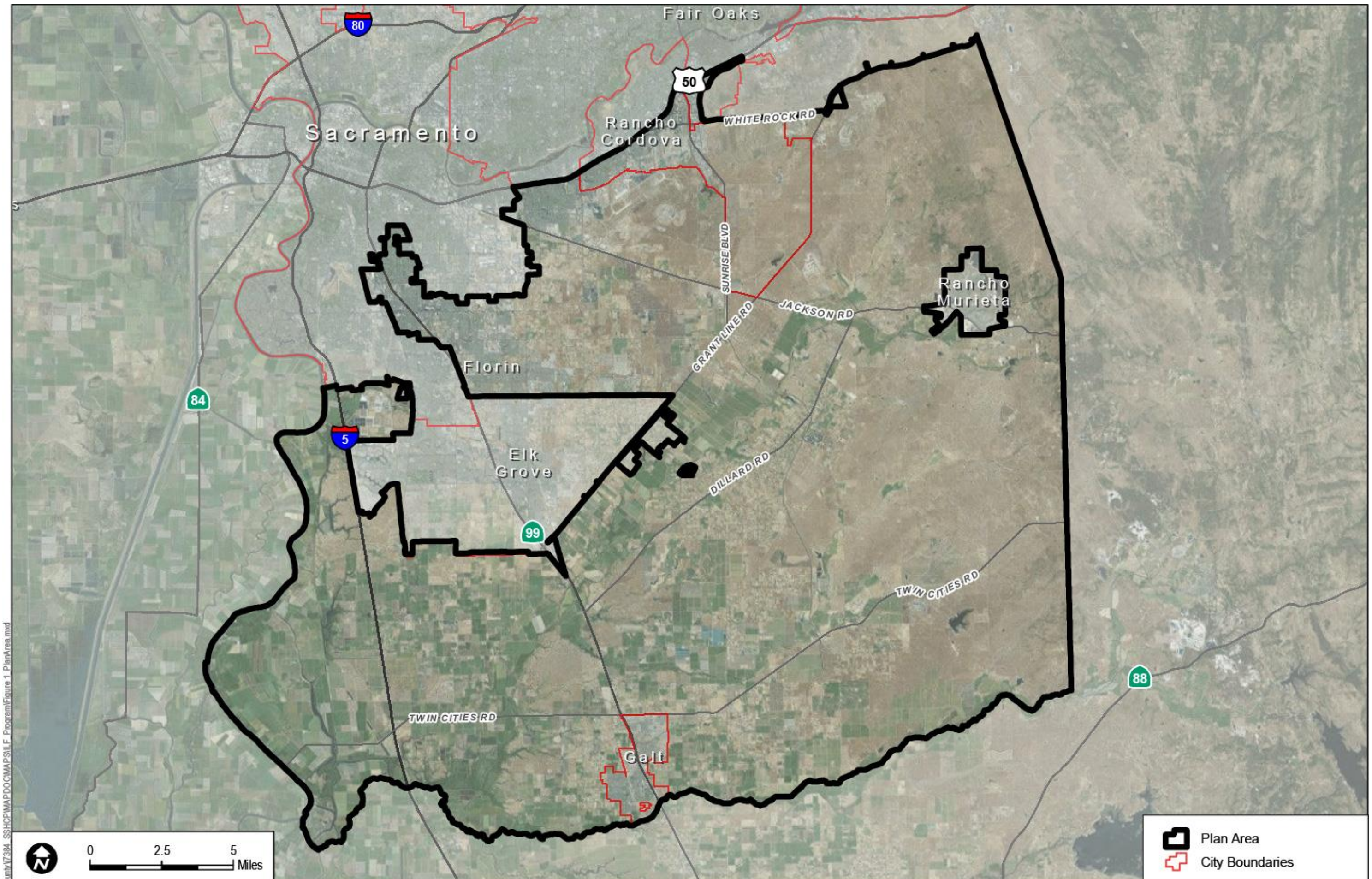
1B = Rare, threatened, or endangered in California and elsewhere
2 = Rare, threatened, or endangered in California but more common elsewhere

CRPR Threat Ranks

0.1 = Seriously threatened in California (high degree/immediacy of threat)
0.2 = Fairly threatened in California (moderate degree/immediacy of threat)
0.3 = Not very threatened in California (low degree/immediacy of threats or no current threats known)

Exhibit B

Map of Plan Area



SOURCE: ESRI, County of Sacramento 2014

SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

FIGURE 1

Plan Area

Exhibit C

Certificate of Inclusion

APPENDIX D

Sample Easements

APPENDIX D1

Sample Conservation Easement

Recording requested, and when
recorded, return to:

South Sacramento Conservation Agency
Street Address
City, State, Zip
Attn: Executive Director

(space above this line reserved for recorder's use)

SAMPLE CONSERVATION EASEMENT DEED AND AGREEMENT CREATING ENFORCEABLE RESTRICTIONS IN PERPETUITY

CONSERVATION EASEMENT DEED

THIS GRANT DEED OF HABITAT CONSERVATION EASEMENT (the "Grant") is made as of ______ ___, 20XX by and between the ___________________________________, a _______________________, as "Grantor" and the South Sacramento Conservation Agency, a California nonprofit public benefit corporation, as "Grantee."

RECITALS

A. Grantor owns real property consisting of approximately _____ acres, in Sacramento County, California, as described in Exhibit A and shown more particularly on the map attached as Exhibit B, attached hereto and incorporated herein, which together with all appurtenances thereto, including without limitation all mineral and mineral rights, if any, and all water and water rights appurtenant to such land (collectively, the "Property").

B. The Property possesses wildlife and habitat values of great importance to Grantor, Grantee, the people of the State of California and the people of the United States. The Property will provide high quality natural habitat for [***specify plant and/or animal species***] and contain [***list habitats; native and/or non-native***], [***include the following phrase only if there are jurisdictional wetlands:*** and restored, created, enhanced and/or preserved jurisdictional waters of the United States]. Individually and collectively, these wildlife and habitat values comprise the "Conservation Values" of the Property.

C. The Property is comprised of open space land, , which also provide essential habitat for South Sacramento Habitat Conservation Plan (SSHCP) Covered Species, and other significant relatively natural habitat and buffer for many species of wildlife.

D. Protection and preservation of the Property, including its wildlife habitat, shall assure that this area and its existing features shall continue to be available for SSHCP Covered Species and other natural habitat values and buffer for wildlife, a significant public benefit by preserving open space against development pressure, and scenic qualities.

E. As fee owner, Grantor owns the affirmative rights to identify, preserve, and protect forever the existing features and Conservation Values of the Property.

F. _____________, a _________, paid for the acquisition of this Conservation Easement Deed for Agricultural Land and Agreement Creating Enforceable Restrictions in Perpetuity from Grantor and provided ___________ Dollars ($_______) in management funds to Grantee to satisfy mitigation requirements imposed by the South Sacramento Habitat Conservation Plan (SSHCP), Plan Participant ______ (the "Plan Participant").

G. The State of California recognizes the public importance and validity of habitat conservation easements by enactment of Section 815 et seq. of the California Civil Code, and Grantee is an entity qualified under such Civil Code provisions to hold conservation easements.

H. Grantee is authorized to hold conservation easements pursuant to California Civil Code §815.3 and, as relevant to tax-exempt non-profit organizations, §501(c)(3) of the Internal Revenue Code.

I. To accomplish all of the aforementioned purposes, Grantor intends to convey to Grantee, and Grantee intends to obtain from Grantor, a Conservation Easement over a portion of the Property (the 'Easement Area"). The Easement Area is more particularly described in Exhibit C attached hereto and incorporated herein and depicted on the map in Exhibit D attached hereto to and incorporated herein (the "Easement Area Map") restricting the use which may be made of the Property to preserve and protect forever the agricultural, open-space, foraging and/or nesting habitat for SSHCP Covered Species and other wildlife habitat and scenic values of the Property.

COVENANTS, TERMS, CONDITIONS AND RESTRICTIONS

For good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, and pursuant to the laws of the United States and the State of California, including California Civil Code Section 815, *et seq.*, Grantor hereby voluntarily grants and conveys to Grantee a conservation easement in perpetuity over the Property.

1. Purposes.

The purposes of this Conservation Easement are to ensure that the Property will be retained forever in its natural, restored, or enhanced condition and to prevent any use of the Property that will impair or interfere with the Conservation Values of the Property. Grantor intends that this Conservation Easement will confine the use of the Property to activities that are consistent with such purposes, including, without limitation, those involving the preservation, restoration and enhancement of native species and their habitats.

2. Easement Documentation Report.

The parties acknowledge that a Preserve Documentation Report (the "Report") of the Property has been prepared by a competent biologist familiar with the environs and approved by Grantor and Grantee in writing, a copy of which is on file with Grantor and Grantee at their respective address for notices, set forth below. Selected portions of the Report are attached hereto as Exhibit C. The parties agree that the Report contains an accurate representation of the biological and physical condition of the Property at the time of this Grant, and of the historical uses of the Property, including historical water uses. Notwithstanding the forgoing, if a controversy arises with respect to the nature and extent of the physical, biological condition of the Property or the permitted historical uses of the Property, the parties shall not be foreclosed from utilizing any and all other relevant documents, surveys or other evidence or information to assist in the resolution of the controversy. The Report includes an aerial photograph where the "Agricultural Area" of the Property is delineated.

3. Grantee's Rights.

To accomplish the purposes of this Conservation Easement, Grantor hereby grants and conveys the following rights to Grantee:

(a) To preserve and protect the Conservation Values of the Property.

(b) To enter the Property at reasonable times, in order to monitor compliance with and otherwise enforce the terms of this Conservation Easement and any Management Plan developed for the Property and to implement at Grantee's sole discretion Management Plan activities that have not been implemented, provided that Grantee shall not unreasonably interfere with Grantor's authorized use and quiet enjoyment of the Property.

(c) To prevent any activity on or use of the Property that is inconsistent with the purposes of this Conservation Easement and to require the restoration of such areas or features of the Property that may be damaged by any act, failure to act, or any use or activity that is inconsistent with the purposes of this Conservation Easement.

(d) To require that all mineral, air and water rights as Grantee deems necessary to preserve and protect the biological resources and Conservation Values of the Property shall remain a part of and be put to beneficial use upon the Property, consistent with the purposes of this Conservation Easement.

(e) All present and future development rights appurtenant to, allocated, implied, reserved or inherent in the Property; such rights are hereby terminated and extinguished, and may not be used on or transferred to any portion of the Property, nor any other property adjacent or otherwise.

(f) Grantee may erect a sign or other appropriate marker in a prominent location on the Property, visible from a public road, bearing information indicating that the environmental and scenic resources of the Property are protected by Grantee. The wording of the information on the sign shall be jointly determined by Grantee and Grantor, but shall clearly indicate that the Property is privately owned and not open to the public. Grantee shall be responsible for the costs of erecting and maintaining its sign or marker.

(g) Subject to Grantor's approval, which approval shall not be unreasonably withheld or denied, Grantee shall have the right to conduct fish, wildlife, plant, and habitat studies on the Property, as well as research and monitoring on the Property, provided that such studies, research, and monitoring shall be carried out in a manner that shall not interfere unreasonably with the permitted use(s) or enjoyment of the Property by Grantor, its successors in interest, or any legally recognized occupant(s) or user(s) of the Property. Any other parties interested in conducting scientific studies on the Property are subject to the approval of Grantor, and such approval shall not be unreasonably withheld or denied.

4. Prohibited Uses.

Any activity on or use of the Property that is inconsistent with the purposes of this Conservation Easement is prohibited. Without limiting the generality of the foregoing, the following uses and activities by Grantor, Grantor's agents, and third parties are expressly prohibited:

(a) Unseasonable watering; use of fertilizers, pesticides, biocides, herbicides or other agricultural chemicals; weed abatement activities; incompatible fire protection activities; and any and all other activities and uses which may impair or interfere with the purposes of this Conservation Easement [***include the following language only if the Management Plan, including any adaptive management measures, specifies such an exception:***], except for [***insert specific exception(s)***] as specifically provided in the Management Plan.

(b) Use of off-road vehicles and use of any other motorized vehicles except on existing roadways [***include the following language only if the Management Plan, including any adaptive management measures, specifies such an exception:***], except for [***insert specific exception(s)***] as specifically provided in the Management Plan.

(c) Agricultural activity of any kind [***include the following language only if the Management Plan, including any adaptive management measures, specifies such an exception:***] except grazing for vegetation management as specifically provided in the Management Plan.

(d) Recreational activities, including, but not limited to, horseback riding, biking, hunting or fishing except for personal, non-commercial, recreational activities of the Grantor, so long as such activities are consistent with the purposes of this Conservation Easement and specifically provided for in the Management Plan.

(e) Commercial, industrial, residential, or institutional uses.

(f) Any legal or de facto division, subdivision or partitioning of the Property.

(g) Construction, reconstruction, erecting or placement of any building, billboard or sign, or any other structure or improvement of any kind [***include the following language only if the Management Plan specifies such an exception:***], except for [***insert specific exception(s)***] as specifically provided in the Management Plan.

(h) Depositing or accumulation of soil, trash, ashes, refuse, waste, bio-solids or any other materials.

(i) Planting, introduction or dispersal of non-native or exotic plant or animal species.

(j) Filling, dumping, excavating, draining, dredging, mining, drilling, removing or exploring for or extracting minerals, loam, soil, sand, gravel, rock or other material on or below the surface of the Property, or granting or authorizing surface entry for any of these purposes.

(k) Altering the surface or general topography of the Property, including but not limited to any alterations to habitat, building roads or trails, paving or otherwise covering the Property with concrete, asphalt or any other impervious material except for those habitat management activities specified in the Management Plan.

(l) Removing, destroying, or cutting of trees, shrubs or other vegetation, except as required by law for (i) fire breaks, (ii) maintenance of existing foot trails or roads, or (iii) prevention or treatment of disease [***include the following language only if the Management Plan specifies such an exception:***]; and except for [***insert specific exception(s)***] as specifically provided in the Management Plan.

(m) Manipulating, impounding or altering any natural water course, body of water or water circulation on the Property, and any activities or uses detrimental to water quality, including but not limited to degradation or pollution of any surface or sub-surface waters [***include the following language only if the Management Plan specifies such an exception:***], except for [***insert specific exception(s)***] as specifically provided in the Management Plan].

(n) Without the prior written consent of Grantee, which Grantee may withhold, transferring, encumbering, selling, leasing, or otherwise separating the mineral, air or water rights for the Property; changing the place or purpose of use of the water rights; abandoning or allowing the abandonment of, by action or inaction, any water or water rights, ditch or ditch rights, spring rights, reservoir or storage rights, wells, ground water rights, or other rights in and to the use of water historically used on or otherwise appurtenant to the Property, including but not limited to: (i) riparian water rights; (ii) appropriative water rights; (iii) rights to waters which are secured under contract with any irrigation or water district, to the extent such waters are customarily applied to the Property; and (iv) any water from wells that are in existence or may be constructed in the future on the Property.

(o) Engaging in any use or activity that may violate, or may fail to comply with, relevant federal, state, or local laws, regulations, or policies applicable to Grantor, the Property, or the use or activity in question.

5. Grantee's Duties.

(a) To ensure that the purposes of this Conservation Easement as described in

Section 1 are being accomplished, Grantee and its successors and assigns shall:

(1) Perform, at a minimum on an annual basis, compliance monitoring inspections of the Property; and

(2) Prepare reports on the results of the compliance monitoring inspections, and provide these reports to the Signatory Agencies on an annual basis.

(b) In the event that the Grantee's interest in this Conservation Easement reverts to or is transferred to the State of California, CDFW will carry out the tasks specified in Section 4(a) to the extent that funds and staff are available for that purpose. If CDFW determines that it cannot carry out the specified tasks, the Third Party Beneficiaries may identify a replacement Grantee, acceptable to all, and CDFW, subject to obtaining all necessary approvals, will transfer this Conservation Easement to the identified replacement Grantee in compliance with Section 10(a) of this Conservation Easement.

6. Grantor's Duties.

Grantor shall undertake all reasonable actions to prevent the unlawful entry and trespass by persons whose activities may degrade or harm the Conservation Values of the Property or that are otherwise inconsistent with this Conservation Easement. In addition, Grantor shall undertake all necessary actions to perfect and defend Grantee's rights under Section 3 of this Conservation Easement, and to observe and carry out the obligations of Grantor under the Management Plan.

7. Reserved Rights.

Grantor reserves to itself, and to its personal representatives, heirs, successors, and assigns, all rights accruing from Grantor's ownership of the Property, including the right to engage in or permit or invite others to engage in all uses of the Property that are not prohibited or limited by, and are consistent with the purposes of, this Conservation Easement.

8. Grantee's Remedies.

If Grantee determines that a violation of this Conservation Easement has occurred or is threatened, Grantee shall give written notice to Grantor of such violation and demand in writing the cure of such violation ("Notice of Violation"). If Grantor fails to cure the violation within thirty (30) days after receipt of a Notice of Violation, or if the cure reasonably requires more than thirty (30) days to complete and Grantor fails to begin the cure within the thirty (30)-day period or fails to continue diligently to complete the cure, Grantee may bring an action at law or in equity in a court of competent jurisdiction for any or all of the following: to recover any damages to which Grantee may be entitled for violation of the terms of this Conservation Easement or for any injury to the Conservation Values of the Property; to enjoin the violation, *ex parte* as necessary, by temporary or permanent injunction without the necessity of proving either actual damages or the inadequacy of otherwise available legal remedies; to pursue any other legal or equitable relief, including but not limited to, the restoration of the Property to the condition in which it existed prior to any violation or injury; or to otherwise enforce this

Conservation Easement. Without limiting the liability of Grantor, Grantee may apply any damages recovered to the cost of undertaking any corrective action on the Property.

If Grantee, in its sole discretion, determines that circumstances require immediate action to prevent or mitigate injury to the Conservation Values of the Property, Grantee may pursue its remedies under this Conservation Easement without prior notice to Grantor or without waiting for the period provided for cure to expire. Grantee's rights under this section apply equally to actual or threatened violations of this Conservation Easement.

Grantor agrees that Grantee's remedies at law for any violation of this Conservation Easement are inadequate and that Grantee shall be entitled to the injunctive relief described in this section, both prohibitive and mandatory, in addition to such other relief to which Grantee may be entitled, including specific performance of this Conservation Easement, without the necessity of proving either actual damages or the inadequacy of otherwise available legal remedies. Grantee's remedies described in this section shall be cumulative and shall be in addition to all remedies now or hereafter existing at law or in equity, including but not limited to the remedies set forth in California Civil Code Section 815, *et seq.* The failure of Grantee to discover a violation or to take immediate legal action shall not bar Grantee from taking such action at a later time.

(a) Costs of Enforcement.

All costs incurred by Grantee, where Grantee is the prevailing party, in enforcing the terms of this Conservation Easement against Grantor, including, but not limited to, costs of suit and attorneys' and experts' fees, and any costs of restoration necessitated by negligence or breach of this Conservation Easement, shall be borne by Grantor.

(b) Grantee's Discretion.

Enforcement of the terms of this Conservation Easement by Grantee shall be at the discretion of Grantee, and any forbearance by Grantee to exercise its rights under this Conservation Easement in the event of any breach of any term of this Conservation Easement shall not be deemed or construed to be a waiver of such term or of any subsequent breach of the same or any other term of this Conservation Easement or of any rights of Grantee under this Conservation Easement. No delay or omission by Grantee in the exercise of any right or remedy shall impair such right or remedy or be construed as a waiver.

(c) Acts Beyond Grantor's Control.

Nothing contained in this Conservation Easement shall be construed to entitle Grantee to bring any action against Grantor for any injury to or change in the Property resulting from (i) any natural cause beyond Grantor's control, including, without limitation, fire not caused by Grantor, flood, storm, and earth movement, or any prudent action taken by Grantor under emergency conditions to prevent, abate, or mitigate significant injury to the Property resulting from such causes; or (ii) acts by Grantee or its employees.

(d) Enforcement; Standing.

All rights and remedies conveyed to Grantee under this Conservation Easement shall extend to and are enforceable by the Third-Party Beneficiaries (as defined in Section 15(m)). These enforcement rights are in addition to, and do not limit, the rights of enforcement under the Management Plan. If at any time in the future Grantor uses, allows the use, or threatens to use or allow use of, the Property for any purpose that is inconsistent with or in violation of this Conservation Easement then, despite the provisions of California Civil Code Section 815.7, the California Attorney General and the Third-Party Beneficiaries each has standing as an interested party in any proceeding affecting this Conservation Easement.

(e) Notice of Conflict.

If Grantor receives a Notice of Violation from Grantee or a Third-Party Beneficiary with which it is impossible for Grantor to comply consistent with any prior uncured Notice(s) of Violation, Grantor shall give written notice of the conflict (hereinafter "Notice of Conflict") to the Grantee and Third-Party Beneficiaries. In order to be valid, a Notice of Conflict shall be given within fifteen (15) days of the date Grantor receives a conflicting Notice of Violation, shall include copies of the conflicting Notices of Violation, and shall describe the conflict with specificity, including how the conflict makes compliance with the uncured Notice(s) of Violation impossible. Upon issuing a valid Notice of Conflict, Grantor shall not be required to comply with the conflicting Notices of Violation until such time as the entity or entities issuing said conflicting Notices of Violation issue(s) revised Notice(s) of Violation that resolve the conflict. Upon receipt of a revised Notice of Violation, Grantor shall comply with such notice within the time period(s) described in the first grammatical paragraph of this Section. The failure of Grantor to issue a valid Notice of Conflict within fifteen (15) days of receipt of a conflicting Notice of Violation shall constitute a waiver of Grantor's ability to claim a conflict.

(f) Reversion.

If the Signatory Agencies determine that Grantee is not holding, monitoring or managing this Conservation Easement for conservation purposes in the manner specified in this Conservation Easement or the Management Plan then, pursuant to California Government Code Section 65965(c), this Conservation Easement shall revert to the State of California, or to another public agency or nonprofit organization qualified pursuant to Civil Code Section 815.3 and Government Code Section 65965 (and any successor or other provision(s) then applicable) and approved by the Signatory Agencies.

9. Access.

This Conservation Easement does not convey a general right of access to the public.

10. Costs and Liabilities.

Grantor retains all responsibilities and shall bear all costs and liabilities of any kind related to the ownership, operation, upkeep, and maintenance of the Property. Grantor agrees that neither Grantee nor Third-Party Beneficiaries shall have any duty or responsibility for the operation, upkeep or maintenance of the Property, the monitoring of hazardous conditions on it, or the protection of Grantor, the public or any third parties from risks relating to conditions on the Property. Grantor remains solely responsible for obtaining any applicable governmental permits and approvals required for any activity or use permitted by this Conservation Easement and any activity or use shall be undertaken in accordance with all applicable federal, state, local and administrative agency laws, statutes, ordinances, rules, regulations, orders and requirements.

(a) Taxes; No Liens.

Grantor shall pay before delinquency all taxes, assessments (general and special), fees, and charges of whatever description levied on or assessed against the Property by competent authority (collectively "Taxes"), including any Taxes imposed upon, or incurred as a result of, this Conservation Easement, and shall furnish Grantee with satisfactory evidence of payment upon request. Grantor shall keep the Property free from any liens (other than a security interest that is expressly subordinated to this Conservation Easement, as provided in Section 15(k)), including those arising out of any obligations incurred by Grantor for any labor or materials furnished or alleged to have been furnished to or for Grantor at or for use on the Property.

(b) Hold Harmless.

(1) Grantor shall hold harmless, protect and indemnify Grantee and its directors, officers, employees, agents, contractors, and representatives and the heirs, personal representatives, successors and assigns of each of them (each a "Grantee Indemnified Party" and collectively, "Grantee's Indemnified Parties") from and against any and all liabilities, penalties, costs, losses, damages, expenses (including, without limitation reasonable attorneys' fees and experts' fees), causes of action, claims, demands, orders, liens or judgments (each a "Claim" and, collectively, "Claims"), arising from or in any way connected with: (i) injury to or the death of any person, or physical damage to any property, resulting from any act, omission, condition, or other matter related to or occurring on or about the Property, regardless of cause, except that this indemnification shall be inapplicable to any Claim due solely to the negligence of Grantee or any of its employees; (ii) the obligations specified in Sections 6, 10 and 10(a); and (iii) the existence or administration of this Conservation Easement. If any action or proceeding is brought against any of the Grantee's Indemnified Parties by reason of any such Claim, Grantor shall, at the election of and upon written notice from Grantee, defend such action or proceeding by counsel reasonably acceptable to the Grantee's Indemnified Party or reimburse Grantee for all charges incurred for services of the California Attorney General in defending the action or proceeding].

(2) Grantor shall hold harmless, protect and indemnify Third-Party Beneficiaries and their respective directors, officers, employees, agents, contractors, and representatives and the heirs, personal representatives, successors and assigns of each of them (each a "Third-Party Beneficiary Indemnified Party" and collectively, "Third-Party Beneficiary Indemnified Parties") from and against any and all Claims arising from or in any way connected with: (i) injury to or the death of any person, or physical damage to any property, resulting from any act, omission, condition, or other matter related to or occurring on or about the Property, regardless of cause and (ii) the existence or administration of this Conservation Easement. *Provided, however,* that the indemnification in this Section 10 (b) (2) shall be inapplicable to a Third-Party Beneficiary Indemnified Party with respect to any Claim due solely to the negligence of that Third-Party Beneficiary Indemnified Party or any of its employees. If any action or proceeding is brought against any of the Third-Party Beneficiary Indemnified Parties by reason of any Claim to which the indemnification in this Section 10 (b) (2) applies, then at the election of and upon written notice from the Third-Party Beneficiary Indemnified Party, Grantor shall defend such action or proceeding by counsel reasonably acceptable to the applicable Third-Party Beneficiary Indemnified Party or reimburse the Third-Party Beneficiary Indemnified Party for all charges incurred for services of the California Attorney General or the U.S. Department of Justice in defending the action or proceeding.

(c) Extinguishment.

If circumstances arise in the future that render the preservation of Conservation Values, [***include this phrase only if there are jurisdictional wetlands:*** including wetland functions and values,] or other purposes of this Conservation Easement impossible to accomplish, this Conservation Easement can only be terminated or extinguished, in whole or in part, by judicial proceedings in a court of competent jurisdiction.

(d) Condemnation.

If all or part of the Property is taken in exercise of eminent domain by public, corporate, or other authority so as to abrogate the restrictions imposed by this Conservation Easement, Grantor and Grantee shall join in appropriate actions at the time of such taking to recover the full value of the taking and all incidental or direct damages resulting from the taking. All expenses incurred by Grantor and Grantee in such action shall be paid out of the recovered proceeds. The remaining proceeds shall be divided consistent with the provisions of this Paragraph using the ratio of the value of Grantee's and Grantor's interests that is set forth in subparagraph A above, it being expressly agreed that the Conservation Easement constitutes a compensable property right.

11. Transfer of Conservation Easement or Property.

(a) Conservation Easement.

This Conservation Easement may be assigned or transferred by Grantee upon written approval of the Signatory Agencies, which approval shall not be unreasonably withheld or delayed, but Grantee shall give Grantor and the Signatory Agencies at least sixty (60) days prior written notice of the proposed assignment or transfer. Grantee may assign or transfer its rights under this Conservation Easement only to an entity or organization: (i) authorized to acquire and hold conservation easements pursuant to California Civil Code Section 815.3 and Government Code Section 65967 (and any successor or other provision(s) then applicable), or the laws of the United States; and (ii) otherwise reasonably acceptable to the Signatory Agencies. Grantee shall require the assignee to record the assignment in the county where the Property is located. The failure of Grantee to perform any act provided in this section shall not impair the validity of this Conservation Easement or limit its enforcement in any way. Any transfer under this section is subject to the requirements of Section 12.

(b) Property.

Grantor agrees to incorporate the terms of this Conservation Easement by reference in any deed or other legal instrument by which Grantor divests itself of any interest in all or any portion of the Property, including, without limitation, a leasehold interest. Grantor agrees that the deed or other legal instrument shall also incorporate by reference the Management Plan, and any amendment(s) to those documents. Grantor further agrees to give written notice to Grantee and the Signatory Agencies of the intent to transfer any interest at least sixty (60) days prior to the date of such transfer. Grantee or the Signatory Agencies shall have the right to prevent any transfers in which prospective subsequent claimants or transferees are not given notice of the terms, covenants, conditions and restrictions of this Conservation Easement (including the exhibits and documents incorporated by reference in it). The failure of Grantor to perform any act provided in this section shall not impair the validity of this Conservation Easement or limit its enforceability in any way. Any transfer under this section is subject to the requirements of Section 12.

12. Merger.

The doctrine of merger shall not operate to extinguish this Conservation Easement if the Conservation Easement and the Property become vested in the same party. If, despite this intent, the doctrine of merger applies to extinguish the Conservation Easement then, unless Grantor, Grantee, and the Signatory Agencies otherwise agree in writing, a replacement conservation easement or restrictive covenant containing the same protections embodied in this Conservation Easement shall be recorded against the Property.

13. Notices.

Any notice, demand, request, consent, approval, or other communication that Grantor or Grantee desires or is required to give to the other shall be in writing, with a copy to each of the Signatory Agencies, and served personally or sent by recognized overnight courier that guarantees next-day delivery or by first class United States mail, postage fully prepaid, addressed as follows:

To Grantor:	[Grantee name] [Grantee address] Attn:______________________
To Grantee:	[***insert the appropriate Grantee information:***]

[***Remove/modify the following blocks as appropriate when CDFW or the USFWS are not third-party beneficiaries to the CE.***]

To CDFW:	[Department of Fish and Game] [Region name] Region [REGION ADDRESS] [Attn: Regional Manager]
With a copy to:	Department of Fish and Game Office of General Counsel 1416 Ninth Street, 12th Floor Sacramento, CA 95814-2090 Attn: General Counsel
To USFWS:	United States Fish and Wildlife Service [Field Office name] Field Office [FIELD OFFICE ADDRESS] Attn: Field Supervisor

or to such other address a party or a Signatory Agency shall designate by written notice to Grantor, Grantee and the Signatory Agencies. Notice shall be deemed effective upon delivery in the case of personal delivery or delivery by overnight courier or, in the case of delivery by first class mail, three (3) days after deposit into the United States mail.

14. Amendment.

This Conservation Easement may be amended only by mutual written agreement of Grantor and Grantee and written approval of the Signatory Agencies, which approval shall not be unreasonably withheld or delayed. Any such amendment shall be consistent with the purposes of this Conservation Easement and California law governing conservation easements, and shall not affect its perpetual duration. Any such amendment shall be recorded in the official records of the county in which the Property is located, and Grantee shall promptly provide a conformed copy of the recorded amendment to the Grantor and the Signatory Agencies.

15. Additional Provisions.

(a) Controlling Law.

The interpretation and performance of this Conservation Easement shall be governed by the laws of the United States and the State of California, disregarding the conflicts of law principles of such state.

(b) Liberal Construction.

Despite any general rule of construction to the contrary, this Conservation Easement shall be liberally construed to effect the purposes of this Conservation Easement and the policy and purpose of California Civil Code Section 815, *et seq.* and Government Code Section 65965. If any provision in this instrument is found to be ambiguous, an interpretation consistent with the purposes of this Conservation Easement that would render the provision valid shall be favored over any interpretation that would render it invalid.

(c) Severability.

If a court of competent jurisdiction voids or invalidates on its face any provision of this Conservation Easement, such action shall not affect the remainder of this Conservation Easement. If a court of competent jurisdiction voids or invalidates the application of any provision of this Conservation Easement to a person or circumstance, such action shall not affect the application of the provision to any other persons or circumstances.

(d) Entire Agreement.

This document (including its exhibits and the Management Plan incorporated by reference in this document) sets forth the entire agreement of the parties and the Signatory Agencies with respect to the Conservation Easement and supersedes all prior discussions, negotiations, understandings, or agreements of the parties relating to the Conservation Easement. No alteration or variation of this Conservation Easement shall be valid or binding unless contained in an amendment in accordance with Section 14.

(e) No Forfeiture.

Nothing contained in this Conservation Easement will result in a forfeiture or reversion of Grantor's title in any respect.

(f) Successors.

The covenants, terms, conditions, and restrictions of this Conservation Easement shall be binding upon, and inure to the benefit of, the parties and their respective personal representatives, heirs, successors, and assigns, and shall constitute a servitude running in perpetuity with the Property.

(g) Termination of Rights and Obligations.

A party's rights and obligations under this Conservation Easement terminate upon transfer of the party's interest in the Conservation Easement or Property, except that liability for acts, omissions or breaches occurring prior to transfer shall survive transfer.

(h) Captions.

The captions in this instrument have been inserted solely for convenience of reference and are not a part of this instrument and shall have no effect upon its construction or interpretation.

(i) No Hazardous Materials Liability.

(1) Grantor represents and warrants that it has no knowledge or notice of any Hazardous Materials (defined below) or underground storage tanks existing, generated, treated, stored, used, released, disposed of, deposited or abandoned in, on, under, or from the Property, or transported to or from or affecting the Property.

(2) Without limiting the obligations of Grantor under Section 10 (b), Grantor hereby releases and agrees to indemnify, protect and hold harmless the Grantee's Indemnified Parties (defined in Section 10 (b) (1)) from and against any and all Claims (defined in Section 10 (b)(1)) arising from or connected with any Hazardous Materials or underground storage tanks present, alleged to be present, released in, from or about, or otherwise associated with the Property at any time, except any Hazardous Materials placed, disposed or released by Grantee or any of its employees. This release and indemnification includes, without limitation, Claims for (A) injury to or death of any person or physical damage to any property; and (B) the violation or alleged violation of, or other failure to comply with, any Environmental Laws (defined below). If any action or proceeding is brought against any of the Grantee's Indemnified Parties by reason of any such Claim, Grantor shall, at the election of and upon written notice from the applicable Grantee Indemnified Party, defend such action or proceeding by counsel reasonably acceptable to the Grantee Indemnified Party or reimburse Grantee for all charges incurred for services of the California Attorney General in defending the action or proceeding].

(3) Without limiting the obligations of Grantor under Section 10 (b), Grantor hereby releases and agrees to indemnify, protect and hold harmless the Third-Party Beneficiary Indemnified Parties (defined in Section 10 (b)(2)) from and against any and all Claims arising from or connected with any Hazardous Materials or underground storage tanks present, alleged to be present, released in, from or about, or otherwise associated with the Property at any time, except that this release and indemnification shall be inapplicable to a Third-Party Beneficiary Indemnified Party with respect to any Hazardous Materials placed, disposed or released by that Third-Party Beneficiary Indemnified Party or any of its employees. This release

and indemnification includes, without limitation, Claims for (A) injury to or death of any person or physical damage to any property; and (B) the violation of alleged violation of, or other failure to comply with, any Environmental Laws. If any action or proceeding is brought against any of the Third-Party Beneficiary Indemnified Parties by reason of any such Claim, Grantor shall, at the election or and upon written notice from the applicable Third-Party Beneficiary Indemnified Party, defend such action or proceeding by counsel reasonably acceptable to the Third-Party Beneficiary Indemnified Party for all charges incurred for services of the California Attorney General or the U.S. Department of Justice in defending the action or proceeding.

(4) Despite any contrary provision of this Conservation Easement, the parties do not intend this Conservation Easement to be, and this Conservation Easement shall not be, construed such that it creates in or gives to Grantee or any Third-Party Beneficiaries any of the following:

(A) The obligations or liability of an "owner" or "operator," as those terms are defined and used in Environmental Laws (defined below), including, without limitation, the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (42 U.S.C. § 9601, *et seq.*; hereinafter, "CERCLA"); or

(B) The obligations or liabilities of a person described in 42 U.S.C. § 9607(a)(3) or (4); or

(C) The obligations of a responsible person under any applicable Environmental Laws; or

(D) The right to investigate and remediate any Hazardous Materials associated with the Property; or

(E) Any control over Grantor's ability to investigate, remove, remediate or otherwise clean up any Hazardous Materials associated with the Property.

(5) The term "Hazardous Materials" includes, without limitation, (a) material that is flammable, explosive or radioactive; (b) petroleum products, including by-products and fractions thereof; and (c) hazardous materials, hazardous wastes, hazardous or toxic substances, or related materials defined in CERCLA, the Resource Conservation and Recovery Act of 1976 (42 U.S.C. § 6901, *et seq.*; hereinafter, "RCRA"); the Hazardous Materials Transportation Act (49 U.S.C. §5101, *et seq.*; hereinafter, "HTA"); the Hazardous Waste Control Law (California Health & Safety Code § 25100, *et seq.*; hereinafter, "HCL"); the Carpenter-Presley-Tanner Hazardous Substance Account Act (California Health & Safety Code § 25300, *et seq.*; hereinafter "HSA"), and in the regulations adopted and publications promulgated pursuant to them, or any other applicable Environmental Laws now in effect or enacted after the date of this Conservation Easement.

(6) The term "Environmental Laws" includes, without limitation, CERCLA, RCRA, HTA, HCL, HSA, and any other federal, state, local or administrative agency statute, ordinance, rule, regulation, order or requirement relating to pollution, protection of

human health or safety, the environment or Hazardous Materials. Grantor represents, warrants and covenants to Grantee and Third-Party Beneficiaries that activities upon and use of the Property by Grantor, its agents, employees, invitees and contractors will comply with all Environmental Laws.

(j) Warranty.

Grantor represents and warrants that Grantor is the sole owner of the Property. Grantor also represents and warrants that, [***choose applicable statement:*** there are no outstanding mortgages, liens, encumbrances or other interests in the Property (including, without limitation, mineral interests) which may conflict or are inconsistent with this Conservation Easement ***or*** the holder of any outstanding mortgage, lien, encumbrance or other interest in the Property (including, without limitation, mineral interest) which conflicts or is inconsistent with this Conservation Easement has expressly subordinated such interest to this Conservation Easement by a recorded Subordination Agreement approved by Grantee and the Signatory Agencies].

(k) Additional Interests.

Grantor shall not grant any additional easements, rights of way or other interests in the Property (other than a security interest that is expressly subordinated to this Conservation Easement), nor shall Grantor grant, transfer, abandon or relinquish (each a "Transfer") any mineral, air, or water right or any water associated with the Property, without first obtaining the written consent of Grantee and the Signatory Agencies. Such consent may be withheld if Grantee or the Signatory Agencies determine(s) that the proposed interest or Transfer is inconsistent with the purposes of this Conservation Easement or will impair or interfere with the Conservation Values of the Property. This Section 15(k) shall not limit the provisions of Section 3(d) or 4(n), nor prohibit transfer of a fee or leasehold interest in the Property that is subject to this Conservation Easement and complies with Section 11. Grantor shall provide a copy of any recorded or unrecorded grant or Transfer document to the Grantee and Signatory Agencies.

(l) Recording.

Grantee shall record this Conservation Easement in the Official Records of the County in which the Property is located, and may re-record it at any time as Grantee deems necessary to preserve its rights in this Conservation Easement.

(m) Third-Party Beneficiary.

Grantor and Grantee acknowledge that the [***include the agencies that will be third-party beneficiaries***] (the "Third-Party Beneficiaries") are third party beneficiaries of this Conservation Easement with the right of access to the Property and the right to enforce all of the obligations of Grantor including, but not limited to, Grantor's obligations under Section 15, and all other rights and remedies of the Grantee under this Conservation Easement.

(n) Funding.

Endowment funding for the perpetual management, maintenance and monitoring of the Property is specified in and governed by the South Sacramento Habitat Conservation Plan.

IN WITNESS WHEREOF Grantor has executed this Conservation Easement Deed the day and year first above written.

GRANTOR: [***Notarization Required***]

BY:______________________________

NAME:___________________________

TITLE:___________________________

DATE: ____________________________

Approved as to form:

South Sacramento Conservation Agency:

BY: ____________________________

(Insert Name)

(Insert Title)

DATE: __________________________

Approved as to form:

BY: ____________________________

(Insert Counsel Name)

APPENDIX D2

Sample Agricultural Easement

APPENDIX D2
Sample Conservation Easement For Agricultural Lands

Recording requested, and when
recorded, return to:

South Sacramento Conservation Agency
Street Address
City, State, Zip
Attn: Executive Director

(space above this line reserved for recorder's use)

SAMPLE CONSERVATION EASEMENT DEED FOR AGRICULTURAL LAND AND AGREEMENT CREATING ENFORCEABLE RESTRICTIONS IN PERPETUITY

THIS GRANT DEED OF HABITAT CONSERVATION EASEMENT (the "Grant") is made as of ______ ___, 20XX by and between the ________________________________, a _____________________, as "Grantor" and the South Sacramento Conservation Agency, a California nonprofit public benefit corporation, as "Grantee."

Recitals

A. Grantor owns real property consisting of approximately _____ acres, in Sacramento County, California, as described in Exhibit A and shown more particularly on the map attached as Exhibit B, attached hereto and incorporated herein, which together with all appurtenances thereto, including without limitation all mineral and mineral rights, if any, and all water and water rights appurtenant to such land (collectively, the "Property").

B. The Property possess significant conservation values, including, without limitation, scenic, natural habitat, hydrologic, open space, ecological, agricultural and scientific values of great importance to Grantor, Grantee, and the people of the State of California and the people of the United States. (collectively, the "Conservation Values").

C. The Property is comprised of open space land, appropriate to use for certain types of agriculture, which also provide essential foraging and/or nesting habitat for South Sacramento Habitat Conservation Plan (SSHCP) Covered Species, and other significant relatively natural habitat and buffer for many species of wildlife including, but not limited to, raptors, migratory birds, and others.

D. Protection and preservation of the Property, including its wildlife habitat, shall assure that this area and its existing features shall continue to be available for certain types of agriculture, which provide foraging and or nesting habitat for SSHCP Covered Species and other natural habitat values and buffer for wildlife, a significant public benefit by preserving open space against development pressure, and scenic qualities.

E. As fee owner, Grantor owns the affirmative rights to identify, preserve, and protect forever the existing features and Conservation Values of the Property.

F. _____________, a _________, paid for the acquisition of this Conservation Easement Deed for Agricultural Land and Agreement Creating Enforceable Restrictions in Perpetuity from Grantor and provided ___________ Dollars ($_______) in management funds to Grantee to satisfy mitigation requirements imposed by the South Sacramento Habitat Conservation Plan (SSHCP), Plan Participant ______ (the "Plan Participant").

G. The State of California recognizes the public importance and validity of agricultural and habitat conservation easements by enactment of Section 815 *et seq*. of the California Civil Code, and Grantee is an entity qualified under such Civil Code provisions to hold conservation easements.

H. Grantee is authorized to hold conservation easements pursuant to California Civil Code §815.3 and, as relevant to tax-exempt non-profit organizations, §501(c)(3) of the Internal Revenue Code.

I. To accomplish all of the aforementioned purposes, Grantor intends to convey to Grantee, and Grantee intends to obtain from Grantor, a Conservation Easement over a portion of the Property (the 'Easement Area"). The Easement Area is more particularly described in Exhibit C attached hereto and incorporated herein and depicted on the map in Exhibit D attached hereto to and incorporated herein (the "Easement Area Map") restricting the use which may be made of the Property to preserve and protect forever the agricultural, open-space, foraging and/or nesting habitat for SSHCP Covered Species and other wildlife habitat and scenic values of the Property.

Grantor Intends to Grant

NOW, THEREFORE, in consideration of the above and the mutual covenants, terms, conditions, and restrictions contained herein, and for the good and valuable consideration, the receipt and sufficiency of which is hereby acknowledge, and pursuant to the laws of the State of California and in particular California Civil Code 815 *et seq.*, Grantor hereby voluntarily grants and conveys to Grantee, its successors and assigns, a Conservation Easement in gross forever in, on, over, and across the Property (the "Conservation Easement"), subject to the terms and conditions set forth herein, restricting forever the uses which may be made of the Property, and the parties agree as follows:

1. **PURPOSES:** The multiple natural resource conservation purposes of this Conservation Easement are to identity, preserve, protect, enhance, monitor and restore in perpetuity the Conservation Values of the Property, including, without limitation,

the following (collectively, "Conservation Purposes"): (a) the availability of the Property for agriculture by protecting the Property from development pressure; (b) the conservation and habitat values of the Property as foraging and/or nesting habitat for SSHCP Covered Species and for other wildlife including the processes which sustain that habitat; and (c) the open space character and scenic qualities of the Property which are important public benefits and are consistent with the availability of the Property for wildlife habitat and agriculture.

It is intended that this Conservation Easement shall foster agricultural practices on the Property in harmony with the protection and preservation of conservation and habitat values of the Property as foraging and/or nesting habitat for SSHCP Covered Species and for other wildlife habitat and the processes that sustain that habitat, and in harmony with the open space qualities of the Property. It is intended that each such purpose shall be conducted in a manner consistent with all of such multiple natural resource conservation purposes. This Conservation Easement prohibits use of the Property for any purpose that would impair, degrade or interfere with any of the multiple natural resources conservation purposes stated above.

2. **EASEMENT DOCUMENTATION REPORT:** The parties acknowledge that a Preserve Documentation Report (the "Report") of the Property has been prepared by a competent biologist familiar with the environs and approved by Grantor and Grantee in writing, a copy of which is on file with Grantor and Grantee at their respective address for notices, set forth below. Selected portions of the Report are attached hereto as Exhibit C. The parties agree that the Report contains an accurate representation of the biological and physical condition of the Property at the time of this Grant, and of the historical uses of the Property, including historical water uses. Notwithstanding the forgoing, if a controversy arises with respect to the nature and extent of the physical, biological condition of the Property or the permitted historical uses of the Property, the parties shall not be foreclosed from utilizing any and all other relevant documents, surveys or other evidence or information to assist in the resolution of the controversy. The Report includes an aerial photograph where the "Agricultural Area" of the Property is delineated.

3. **GRANTEE'S RIGHTS:** To accomplish the purpose of this Conservation Easement, the rights and interests which are conveyed to Grantee by this Conservation Easement include, but are not limited to, the following:

   a. **Preserve and Protect.** Grantee may identify, preserve, protect, enhance, monitor (including the right to conduct evaluations of habitat quantity and quality and to survey for threatened species and monitor their populations) and restore in perpetuity the Conservation Values of the Property. If Grantor chooses not to farm in the Agricultural Area, Grantee shall have the right to farm the Agricultural Area or lease the Agricultural Area for farming, provided such farming is consistent with the terms of this Conservation Easement and Grantor has approved Grantee's lessee, which approval shall not be unreasonably withheld or delayed.

b. To require that all mineral, air, and water rights as Grantee deems necessary to preserve and protect the biological resources and Conservation Values of the Property shall remain a part of and be put to beneficial use upon the Property, consistent with the purposes of this Conservation Easement.

c. **Entry and Access Rights:** Grantee and Grantee's employees and agents, and staff from the South Sacramento Conservation Agency, are hereby granted rights of access to enter upon the Property, using appurtenant easements and rights-of-way, if any, and may enter upon the Property at reasonable times in order to monitor compliance with and otherwise enforce the terms of this Conservation Easement, to study and make scientific observations of the natural elements and ecosystems of the Property, to determine whether Grantor's activities are in compliance with the terms this Conservation Easement and to take all actions deemed necessary by Grantee to identify, preserve, protect, enhance, monitor and restore in perpetuity the Conservation Values. Except in cases where Grantee determines that immediate entry is required to prevent, terminate, or mitigate a violation of the Conservation Easement, such entry shall be upon prior reasonable notice to Grantor and shall not unreasonably interfere with Grantor's use and quiet enjoyment of the Property.

d. **Enforcement.** Grantee may prevent or enjoin any activity on, or use of, the Property that is inconsistent with the purposes of this Conservation Easement, and may enforce the restoration of such areas or features of the Property that may be damaged by any inconsistent activity or use. This right of enforcement extends to the South Sacramento Conservation Agency or its designee as third party beneficiary hereof.

e. **Signs.** Grantee may erect a sign or other appropriate marker in a prominent location on the Property, visible from a public road, bearing information indicating that the environmental and scenic resources of the Property are protected by Grantee. The wording of the information on the sign shall be jointly determined by Grantee and Grantor, but shall clearly indicate that the Property is privately owned and not open to the public. Grantee shall be responsible for the costs of erecting and maintaining its sign or marker.

f. **Scientific Studies.** Subject to Grantor's approval, which approval shall not be unreasonably withheld or denied, Grantee shall have the right to conduct fish, wildlife, plant, and habitat studies on the Property, as well as research and monitoring on the Property, provided that such studies, research, and monitoring shall be carried out in a manner that shall not interfere unreasonably with the permitted use(s) or enjoyment of the Property by Grantor, its successors in interest, or any legally recognized occupant(s) or user(s) of the Property. Any other parties interested in conducting scientific studies on the Property are subject to the approval of Grantor, and such approval shall not be unreasonably withheld or denied.

4. **PERMITTED USES OF THE PROPERTY.** Grantor and Grantee intend that this Conservation Easement shall confine the uses of the Property to the multiple natural resource conservation uses of agriculture, open space, scenic, conservation, and wildlife habitat, including the processes which sustain that habitat, and to such other incidental uses as are expressly permitted herein, all in accordance with the terms and conditions of this Conservation Easement. Except as prohibited or otherwise limited by Paragraph 5 below and Exhibit E attached hereto, Grantor reserves the right to use and enjoy the Property in any manner which is consistent with the Conservation Purposes of this Conservation Easement. In that regard, the uses set forth in Exhibit D attached hereto, though not an exhaustive list of consistent permitted uses, are consistent with this Conservation Easement, and shall not be precluded, prevented or limited by this Conservation Easement, except as follows: (a) as provided in Paragraph 5 below and Exhibit E attached hereto; (b) in those instances in which prior approval by Grantee is required under this Conservation Easement; and (c) in those instances in which any action or practice is or becomes inconsistent with the Conservation Purposes or diminishes or impairs any of the specific Conservation Values, as determined by Grantee in the exercise of Grantee's reasonable discretion.

5. **PROHIBITED USES OF THE PROPERTY.** Any activity on or use of the Property that is inconsistent with the Conservation Purposes (including, without limitation, any activity or use that diminishes or impairs the Conservation Values) is prohibited. Though not an exhaustive list of prohibited uses, none of the uses described in Exhibit E attached hereto and incorporated herein by reference shall be made of or on the Property. In making this Grant, Grantor has considered the possibility that uses prohibited by the terms of this Grant may become more economically valuable than permitted uses and that neighboring properties may in the future be put entirely to such prohibited uses. It is the intent of both Grantor and Grantee that any such changes shall not be deemed to be circumstances justifying the termination, extinguishment, or modification of this Grant or the Conservation Easement. In addition, the inability of Grantor, or Grantor's heirs, successors, or assigns, to conduct or implement any or all of the uses permitted under the terms of this Grant, or the unprofitability of doing so, shall not impair the validity of this Grant or the Conservation Easement or be considered grounds for the termination, extinguishment, or modification of same.

6. **REMEDIES.**

   a. Notice of Violation: corrective action. If grantee becomes aware that a violation of the terms of this conservation easement has occurred or is threatened to occur, grantee shall give written notice to the grantor of such violation and demand corrective action sufficient to cure the violation and, where the violation involves injury to the property resulting from any use or activity inconsistent with the conservation values or the conservation purposes, to restore the portion of the property so injured. If grantor fails to cure the violation within thirty (30) days after receipt of notice from grantee, or under circumstances where the violation cannot reasonably be cured within a thirty (30) day period, fails to begin curing such violation within the thirty (30) day period or fail to continue diligently to cure such violation until finally cured, grantee shall have all remedies available at law or in equity to enforce the terms of this conservation easement, including without limitation the right to seek a temporary or permanent injunction with respect to such activity, to cause the restoration of that portion of the property affected by such activity to the condition that existed prior to the undertaking of such prohibited activity, to pay monetary amounts which, if not paid, could result in the extinguishment, modification, non-enforcement or impairment of the conservation easement, and/or to recover any damages arising from the violation. Grantee's rights under this paragraph 6.a apply equally to actual or threatened violations of the terms of this conservation easement. Grantor agrees that grantee's remedies at law for any violation of the terms of this conservation easement are inadequate and that grantee shall be entitled to seek the injunctive relief described in this paragraph 6.a, both prohibitive and mandatory, in addition to such other relief to which grantee may be entitled, including specific performance of the terms of this conservation easement, without the necessity of proving either actual damages or the inadequacy of otherwise available legal remedies. The remedies described in this paragraph 6 shall be cumulative and shall be in addition to all remedies hereafter existing at law or in equity. Furthermore, the provisions of California civil code section 815 *et seq*. Are incorporated herein by this reference, and this conservation easement shall include all of the rights and remedies set forth therein.

   b. **Cost of Enforcement.** In any action, suit or other proceeding undertaken to enforce the provisions of this Conservation Easement, the prevailing party shall be entitled to recover from the non-prevailing all reasonable costs and expenses including, without limitation, attorneys' and experts' fees and costs, and if such prevailing party shall recover judgment in any action or proceeding, such costs and expenses shall be included as part of the judgment. In addition, any costs of restoration shall be borne by the Grantor.

c. **Emergency Enforcement.** If Grantee, in its sole discretion, determines that circumstances require immediate action to prevent or mitigate significant damage to the Conservation Values or to prevent breach or extinguishment of the Conservation Easement, Grantee may purse its remedies under this Paragraph 6 without prior notice to Grantor or without waiting for the period to cure to expire.

d. **Non-Waiver.** Enforcement of the terms and provisions of this Conservation Easement shall be at the discretion of Grantee, and the failure of Grantee to discover a violation or to take action under this Paragraph 6 shall not be deemed or construed to be a waiver of Grantee's rights hereunder with respect to such violation in the event of any subsequent breach. In no event shall any delay or omission by Grantee in exercising any right or remedy constitute an impairment of or a waiver or such right or remedy.

e. **Acts Beyond Grantor's Control.** Nothing contained in this Conservation Easement shall be construed to entitle Grantee to bring any action against Grantor for any injury to or change in the Property resulting from causes beyond Grantor's control, including fire, flood, storm, and earth movement.

f. **Third Party Beneficiary Enforcement.** It is understood by the Grantor that all rights and remedies conveyed under this Conservation Easement shall extend to and are enforceable by the South Sacramento Conservation Agency and California Department of Fish and Game as a third party beneficiaries.

   i. **TRANSFER.** Grantee may, in Grantee's sole and absolute discretion, transfer all or any of its interests in this Conservation Easement without Grantor's consent, provided that (1) Grantee requires, as a condition of such transfer, that the Conservation Purposes of the Conservation Easement continue to be carried out following such transfer; (2) any assignment shall be approved by the South Sacramento Conservation Agency and made only to a local, state or federal agency and/or to an organization qualified at the time of the transfer as an eligible donee under Internal Revenue Code Section 170(h)(3) or its successor, or any regulation issued thereunder, and such organization shall be an entity qualified pursuant to Civil Code Section 815 et seq. or any subsequent State law governing the creation, transfer and enforcement of conservation easements; and (3) Grantee shall provide Grantor with notice of the assignment, at the address last provided by Grantor to Grantee, within thirty (30) days of the effective date of the assignment.

   If Grantee, or its successors, ceases to exist or no longer qualifies under Section 170(h)(3) of the Internal Revenue Code, then the South Sacramento Conservation Agency shall identify and select an appropriate local, state or federal agency and/or organization qualified at the time of the transfer as an eligible donee under

Internal Revenue Code Section 170(h)(3) or its successor, or any regulation issued thereunder, and such organization shall be an entity qualified pursuant to Civil Code Section 815 et seq. or any subsequent State law governing the creation, transfer and enforcement of conservation easements, having similar purposes that agrees to assume the responsibility imposed by this Conservation Easement to which to transfer this Conservation Easement.

7. **MANAGEMENT FUNDS.** Concurrent with the recordation of this Conservation Easement and as reflected in Recital F, above, Grantee received a one-time distribution of __________________ Dollars ($______) in management funds (the "Management Funds"), of which _________________ Dollars ($_______) shall be a non-wasting endowment. Grantee may spend the Management Funds on any property interest held by Grantee for XX in Sacramento County for any purpose related to such property interest in the Grantee's sole and absolute discretion, including, but not limited to, management, monitoring, enforcement, or restoration..

8. **RUNNING WITH THE LAND.** The Conservation Easement created by this Grant is perpetual and shall burden and run with the Property forever. Every provision of this Conservation Easement that applies to the Grantor or Grantee shall also apply forever to and shall burden or benefit, as applicable, their respective agents, heirs, devisees, administrators, employees, personal representatives, lessees, and assigns, and all other successors as their interest may appear. Grantor agrees that transfer by Grantor of any interest in the Property shall be in accordance with the terms of Paragraph 20 of this Conservation Easement and Paragraph 11 of Exhibit D attached hereto, and shall not be made in violation with the terms of Exhibit E attached hereto.

9. **REPRESENTATION AND WARRANTIES.**

   a. **Hazardous Materials.** Grantor represents and warrants that the Property (including, without limitation, any associated air, soil, groundwater, and surface water) is free of any conditions that individually or in aggregate (1) pose a significant risk to human health or the environment; (2) violate any Environmental Law, as that term is defined below in Paragraph 16; or (3) could reasonably be expected to cause any person to incur environmental investigation, removal, remediation, or other cleanup costs. There are no underground tanks located on the Property. Grantor represents and warrants that Grantor shall comply with all Environmental Laws in using the Property and that Grantor shall keep the Property free of any material environmental defect, including, without limitation, contamination from Hazardous Materials, as that term is defined below in Paragraph 16.

   b. **State of Title.** Subject to matters of record as disclosed in the title policy issued to Grantee insuring Grantee's interests in the Conservation Easement created by this

Grant, Grantor warrants that Grantor has good and sufficient title to the Property (including all appurtenances thereto, including, without limitation, all minerals and mineral rights and all water and water rights) and that Grantor has full right and authority to grant this Conservation Easement to Grantee. All deeds of trust and mortgages recorded against the Property, or any portion thereof, are and shall continue to be subordinated to the Conservation Easement created by this Grant.

c. **Compliance with Laws.** Grantor has not received notice of and has no knowledge of any material violation of any federal, state, county or other governmental or quasi-governmental statute, ordinance, regulation, law or administrative or judicial order with respect to the Property.

d. **No Litigation.** There is no action, suit or proceeding which is pending or threatened against the Property or any portion thereof relating to or arising out of the ownership or use of the Property, or any portion thereof, in any court or in any federal, state, county, or municipal department, commission, board, bureau, agency or other governmental instrumentality.

e. **Authority To Execute Conservation Easement.** The person executing this Conservation Easement on behalf of Grantee represents that execution of this Conservation Easement has been duly authorized by Grantee. The person(s) executing this Conservation Easement on behalf of the Grantor represents that the execution of this Conservation Easement has been duly authorized by the Grantor.

10. **COSTS, LEGAL REQUIREMENTS, AND LIABILITIES.** Grantor retains all responsibilities and shall bear all costs and liabilities of any kind related to the ownership, operation, upkeep and maintenance of the Property and agrees that Grantee shall have no duty or responsibility for the operation or maintenance of the Property, the monitoring of hazardous conditions thereon, or the protection of Grantor, the public, or any third parties from risks relating to conditions on the Property. Grantor agrees to pay any and all real property taxes and assessments levied by competent authority on the Property before delinquency and that Grantor shall keep Grantee's interest in the Property free of any liens, including those arising out of any work performed for, materials furnished to or obligations incurred by Grantor. Grantor shall be solely responsible for any costs related to the maintenance of general liability insurance covering acts on the Property. Grantor remains solely responsible for obtaining any applicable governmental permits and approvals for any activity or use permitted by this Conservation Easement, and any activity or use shall be undertaken in accordance with all applicable federal, state, and local laws, regulations, and requirements.

11. **INDEMNIFICATION BY GRANTOR.** Notwithstanding any other provision herein to the contrary, Grantor hereby agrees to indemnify, defend, and hold harmless Grantee, its

members, directors, officers, employees, agents, and contractors and their heirs and assigns (the "Indemnified Parties") from and against any costs, liabilities, penalties, damages, claims or expenses (including, without limitation, reasonable attorneys' fees and costs) and litigation costs (collectively, "Damages") which the Indemnified Parties may suffer or incur as a result of or arising out of any of the following: (a) the activities of Grantor on the Property; (b) the inaccuracy of any representation or warranty made by Grantor; (c) the breach of any provision of this Conservation Easement; (d) any injury to or the death of any person or physical damage to any property resulting from any act, omission, condition or other matter related to or occurring on or about the Property, regardless of cause, except to the extent caused by the negligence or willful misconduct of any of the Indemnified Parties; or (e) the existence or the administration of this Conservation Easement. Without limiting the foregoing, Grantor shall indemnify, defend, and hold harmless the Indemnified Parties for all of the following:

a. **Approvals.** Approvals requested by Grantor, whether given or withheld by Grantee hereunder, except as such Damage is the result of Grantee's gross negligence or intentional misconduct.

b. **Taxes.** Any real property taxes, insurance, utilities or assessments that are levied against the Property, including those for which exemption cannot be obtained, or any other costs of maintaining the Property.

c. **Hazardous Materials.** Any Hazardous Material, as that term is defined in Paragraph 16, present, alleged to be present, or otherwise connected in any way to the Property, whether by or after the date of this Conservation Easement.

12. **NOTICE; APPROVAL.**

a. **Notice for Entry.** Where notice to Grantor of Grantee's entry upon Property is required herein, Grantee shall notify any of the persons constituting Grantor or their authorized agents by telephone or in person, or by written notice in the manner described below in subparagraph C, prior to such entry.

b. **Other Notice.** Except as provided in subparagraph A above, whenever express approval, agreement or consent is required by this document, the initiating party shall give written notice, in the manner described below in subparagraph C, and detailed information to the other party. The receiving party shall review the proposed activity and notify the initiating party, within sixty (60) days after receipt of notice of any objections to such activity. Any objections by a party shall be based upon its opinion that the proposed activity is inconsistent with the terms of the Conservation Easement.

c. **Written Notices.** Any written notice called for in this Conservation Easement may be delivered (1) in person; (2) by certified mail, return receipt requested, postage paid;

(3) by facsimile with the original deposited with the United States Post office, postage prepaid on the same date as sent by facsimile; or (4) by a reputable overnight courier that guarantees next day delivery and provided a receipt, and addressed as follows:

To the Grantor: XX

To Grantee: XX

Either party may, from time to time, by written notice to the other, designate a different address which shall be substituted for the one above specified. Notice is deemed to be given upon receipt.

d. **Notice of Reserved Rights.** Grantor shall notify Grantee, in writing, at least sixty (60) days before exercising any reserved right which may have an adverse impact on any Conservation Values.

e. **Subsequent Activities.** Permission to carry out, or failure to object to, any proposed use or activity shall not constitute consent to any subsequent use or activity of the same or any different nature.

13. **SEVERABILITY AND ENFORCEABILITY.** The terms and purposes of this Conservation Easement are intended to be perpetual. If any provision or purpose of the Conservation Easement or the application thereof to any person or circumstance is found to be invalid, the remainder of the provisions and purposes of the Conservation Easement, and the application of such provision or purpose to persons or circumstances other than those as to which it is found to be invalid, shall not be affected thereby.

14. **VALUATION; EXTINGUISHMENT; CONDEMNATION.**

a. **Stipulated Fair Market Value.** Grantor and Grantee agrees that this Grant of a perpetual Conservation Easement gives rise to a property right, immediately vested in Grantee, which for purposes of this Paragraph, the parties stipulate to have a fair market value of the greater of:

i. $______________, which is the product obtained when the per acre value paid to the Grantor of this Conservation Easement for the purchase of this easement is multiplied by ____, the total number of acres of Property; or

ii. the number obtained by multiplying (1) the fair market value of the Property unencumbered by this Conservation Easement (minus any increase in value after the date of this grant attributable to improvements) by (2) [insert x], which is the ratio of the value of the Conservation Easement at the time of this grant to the value of the Property, without the deduction for the value of the Conservation Easement. For Purposes of this Paragraph, the ratio of the value of the

Conservation Easement to the value of the Property unencumbered by the Conservation Easement shall remain constant.

If for any reason there is an extinguishment of the restrictions of this Conservation Easement, Grantee, on a subsequent sale, exchange, or taking of the Property, shall be entitled to a portion of the proceeds at least equal to the amount determined in accordance with this Paragraph. If such extinguishment occurs with respect to fewer than all acres of the Property, the amounts described above shall be calculated based on the actual number of acres subject to extinguishment.

b. **Judicial Extinguishment.** It is the intention of the parties that the Conservation Purposes of the Conservation Easement shall be carried out in perpetuity. Liberal construction is expressly required for purposes of effectuating the Conservation Easement in perpetuity, notwithstanding economic hardship or changed conditions of any kind.

c. **Condemnation.** If all or part of the Property is taken in exercise of eminent domain by public, corporate, or other authority so as to abrogate the restrictions imposed by this Conservation Easement, Grantor and Grantee shall join in appropriate actions at the time of such taking to recover the full value of the taking and all incidental or direct damages resulting from the taking. All expenses incurred by Grantor and Grantee in such action shall be paid out of the recovered proceeds. The remaining proceeds shall be divided consistent with the provisions of this Paragraph using the ratio of the value of Grantee’s and Grantor's interests that is set forth in subparagraph A above, it being expressly agreed that the Conservation Easement constitutes a compensable property right.

15. **INTERPRETATION**

a. **Liberally Construed.** It is the intent of this Conservation Easement to preserve the condition of the Property and each of the Conservation Purposes protected herein, notwithstanding economic or other hardship or changes in surrounding conditions. The provisions of this Conservation Easement shall be liberally construed to effectuate their purposes of preserving and protecting in perpetuity the Conservation Values and other Conservation Purposes described above, and allowing Grantor’s use and enjoyment of the Property to the extent consistent with the Conservation Purposes. Liberal construction is expressly required for purposes of effectuating this Conservation Easement in perpetuity, notwithstanding economic hardship or changed conditions of any kind. The Conservation Purposes described herein are the intended best and most productive use of the Property. No remedy or election given by any provision in this Conservation Easement shall be deemed exclusive unless so indicated, but it shall, wherever possible, be cumulative with all other remedies at law or in equity. The parties acknowledge that each party and its counsel have reviewed and revised this

Conservation Easement and that no rule of construction that ambiguities are to be resolved against the drafting party shall be employed in the interpretation of this Conservation Easement. In the event of any conflict between the provisions of this Conservation Easement and the provisions of any use and zoning restrictions of the State of California, the county in which the Property is located, or any other governmental entity with jurisdiction, the more restrictive provisions shall apply.

b. **Governing Law.** This Conservation Easement shall be interpreted in accordance with the laws of the State of California, and shall be subject to the provisions of Civil Code Section 815 *et seq*. or any subsequent State law governing the creation, transfer and enforcement of conservation easements.

c. **Captions.** The captions have been inserted solely for convenience of reference and are not part of the Conservation Easement and shall have no effect upon construction or interpretation.

d. **No Hazardous Materials Liability.** Notwithstanding any other provision herein to the contrary, the parties do not intend this Conservation Easement to be construed such that it creates in or gives to Grantee:

   i. the obligations or liabilities of an "owner" or "operator" as those words are defined and used in Environmental Laws, as defined below, including, without limitation, the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (42 USC § 9601 *et seq*. and hereinafter "CERCLA");

   ii. the obligations or liabilities of a person described in 42 USC §9607(a)(3);

   iii. the obligations of a responsible person under any applicable Environmental Laws, as defined below;

   iv. the right to investigate and remediate any Hazardous Materials, as defined below, associated with the Property; or

   v. any control over Grantor's ability to investigate, remove, remediate or otherwise clean up any Hazardous Materials associated with the Property.

e. Definitions.

   i. The terms "Grantor" and "Grantee," wherever used in this Conservation Easement and any pronouns used in place thereof, shall mean and include, respectively, the above-named Grantor, its personal representatives, heirs, devisee, personal representatives, and assigns, and all other successors as their interest may appear and Grantee and its successors and assigns.

   ii. The term "Hazardous Materials" includes, without limitation, (a) material that is flammable, explosive, or radioactive; (b) petroleum products; and (c) hazardous wastes, hazardous or toxic substances, or related materials defined in the CERCLA (42 USC 9601 *et seq*.), the Hazardous Materials Transportation Act (49 USC §6901 *et seq*.), the Hazardous Waste Control Law (Cal. Health & Safety Code §25100 *et seq*.), the Hazardous Substance Account Act (Cal. Health & Safety Code §25300 *et seq*.), and in the regulations adopted and publications promulgated pursuant to them, or any other applicable Environmental Laws now in effect or enacted after this date.

iii. The term "Environmental Laws" includes, without limitation, any federal, state, local, or administrative agency statute, regulation, rule, ordinance, order or requirement relating to pollution, protection of human health, the environment or Hazardous Materials.

16. **SUBSEQUENT LIENS ON PROPERTY.** No provision of the Conservation Easement should be construed as impairing the ability of Grantor to use this Property as collateral for subsequent borrowing, provided that any deed of trust, mortgage, lien, or encumbrance arising from such a borrowing must, at all times, be subordinated to the Conservation Easement and this Grant. Any successor interest of Grantor, by acceptance of a deed, lease or other document purporting to convey an interest in the Property, shall be deemed to have consented to, reaffirmed and agreed to be bound by all of the terms, covenants, restrictions and conditions of this Conservation Easement.

17. **RE-RECORDING**. Grantee is authorized to re-record this Grant Deed, or record or file any notices or instruments necessary, as appropriate to assure the enforceability in perpetuity of this Conservation Easement. For such purpose, Grantor appoints Grantee as Grantor's attorney-in-fact to execute, acknowledge and deliver any such instrument for recording or filing on Grantor's behalf. The power of attorney in the immediately preceding sentence is irrevocable and coupled with any interest. Without limiting the foregoing, the Grantor agrees to execute any such instruments upon request.

18. **ACCESS.** Nothing contained in this Conservation Easement shall give or grant to the public a right to enter upon or use the Property or any portion thereof where no such right existed in the public immediately prior to the execution of this Grant Deed. Grantor shall undertake all reasonable actions to prevent the unlawful entry and trespass by persons whose activities might diminish or impair the Conservation Values.

19. **SUBSEQUENT TRANSFERS; NO MERGER.** Grantor shall incorporate the terms of this Grant Deed by reference in any deed or legal instrument by which Grantor divests any interest in the Property, including without limitation, any lease. Grantor shall give Grantee at least thirty (30) days written notice prior to the date of such transfer, which notice shall include the name, address and telephone number of the transferee. Grantor's failure to perform any act required by this Paragraph shall not impair the validity of the Conservation Easement or this Grant Deed or limit its enforceability in any way. Any

successor in interest of Grantor, by acceptance of a deed, lease, or other document purporting to convey an interest in the Property, shall be deemed to have consented to, reaffirmed and agreed to be bound by all of the terms, covenants, restrictions, and conditions of this Conservation Easement.

20. **ENTIRE AGREEMENT.** This Grant Deed, together with the attached exhibits and schedules, and any documents incorporated herein by reference, constitutes the entire agreement of the parties with respect to the subject matter hereof, and supersedes all prior agreement and understandings of the parties.

21. **AMENDMENTS.** The Conservation Easement may be amended only by way of a written instrument signed by Grantor and Grantee, and approved by the South Sacramento Conservation Agency. Any such amendment shall be consistent with the Conservation Purposes, and shall comply with Section 815 *et seq*. of the California Civil Code.

22. **COUNTERPARTS.** This Grant Deed may be signed in one or more counterparts, all of which shall constitute one and the same instrument.

IN WITNESS WHEREOF, the parties have executed this Grant Deed of Conservation Easement as of the date first above written.

____

DATE:________________________

BY:______________________________

NAME:___________________________

ITS: ____________________________

DATE:___________________________

EXHIBITS

Exhibit A – Legal Description of Property
Exhibit B – Map of Property
Exhibit C – Selected Portion of the Easement Documentation Report
Exhibit D – Permitted Uses of the Property
Exhibit E – Prohibited Uses of the Property
Exhibit F – Prohibited Plant List

STATE OF CALIFORNIA)

) ss.

COUNTY OF ___________________)

On ___________ ____, 20xx, before me, ____, the undersigned, personally appeared ______________________ personally known to me (or proved to me on the basis of satisfactory evidence) to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS by hand and official seal.

____

EXHIBIT A

Legal Description of Property

EXHIBIT B

Map of Property

EXHIBIT C

Selected Portion of the Easement Documentation Report

EXHIBIT D

Permitted Uses of the Property

EXHIBIT D
Permitted Uses of the Property

The uses set forth in this Exhibit D detail specific activities that are permitted under the Conservation Easement. The uses set forth in this Exhibit D are also intended to provide guidance in determining the consistency of other activities with the Conservation Purposes. Notwithstanding the uses set forth in this Exhibit D and, notwithstanding any provision of this Grant to the contrary, in no event shall any of the permitted uses of the Property (whether set forth in this Exhibit D or elsewhere in this Grant) be conducted in a manner or to an extent that diminishes or impairs the Conservation Values or that otherwise violates this Grant.

1. **Historical Agricultural Practices.** Except as prohibited or restricted in Paragraph 6 of Exhibit E of this Grant, Grantor may continue historical agricultural practices on the Property in the manner and location as set forth in the Report to the extent that such practices are consistent with the Conservation Values and Conservation Purposes of the Conservation Easement. All farming operations on the Property shall be consistent with reasonable farming practices and shall be in full compliance with all applicable federal, state and local statutes, laws, rules, regulations and ordinances (collectively, the "Laws"). The term "historical agricultural practices" includes the continued historic use of fertilizers, pesticides herbicides, and other biocides, provided that such use, including, without limitation, the amount, frequency, and manner of application, shall be in accordance with all applicable Laws, and such use does not diminish or impair the Conservation Values or the Conservation Purposes of the Conservation Easement and shall not diminish or impair the naturally occurring ecosystem on and around the Property (not including any impacts caused to such ecosystems that are the intended result of the application of such fertilizers, pesticides, herbicides and/or biocides as long as the application of such substances has been conducted in accordance with the instructions for application set forth for such substance and such application is consistent with those good farm management practices that are customary in the general geographic area in which the Property is located).

2. **New Practices.** Except as prohibited or restricted in Paragraph 5 or Exhibit E of this Grant, and subject to obtaining Grantee's prior approval in accordance with the notice and approval provisions contained herein, it shall be permissible to carry on agricultural practices, and other practices or activities, that differ from historical agricultural practices, so long as such practices do not result in significant soil degradation, or significant pollution or degradation of any surface or subsurface waters, and such practices are consistent with and do not diminish or impair the Conservation Purposes of this Conservation Easement.

   The following new practices are hereby found to be consistent with the Conservation Purposes of this Conservation Easement and do not require compliance with the notice and approval procedures described above so long as such new practices shall not result in significant soil degradation, or significant pollution or degradation of any surface or subsurface waters and such new practices are consistent with and do not diminish or impair the Conservation Purposes of this Conservation Easement:

a. grazing of livestock;

b. cultivation and harvest of alfalfa, clover and other permanent pasture; and

c. substitution of new fertilizers, pesticides and herbicides for those Grantor presently uses, provided that such use, including, but not limited to, the amount, frequency, and manner of application shall be in accordance with all applicable Laws, and such use does not diminish or impair the naturally occurring ecosystems existing on the Property (not including any impacts caused to such ecosystems that are the intended result of the application of such fertilizers, pesticides, herbicides and/or biocides as long as the application of such substances has been conducted in accordance with the instructions for application set forth for such substance and such application is consistent with those good farm management practices that are customary in the general geographic area in which the Property is located); and

d. the planting of native trees and shrubs anywhere on the Property except within the Agricultural Area of the Property as identified in the Report.

Except as expressly permitted in the immediately preceding sentence, the cultivation and harvest of any non-annual crops on the Property requires Grantee's prior approval in accordance with the notice and approval provisions contained above.

3. **Fences.** Grantor may maintain, repair, replace and rebuild the fences that exist on the Property as of the date of this Grant. Grantor, with Grantee's prior written approval, may construct and maintain new fences anywhere on the Property for purposes reasonable and customary management of agriculture, livestock, and wildlife.

4. **Irrigation Systems.** Grantor may maintain, repair, replace and rebuild any irrigation systems that exists on the Property as of the date of this Grant, and may construct and maintain new irrigation system improvement anywhere on the Property for purposes reasonable and customary management of agriculture, livestock, and wildlife.

5. **Roads.** Grantor may maintain and repair existing roads at currently existing levels of improvement, and construct and maintain such new unpaved and otherwise unimproved roads as may be reasonably necessary for Grantor's agricultural activities on the Property and in manner that shall not diminish or impair the Conservation Values of the Property or the Conservation Purposes of this Conservation Easement, provided, however, that any new roads may not be constructed unless prior written consent has been obtained from Grantee, which approval shall not be unreasonably withheld.

6. **Fishing and Hunting.** Grantor may fish or to hunt or trap wildlife on the Property, to the extent that fish or animals subject to such activities are not afforded protection under applicable Laws and provided such fishing, hunting or trapping is conducted in compliance with applicable Laws, and in a manner that does not significantly deplete the wildlife resources on the Property; and provided, further, that hunting on the Property shall be subject to regional hunting season restrictions applicable to individual hunters at local State Wildlife Areas, which shall in no event include any special regulation hunting seasons that would increase hunting activities on the Property in a manner that would be inconsistent with the Conservation Purposes or the Conservation Values of the Conservation Easement. Commercial hunting and fishing are permitted so long as conducted in accordance with the provisions of this Paragraph, provided, however, that commercial fish farms are prohibited. Control of predatory and problem animals shall use selective control techniques, which shall be limited in their effectiveness to specific animals which have caused damage to agriculture, livestock and other property.
7. **Water Resources.** Grantor may develop and maintain such groundwater resources on the Property as are necessary or convenient for agricultural, livestock, and wildlife habitat uses in a manner consistent with this Conservation Easement. Grantor may maintain such surface water resources on the Property as are noted in the Report as currently existing on the Property.
8. **Passive Recreational Uses.** Grantor may conduct passive recreational uses on the Property, including, but not limited to, bird watching, hiking, horseback riding, and picnicking, provided that these uses require no surface alteration or other development of the Property.
9. **Signs.** Grantor may erect a reasonable number of signs or other appropriate markers in a prominent location on the Property, visible from a public road, which identify agricultural or open space activities on the Property and/or state that no trespassing or no hunting is allowed on the Property.
10. **Transfer of Property.** Grantor may transfer the Property, provided that the transfer is not prohibited in Exhibit E and that Grantor notifies Grantee before the transfer of the Property, and the document of conveyance shall expressly incorporate by reference this Grant. Leasing of the Property for a period of five (5) or more years must be approved in writing by Grantee, whose approval shall not unreasonably be withheld. The failure of Grantor to perform any act required by this Paragraph shall not impair the validity of this Grant or the Conservation Easement or limit the enforceability in any way.
11. **Residual Rights; Prior Approval.** Except as expressly limited herein, Grantor may exercise and enjoy all rights as fee owner of the Property, including the right to use the Property for any purpose which is consistent with and does not diminish or impair

the Conservation Values of the Property or the Conservation Purposes of the Conservation Easement.

If any question exists regarding whether historic or new practices or activities are permitted or would impair or diminish the Conservation Values of the Property or the Conservation Purposes of the Conservation Easement, Grantor shall notify Grantee pursuant to Paragraph 13 of the Conservation Easement and obtain Grantee's written approval prior to engaging in such practices or activities.

EXHIBIT E

Prohibited Uses of the Property

EXHIBIT E
Prohibited Uses of the Property

Though not an exhaustive list of prohibited uses, none of the uses described below shall be made of the Property. The following are set forth both to list specific prohibited activities on the Property, and to provide guidance in determining whether other activities are not consistent with the Conservation Purposes of the Conservation Easement:

1. **No Subdivision.** The legal or de facto division, subdivision, or partitioning of the Property, any fee transfer of less than the entire Property.
2. **No Non-Agricultural Commercial Uses.** The establishment of any commercial or industrial uses on the Property other than the agricultural uses and commercial practices allowed by the terms of Exhibit D of this Grant. Examples of prohibited commercial or industrial uses include, but are not limited to, (a) the establishment or maintenance of any commercial feedlots, which are defined as any open or enclosed area where domestic livestock are grouped together for intensive feeding purposes; (b) the planting and cultivation orchards or vineyards; (c) the establishment or maintenance of any commercial greenhouses or plant nurseries; the (d) establishment or maintenance of any gravel mines; and (e) the establishment of any multi-family dwellings.
3. **No Non-Agricultural Practices in the Agricultural Area.** The planting and cultivation of any non-agricultural plants, including, but not limited to, native trees and shrubs, in the Agricultural Area as identified in the Report.
4. **No Use or Transfer of Development Rights.** Except as expressly permitted by terms of Exhibit D of this Grant, the exercise of any development rights associated with the Property, including without limitation, the construction or placement of any residential or other buildings, golf courses, camping accommodations, boat ramps, bridges, mobile homes, house trailers, permanent tent facilities, Quonset huts or similar structures, underground tanks, billboards, signs, or other advertising, and/or other structures or improvements, street lights, utility structures or lines, sewer systems or lines.

   Except as expressly permitted by terms of Exhibit D of this Grant, all development rights that are now or hereafter allocated to, implied, reserved or inherent in the Property are terminated and extinguished, and may not be used on or transferred to any portion of the Property as it now or hereafter may be bounded or described, or to any other property adjacent or otherwise, nor used for the purpose of calculating permissible lot yield of the Property or any other property.
5. **Natural Resource Development.** Except soils, sands and other material as appropriate for the conduct of the agricultural and other activities expressly permitted on the Property in this Grant, the exploration for or extraction of minerals, gas, hydrocarbons, soils, sands, gravel or rock or any other material on or below the surface of the Property.

6. **Prohibited Agriculture.** Any annual crop not historically planted on the Property or approved in writing by Grantor. Any non-annual crop not expressly permitted by the terms of Exhibit D of this Grant or approved in writing by Grantor. The planting, cultivation and harvest of any orchards, vineyards, artichokes, asparagus, sod, rice, safflower, or cotton.
7. **No Dumping.** The dumping, storage, or other disposal of non-compostable refuse, trash, sewer sludge or unsightly or toxic or Hazardous Materials or agrichemicals, except that fertilizers, pesticides, biocides, and herbicides permitted under Paragraphs 1 and 2 of Exhibit D may be stored on the Property provided that such storage is in full compliance with applicable Laws, best management practices, and does not diminish or impair the Conservation Values of the Property.
8. **No New Roads.** The construction, reconstruction or replacement of any roadways, except as expressly permitted in Exhibit D of this Grant, without the consent of Grantee.
9. **No Destruction of Native Trees or Shrubs.** The removal, cutting or destruction of native trees or shrubs on the Property, except for disease or insect control or to prevent property damage or personal injury and except for the removal of native trees that are four inches or less in diameter when measured at chest height from those areas of the Property that are used by Grantor for agricultural purposes permitted under this Grant.
10. **No Biocides.** The use of fertilizers, pesticides, biocides, and herbicides or other agricultural chemicals on the Property, except as expressly permitted in Exhibit D of this Grant.
11. **No Long-Term Leases.** Leasing the Property for a period of five (5) or more years without the prior written approval of Grantee.
12. **No Alteration of Natural Water Courses; Degradation of Water Quality.** Except with the prior consent of Grantee, the manipulation or alteration of natural water courses, wetland, streambank, shoreline, or body of water. Activities or uses detrimental to water quality, including but not limited to, degradation or pollution of any surface or subsurface waters; provided, however, that Grantor shall be allowed to conduct any of the uses specifically permitted in this Grant even if such uses result in some adverse impact on water quality so long as such permitted uses are conducted in full compliance with all applicable Laws and consistent with those good farming practices that are customary in the general geographic area in which the Property is located.
13. **No Impairment of Water Rights.** Severance, conveyance, or encumbrance of water or water rights appurtenant to the Property, separately from the underlying title to the Property, or other action which diminishes or extinguishes such water rights.

Nothing in this provision shall restrict the right of the Grantor to sell rights to use water, or to use water on the Property, or on lands other than the Property on a temporary basis (maximum one-year increments), provided that such sale or use does not permanently impair the riparian or other water rights appurtenant to the Property nor reduce water rights below what is necessary for present or future agricultural production on the Property.

This Conservation Easement for Agricultural Lands shall not sever or impair any riparian water rights appurtenant to the Property.

14. **Inconsistent or Adverse Actions.** Any action or practice which is or becomes not consistent with, or which diminishes or impairs the Conservation Values of the Property or the Conservation Purposes of the Conservation Easement.

15. **Vehicles.** The use of any motorized vehicles off designated roadways, except for agricultural purposes.

16. **Introduction of Non-native Species.** The intentional or reckless introduction of non-native plant or animal species which may in Grantee's determination threaten the Conservation Values of the Property or the Conservation Purposes of the Conservation Easement, which species include, but are not limited to, the plants, trees and weeds listed on Exhibit F, attached hereto and incorporated herein by reference. Grantor shall not be considered reckless for failure to prevent, investigate or research any potential manner that such items may be introduced to the Property if such prevention, investigation or research is not within Grantor's normal business practices, or such potential manner has not been brought to Grantor's attention.

17. **Subsequent Transfers.** Conveyance by Grantor of any interest in the Property in a manner that would directly or indirectly violate the prohibitions of this Exhibit E, or in any manner that does not comply with the requirements of Exhibit D and Paragraph 20 of this Grant.

18. **No Hazing.** The hazing or other disturbance of cranes or Swainson's hawks on, approaching, or leaving the Property for the purpose of, without limitation, discouraging the presence of or habitat use by cranes and other migratory birds on the Property.

19. **Junkyards.** The storage or disassembly of inoperable automobiles, machinery, equipment, trucks, and similar items for purposes of storage, sale, or rental of space for any such purpose.

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EXHIBIT F

Prohibited Plant List

EXHIBIT F
Prohibited Plant List

None of the following plant, tree, or weed species shall be planted on the Property:

Alligatorweed	*Alternanthera philoxeroides*
Ambulia	*Limnophila indica*
Arundo or Giant Weed	*Arundo donax*
Baby's breath	*Gypsophila paniculata*
Beancaper, Syrian	*Zygophyllum fabago*
Bearded creeper	*Crupina vulgaris*
Bermudagrass	*Cynodon* spp. and hybrids
Biddy biddy	*Acaena novae-zelandiae*
Biddy biddy, pale	*Acaena pallida*
Birdweed, field	*Convolvulus arvensis*
Black locust	*Robinia pseudoacacia*
Bladderflower	*Araujia sericifera*
Blueweed	*Helianthus ciliaris*
Broom, French	*Genista monspessulana*
Broom, Scotch	*Cytisus scoparius*
Broomrape, branched	*Orobanche ramosa*
Broomrape, Cooper's	*Orobanche cooperi*
Broomrape, Desert	*Orobanche cooperi*
Camelthorn	*Alhagi maurorum*
Capeweed	*Arctotheca calendula*
Chinese pistachio	*Pistacia atlantica* or *P. chinensis*
Chinese tallow tree	*Sapium sebiferum*
Chinese or scarlet wisteria	*Sesbania punicea*
Comfrey, rough	*Symphytum asperum*
Crupina, common	*Crupina vulgaris*
Distaff thistle, smooth	*Carthamus baeticus*
Distaff thistle, whitestern	*Carthamus leucocaulos*
Distaff thistle, woolly	*Carthamus lanatus*
Dodder, all species except giant dodder	*Cuscuta* spp.
Dodder, giant	*Cuscuta reflexa*
Diver's woad	*Isatis tinctoria*
Edible fig	*Ficus carica*
English Ivy	*Hedera helix*
Eucalyptus	*Eucalyptus* spp.
Fanwort, Carolina	*Cabomba caroliniana*
Field cress, Austrian	*Rorippa autriaca*
Field cress, creeping yellow	*Rorippa sylvestris*
Flag, western blue	*Iris missouriensis*
Foxtail, giant	*Setaria faberi*
Garlic, false	*Nothoscordum inodorum*

Garlic, wild	*Allium vineale*
Gaura, scarlet	*Gaura coccinea*
Gaura, Drummond's	*Gaura drummondii*
Gaura, wavy-leaved	*Gaura sinuata*
Goatgrass, barb	*Aegilops triuncialis*
Goatgrass, jointed	*Aegilops cylindrica*
Goatgrass, oyate	*Aegilops ovata*
Gorse	*Ulex europaeus*
Groundcherry, grape	*Physalis viscosa*
Groundcherry, long-leaf	*Physalis longifolia*
Halogeton	*Halogeton glomeratus*
Hermal	*Pegamon harmala*
Henbane, black	*Hyoscyamus niger*
Himalayan Blackberry	*Rubus discolor.*
Hoarycress, globe-podded	*Cardaria pubescens*
Hoarycress, heart-podded	*Cardaria draba*
Hoarycress, lens-podded	*Cardaria chalepensis*
Horsenettle, Carolina	*Solanum carolinense*
Horsenettle, white	*Solanum elaeagnifolium*
Hydrilla	*Hydrilla verticillata*
Iris, Douglas	*Iris douglasiana*
Iris, western blue flag	*Iris missouriensis*
Johnsongrass	*Sorghum halepense*
Jointvetch, rough	*Aeschynomene rudis*
Kangaroothorn	*Acacia paradoxa*
Kelp	*Polygonum amphibium* var. *emersum*
Kikuyugrass	*Pennisetum clandestinum*
Klamathweed	*Hypericum perforatum*
Knapweed, diffuse	*Centaurea diffusa*
Knapweed, Russian	*Acroptilon repens*
Knapweed, spotted	*Centaurea maculosa*
Knapweed, squarrose	*Centaurea squarrosa*
Knotweed, giant	*Polygonum sachalinensis*
Knotweed, Himalayan	*Polygonum polystachyum*
Knotweed, Japanese	*Polygonum cuspidatum*
Loosestrife, purple	*Lythrum salicaria*
Lettuce, water	*Pistia stratiotes*
Mallow, alkali	*Malvella leprosa*
Marigold, wild	*Tagetes minuta*
Medusahead	*Taeniatherum caput-medusae*
Melon, dedaim	*Cucumis melo* var. *Dudaim*
Melon, paddy	*Cucumis myriocarpus*
Mesquite, creeping	*Prosopis strombulifera*

EXHIBIT F (Continued)

Mistletoe, European	*Viscum album*
Mustard, purple	*Chorispora tenella*
Nightshade, heartleaf	*Solanum cardiophyllum*
Nightshade lanceleaf	*Solanum lanceolatum*
Nightshade, Torrey's	*Solanum dimidiatum*
Nightshade, white-margined	*Solanum arginatum*
Nimblewill	*Muhlenbergia schreberi*
Nutsedge, purple	*Cyperus rotundus*
Nutsedge, yellow	*Cyperus esculentus*
Onion, panicled	*Allium paniculatum*
Osage orange	*Maclura pomifera*
Pampas Grass	*Cortaderia jabata* or *C. selloana*
Peaweed, Austrian	*Sphaerophysa salsula*
Peppercress, perennial	*Lepidium latifolium*
Periwinkle	*Vinca major*
Povertyweed	*Iva axillaris*
Punagrass	*Achnatherum brachychaetum*
Puncturevine	*Tribulus terrestris*
Quackgrass	*Elytrigia repens*
Ragweed, giant	*Ambrosia trifida*
Ragwort, Oxford	*Senecio squalidus*
Ragwort, tansy	*Senecio jacobaea*
Restharrow, foxtail	*Ononis alopecuroides*
Rice, red	*Oryza rufipogon*
Russianthistle, barbwire	*Salsola paulsenii*
Russionthistle, common	*Salsola tragus*
Russianthistle, spineless	*Salsola collina*
St. Johnswort	as *Hypericum perforatum* (see Klamathweed)
Sage, meadow	*Salvia virgata*
Sage, Mediterranean	*Salvia aethiopis*
Salsola, wormleaf	*Salsola vermiculata*
Salt cedar (Tamarisk)	*Tamarix* spp.
Salttree, Russian	*Halimodendron halodendron*
Salvinia	*Salvinia auriculata complex*
Sandbur, coast	*Cenchrus incertus*
Sandbur, mat	*Cenchrus longispinus*
Sandbur, southern	*Cenchrus echinatus*
Satintail	*Imperata brevifolia*
Sicilian starthistle	*Centaurea sulphurea*
Skeletonweed	*Chondrilla juncea*
Sowthistle, perennial	*Sonchus arvensis*
Smooth-leaved elm	*Ulmus minor*
Spongeplant (S. American & N. American)	*Limnobium spongia sensu lato*

Spurge, leafy	*Euphorbia esula*
Spurge, oblong	*Euphorbia oblongata*
Spurge serrate	*Euphorbia serrata*
Spurge, Geraldton carnation	*Euphorbia terracina*
Starthistle, Iberian	*Centaurea iberica*
Starthistle, purple	*Centaurea calcitrapa*
Starthistle, Sicilian	*Centaurea sulphurea*
Starthistle, yellow	*Centaurea solstitialis*
Swinecress	*Coronopus squamatus*
Tanglehead	*Heteropogon contortus*
Thistle, artichoke	*Cynara cardunculus*
Thistle, Canada	*Cirsium arvense*
Thistle, distaff, smooth	*Carthamus baeticus*
Thistle, distaff, whitestern	*Carthamus leucocaulos*
Thistle, distaff, woolly	*Carthamus lanatus*
Thistle, golden	*Scolymus hispanicus*
Thistle, Illyrian	*Onopordum illyricum*
Thistle, Itaslian (see also "Thistle, slenderflowered")	*Arduus pycnocephalus*
Thistle, Japanese	*Cirsium japonicum*
Thistle, musk	*Carduus nutans*
Thistle, plumeless	*Carduus acanthoides*
Thistle, Scotch	*Onopordum acanthium*
Thistle, slenderflowered	*Carduus tenuiflorus*
Thistle, Taurian	*Onopordum tauricum*
Thistle, wavyleaf	*Cirsium undulatum*
Thistle yellowspine	*Cirsium ochrocentrum*
Toadflax, Dalmatian	*Linaria genistifolia* subsp. *Dalmatica*
Tree of Heaven or Ailanthus	*Ailanthus altissima*
Waterlily, banana	*Nymphaea mexicana*
Witchweed	*Striga asiatica*

APPENDIX E

Land Cover Type Report/ Vernal Pool Watershed Mapping

APPENDIX E1

Land Cover Type Report

APPENDIX E1
Land Cover Type Report

1 INTRODUCTION

The purpose of developing a land cover type map of the Plan Area is to provide current land cover type baseline data for use in the development of the South Sacramento Habitat Conservation Plan (SSHCP) and of other necessary permits (e.g., Clean Water Act Section 404). Classification of habitats in the Plan Area, particularly aquatic resources, is necessary to ensure protection of a vast array of aquatic, wetland, and riparian land cover types. This effort to map land cover types should not be confused with General Plan Land Use designations that are used by local governmental jurisdictions to define what type of uses are allowed to occur on any given parcel. Land cover types are defined as the dominant feature of the land surface discernible from aerial photographs and defined by vegetation, water, or human uses.

2 METHODS

The original delineation of vernal pool and swale land cover types are based on the interpretation of black and white aerial imagery dated March 2001. All vernal pool or swale cover types, approximately 5,000 acres, were mapped at a scale of 1 inch = 200 feet (1:2,400). The original delineation of all other land cover types are based on the interpretation of color aerial imagery dated November 2002. A total of approximately 336,000 acres were mapped at a scale of 1 inch = 400 feet (1:4,800). As SSHCP planning progressed, approximately 3,000 additional acres were mapped and included in the Plan Area. Changes to habitat that occurred after the initial mapping (e.g. changing from a natural habitat to an urban land use) are reflected on the land cover type map as of 2014.

Twenty-five (25) different land cover types are displayed on the land cover types map. Seventeen land cover types are classified as SSHCP “natural land covers,” which includes native and naturalized environments and agricultural lands that have habitat value for SSHCP Covered Species. Eight SSHCP land cover types are classified as “developed/non-habitat land covers” and provide minimal habitat value for native species, including the SSHCP Covered Species These 25 land cover types reflect the most comprehensive coverage of land cover types discernable at the chosen mapping scales. Land cover type categories are roughly based on the habitat types described in the California Department of Fish and Game’s (CDFG) List of California Natural Communities and were modified to meet the needs of Sacramento County for inclusion in the SSHCP process.

Initial field surveys were conducted on approximately 4,000 acres of selected, County-owned parcels located throughout the Plan Area to provide recognition of signatures for aerial interpretation of the remaining portions of the Plan Area. These areas were selected by the County primarily for accessibility reasons. Areas used in field verification included a parcel along the Cosumnes River in Rancho Murieta, Gene Andal Park and Wetlands Preserve, the Sacramento Regional County Sanitation District (SRCSD) Bufferlands, the Nicholas Ranch and Valensin Ranch parcels of the Cosumnes River Preserve, and Deer Creek Hills. Problematic aerial signatures that were not contained in the field survey areas or easily identified from aerial photographs were spot-checked from public roads to the degree feasible.

Vernal Pool and Swale Mapping Conducted by the Geographical Information Center

Initial mapping was completed in two phases: Phase I included all maps contained in the Urban Development Area (UDA) and Phase II included all of the remaining non-UDA maps located in the south Sacramento County area. The black and white ortho-photographic images were brought into ArcView 3.3 Geographic Information System (GIS) software and the vernal-wetland signatures were heads-up digitized into polygons which were recorded as a shape file. Vernal pool/wetlands were identified primarily by visual signatures, including contrasting shades (color) and to some degree texture and shape. Geographic Information Center (GIC) cartographers then vectorized, and attributed these maps to create a seamless GIS layer for both Phase I and Phase II of the Plan Area.

All Other Land Cover Type Mapping Conducted by EDAW

Initial mapping was completed in two phases: Phase I included all maps contained in the UDA and Phase II included all of the remaining non-UDA maps located in the south Sacramento County area. The entire Plan Area was hand-mapped by qualified EDAW botanists onto color print-outs of the aerial photographs based on interpretations using habitat signatures verified in the field. EDAW GIS specialists and Geographic Computer Technologies (GCT) scanned, vectorized, and attributed these maps to create a seamless GIS layer for both Phase I and Phase II of the Plan Area.

Land cover types mapped by EDAW that were identified in the field, but that were not discernable at the mapping scale of 1:4,800, were not included in the resulting map layer. If features were present during 2004 field surveys (e.g., new development, additional restoration activities) that were not yet present when the 2002 aerial photographs were flown, these features were omitted from the initial mapping effort. Similarly, care was taken by EDAW botanists and GIS specialists when mapping portions of the Plan Area familiar to the botanists to delineate only the aerial signatures readily identifiable at the 1:4,800 scale to reduce potential sources of bias.

Integration of EDAW and GIC Mapping Efforts

Upon completion of both mapping efforts by EDAW and GIC, Sacramento County staff integrated the GIC vernal pool and swale shape file into the broader EDAW land cover type shape file. This was done by first clipping the EDAW land cover types shape file with the GIC vernal pool and swale shape file. The GIC vernal pool and swale file and the EDAW land cover type map were then merged to create the final land cover types map.

Sacramento County staff then reviewed the final land cover type map for shape file registration errors and inaccurately labeled land cover types and modified the map where needed. This included identifying intersections between land cover type features that should not intersect, such as vernal pools intersecting open water features. Intersections where then reviewed against aerial images and corrected where necessary.

SSHCP Expansion Area Mapping Conducted by PMC

The initial SSHCP study area excluded lands west of Interstate 5. These lands, approximately 33,000-acres, were later included within the final Plan Area. Experienced PMC GIS specialist heads-up digitized 2009 aerial imagery creating habitat features into polygons. The mapping was conducted utilizing ArcView 9.3 at a maximum scale of 1:4,800 (1 inch = 400 feet). This area was then added to land cover type mapping prepared for the Plan Area to create a seamless land cover type layer for the entire Plan Area.

Periodic Map Updates and Refinement

Overtime, the SSHCP land cover type mapping required periodic updates to reflect changes to the environment (e.g., development, conversion of agricultural lands, and habitat restoration) as well as further refinement to better inform the SSHCP planning process (e.g., more precise mapping of agricultural residential areas).

- **Vernal swale** – initial mapping efforts included two categories of swales – vernal swales that provide habitat for listed vernal pool invertebrate species and swales that do not provide habitat for listed vernal pool invertebrate species. In consultation with the Wildlife Agencies, it was determined that it was not possible to differentiate between these two cover types using aerial photography. All features that were classified as vernal swale were re-classified as swale.
- **Vernal impoundment** – initial mapping efforts included a vernal impoundment land cover-type classification. In consultation with the Wildlife Agencies, it was determined that vernal impoundments would be re-classified to vernal pool, open water or seasonal wetland land cover types. Each feature that was classified as vernal impoundment was checked against four sets of aerial photos flown during the summer months (2003, 2005, 2009 & 2010). If water or vegetation was present in at least three of the four aerial photos the feature was re-classified as open water or seasonal wetland. The open water classification was applied when at least half of the feature was inundated. When little or no water was present but vegetation was present indicating that the feature did not completely dry down,

then the feature was re-classified as seasonal wetland. If water or vegetation was not present in at least three of the four aerial photos then the feature was re-classified as vernal pool with a few exceptions. Those exceptions are if woody vegetation was present around the perimeter or within the feature, then the feature was re-classified to open water or seasonal wetland. If a feature was surrounded by an agricultural cover type or within topography dominated by mine tailings the feature was re-classified as open water or seasonal wetland. Features completely surrounded by non-habitat cover types were re-classified to the surrounding non-habitat cover type classification.

- **Seasonal impoundments** –The same methodology used to reclassify vernal impoundments was used to reclassify seasonal impoundments.
- **Wetland Restoration** – initial mapping efforts included a land cover type classification that attempted to identify restored or created wetlands. This classification was abandoned as it was difficult to accurately identify all restored or created wetlands using aerial photography. All features with the wetland restoration land cover type classification were re-classified to an appropriate wetland land cover type classification. The SSHCP land cover type database does include coding that identifies if a vernal pool feature is suspected of being created or restored.
- **Woodland Restoration –** initial mapping efforts included a land cover type classification that attempted to identify restored or created riparian woodland areas. This classification was abandoned as it was difficult to accurately identify all restored or created riparian woodland using aerial photography. All features with the woodland restoration land cover type classification were re-classified to either mixed riparian scrub or mixed riparian woodland.
- **Agricultural-residential mapping** – the initial mapping under represented the acres of upland habitats (e.g., valley grassland) in areas characterized by small parcels (less than 5 acres in size); therefore, it was determined that further refinement of the land cover type mapping was necessary to assess effects to covered species habitat in these areas. Specifically at issue is that many backyard areas within Agricultural-residential developments were mapped as grassland and a number of larger fields were mapped as low density development. Areas with agricultural-residential development were reviewed against aerial photos and where appropriate were re-classified to reflect the correct cover type. All parcels less than 5-acres were reviewed against March 2009 aerial imagery and the land cover type mapping was adjusted were upland habitats represented more than 0.5 acres.
- **Streams/creeks and swales** – the initial mapping relied on aerial interpretation of streams. In February 2008, the United States Army Corps of Engineers (USACE) Research and Development Center conducted an "Assessment of the Riparian Integrity

for the South Sacramento Habitat Conservation Plan." The draft document reported on the hydrology, water quality, and habitat integrity of stream reaches inside the SSHCP Urban Development Area (UDA). The assessment also produced a GIS data set of the stream reaches inside the UDA. This data is a reliable representation of streams within the UDA and more accurate than the original aerial interpretation. The land cover type map was then reviewed against the USACE derived data to ensure the land cover type map was consistent with the USACE derived data. Features mapped as streams/creeks where the USACE did not identify a stream were reclassified as a swale or other land cover type based on March 2009 imagery.

- **Streams/creek vernal pool invertebrate habitat (VPIH)** – The stream/creek VPIH land cover type was created in late 2012 to distinguish intermittent drainages that provide suitable habitat for vernal pool crustaceans from those that do not. The stream/creek (VPIH) land cover type is vegetated with valley grassland plant species and conveys water after rain events. Unlike the Swale land cover type, the Stream/Creek (VPIH) land cover is less likely to support vegetation characteristic of vernal pools, and the SSHCP does not consider the Stream/Creek (VPIH) land cover habitat for vernal pool plant Covered Species. However, the Stream/Creek (VPIH) land cover is known to provide movement corridors and may provide habitat for vernal pool crustaceans.
- **Eucalyptus woodland and valley oak riparian woodland** – These two land cover type classifications were included as part of the initial mapping efforts, but are no longer used by the SSHCP. The eucalyptus woodland classification was abandoned after a large grove was removed leaving only small scattered clusters of eucalyptus trees that are difficult to discern form aerial photos. The valley oak riparian woodland classification was abandoned after it was determined that features mapped valley oak riparian woodland were indistinguishable from the mixed riparian woodland land cover type classification.

Minimum Mapping Units and Linear Features

The minimum mapping units listed in Table E-1 reflect the level of accuracy at which particular land cover types could be identified and delineated from aerial photographs and digitized using ArcMap. Minimum mapping units were calculated based on an average of the five smallest complete polygons for each cover type. Linear features (i.e., streams and creeks, aqueducts, and roads) do not have associated minimum mapping units. Linear features with discernable widths were mapped as polygons wherever possible; however, stream features for which widths were indiscernible at the mapping scale of 1:4,800 were digitized as line features and subsequently buffered. The average width of small streams and drainage ditches during the field verification surveys was identified as 6 feet with the concurrence of Sacramento County staff. Therefore, a 3-

foot buffer was added to each side of these line features and the resulting polygons were then merged into the land cover type layer using batch erase and union functions.

Table E-1
Minimum Mapping Unit for SSHCP Land Cover Type Map

Land Cover Type	Minimum Mapping Unit (acres)
Aqueducts	3.8
Blue Oak Savanna	3.8
Blue Oak Woodland	2.0
Cropland	2.5
Disturbed	0.9
Freshwater Marsh	0.01
High Density Development	0.4
Irrigated Pasture-Grassland	0.7
Low Density Development	0.08
Major Road	1.7
Mine Tailing Riparian Woodland	0.1
Mine Tailings	0.4
Mixed Riparian Scrub	0.1
Mixed Riparian Woodland	0.04
Open Water	0.1
Orchards	0.5
Recreation/Landscaped	0.2
Seasonal Wetlands	0.1
Streams/Creeks	0.02
Streams/Creeks (VPIH)	0.02
Swale	0.003
Valley Grassland	0.01
Vernal Pool	0.001
Swale	0.001
Vineyards	1.2

3 LAND COVER MAPPING RESULTS

Each of the 25 land cover types is described below. Total acreages and percentages of the total Plan Area covered by each land cover type are listed in Table E-2.

Table E-2
Acreages and Percentages of Land Cover Types Within the Plan Area

SSHCP Land Cover Type	Area (Acres) in Plan Area	Percentage of Total Plan Area
Natural Land Cover Category (have habitat value)		
Aquatic Land Cover Types		
Vernal Pool	4,536	1.4
Swale	1,252	0.4
Seasonal Wetland	2,600	0.8
Freshwater Marsh	2,954	0.9
Mixed Riparian Woodland	5,856	0.2
Mixed Riparian Scrub	1,454	0.5
Mine Tailings Riparian Woodland	641	0.2
Stream/Creek (Vernal Pool Invertebrate Habitat)*	73	0.02
Stream/Creek	2,778	0.9
Open Water	2,344	0.7
Terrestrial Land Cover Types		
Valley Grassland	135,152	42.5
Blue Oak Savanna	5,637	1.8
Blue Oak Woodland	9,132	2.9
Cropland	51,829	16.3
Orchard	3,907	1.2
Vineyard	26,460	8.3
Irrigated Pasture	15,991	5.0
Developed / Non-Habitat Land Cover Category		
Aqueduct	264	0.1
Disturbed	6,288	2.0
High-Density Development	13,073	4.1
Low-Density Development	18,608	5.9
Major Roads	2,764	0.9
Mine Tailings	1,098	0.3
Recreation/Landscaped	2,180	0.7
Not Mapped	784	0.2
Total	**317,655**	

Land Cover Type Descriptions

Vernal Pool Land Cover

Vernal pools are seasonal ephemeral wetlands that fill and dry each year. In Central Valley annual grasslands, they form in shallow depressions that are underlain with a soil or a soil layer impermeable to water. In California's Mediterranean climate (rainy winter months followed by a hot, dry season), vernal pool soils typically become wetted in November. Water collects in the depressions and stands during late winter and early spring, then recedes as temperatures rise and rainfall diminishes. The soil, however, remains moist through April and May, then it desiccates and stays dry until the cycle begins again. The specific regime of vernal pool inundation—too short and unpredictable to support aquatic species but long enough to eliminate upland species—is what characterizes vernal pools as ephemeral wetlands and differentiates them from other aquatic ecosystems such as alkali meadows and seasonally flooded emergent bulrush or tule marshes (Solomeshch et al. 2007).

Vernal pools support unique assemblages of highly specialized plants and animals that are adapted to the annual cycle of winter inundation and summer drought. Consequently, vernal pools are one of the few habitats in California still dominated by native plant and animal species (Rains et al. 2008). Many vernal pool plant genera and species are endemic to California, and their presence indicates the specific hydrology and water chemistry of the vernal pool. Vernal pools were once a very common element of the Central Valley landscape, but only a small portion has not been converted to agricultural and urban developments; consequently, many vernal pool taxa are now rare and endangered.

Vernal pools provide habitat for rare and endangered animals such as vernal pool tadpole shrimp (*Lepidurus packardi*), vernal pool fairy shrimp (*Branchinecta lynchi*), conservancy fairy shrimp, Ricksecker's water scavenger beetle (*Hydrochara richseckeri*), and several amphibians (e.g., western spadefoot toad (*Spea hammondii*), California tiger salamander (*Ambystoma californiense*)), and vernal pools support a number of migratory birds in the winter (Alexander 1976; Helm 1998; Silveira 1998; Solomeshch et al. 2007; USFWS 2004b). A specific group of plant taxa occupies vernal pools, most of which are annuals capable of slow underwater growth in winter and rapid development and reproduction in spring after the water is gone but before soils dry. Plant species are not distributed evenly through the pools, but grow in concentric zones that reflect different lengths of inundation as the pool dries (Solomeshch et al. 2007). As discussed in Chapter 2, Central Valley vernal pools occur on many geological surfaces, but in all cases, vernal pools are underlain by a low-permeability layer such as claypans, hardpans (e.g., silica-cemented duripans), mudflows, or bedrock (Rains et al. 2008). Because vernal pools are associated with specific landforms, geologic formations, and soils (Smith and Verrill 1998), vernal pools tend to be clustered at the landscape scale, forming vernal pool complexes (Rains et al. 2006; USFWS 2006). Based on a vernal pool's landform, underlying geology, nature of the soil's water-restricting layer, frequency of ponding, and ponding duration, Sawyer and Keeler-Wolf (1995) have identified five vernal pool types in Northern California. As discussed in Section 2.3, most vernal pools in the Plan Area are broadly classified as Northern Hardpan vernal pools and Northern Volcanic Mudflow vernal pools (Jones and Stokes 1990). In addition, a less specialized vernal pool type with generally lower species richness is found on Drainageway formation soils in the Plan Area.

Northern Volcanic Mudflow vernal pools occur on ancient mudflows called lahars (see Section 2.3). These pools are small, form in irregular depressions in gently sloping surfaces, and are often rocky and shallow. Water chemistry is mixo-saline, fresh (Sawyer and Keeler-Wolf 1995). In the Plan Area, Northern Volcanic Mudflow vernal pools are found on the Mehrten and Valley Springs formation in rocky soil series and complexes such as Hadselville-Pentz, Red Bluff-Redding, Corning-Redding, Amador-Gillender, and Pardee-Rancho Seco (Jones and Stokes 1990). Mudflow pools in the Plan Area are hydrologically complex; in some areas, vernal pools are in complex reticulated drainage networks with a high density of interconnected pools, swales, and ephemeral drainages (Jones and Stokes 1990). The seasonal hydrology of Northern Volcanic Mudflow vernal pools includes a perched water table (see Section 3.2.3), but pool hydrology is relatively "flashy" (i.e., pools fill and drain relatively rapidly). Northern Volcanic Mudflow vernal pools contain relatively rich flora that includes several vernal pool obligate species. The species richness and ecological complexity of Northern Mudflow pools in the Plan Area exceed that of the Young-Terrace Northern Hardpan pools and the Drainageway vernal pools in the Plan Area. Possible explanations of the rich (less specialized) flora of Northern Mudflow pools include the recent origin of the pools and their quickly changing or "flashy" hydrology. Mudflow pools fill and drain rapidly, and may be less stressful to most plant life than pools that remain flooded for extended periods, such as the Old-Terrace Northern Hardpan vernal pools (Jokerst 1990; Jones and Stokes 1990).

Northern Hardpan vernal pools form on alluvial terraces in old, acidic, nutrient-depleted soils with iron-silicate cemented soil layer. These soils often exhibit well-developed mound-intermound topography to form aggregations of pools and "mima mounds." Water chemistry is mixo-saline fresh (Sawyer and Keeler-Wolf 1995; USFWS 2005). Northern Hardpan vernal pools typically have a conductivity of 40 to 70 mhos per 1 centimeter, which is similar to an oligotrophic high Sierran lake (Keeley and Zedler 1998; Williamson et al. 2005). Water in hardpan vernal pools is not only low in dissolved salts, but also in dissolved nitrogen. For example, Rains et al. (2006) reported that, during the growing season, nitrate and phosphate concentrations were below detection limits (i.e., 0.006 milligrams per liter (mg/L) and 0.03 mg/L, respectively), and the amount of ammonium was negligible (0.1 mg/L). Within the Plan Area, Northern Hardpan vernal pools occur on the low (younger) terrace Riverbank Formation soil series (e.g., San Joaquin, Galt, Madera, Tehama), as well as on the high (older) terrace Laguna Formation and Arroyo Seco gravels (e.g. Corning, Redding, Red Bluff, Mokelumne soil series). Vernal pools occur extensively on both landforms types (Jones and Stokes 1990).

The Plan Area's Low-Terrace Northern Hardpan vernal pools (e.g., on San Joaquin soils) are of recent geologic origin, which may explain their relatively unspecialized flora that often includes non-native plants, low species richness, scarcity of vernal pool obligates, and low numbers of special-status plants. Most young terrace sites in the Plan Area have been plowed, graded, or heavily grazed because of their arable soils and proximity to reliable water; this may also account for their less specialized flora. Low-Terrace Northern Hardpan vernal pools also serve an important function as habitat for shorebirds, waterfowl, and raptors because of their location in the central portion of the valley along the Sacramento River (Jones and Stokes 1990; Silveira 1998).

High-Terrace Northern Hardpan vernal pools (e.g., on Corning and Redding soil series) are the most complex type of vernal pool in the Plan Area because of their rich and varied flora, presence of special-status plant and invertebrate species, and complex hydrology, and because they often occur in areas with complex, highly convoluted interspersions of several soil types. Soils on high-terrace landform sites varies over short distances such that sites in proximity to each other may have entirely different restricting layer types, depth, and vernal pool plant community. High-Terrace Northern Hardpan vernal pools are floristically rich and dominated by vernal pool obligate plant species (true “specialists”), and typically support special-status species. The tremendous age and geographic location of High-Terrace Northern Hardpan pools may account for their rich and highly specialized flora (Jones and Stokes 1990). Little of the high-terrace landform has been farmed in the Plan Area because irrigation water is lacking and many sites are not arable. Some high-terrace vernal pool areas were dryland farmed in the past with wheat or oats; this type of farming appears to have had little effect on high-terrace vernal pools, while on other formations, this disrupted vernal pool surface hydrology. Consequently, High-Terrace Northern Hardpan vernal pools are relatively abundant in the Plan Area (Jones and Stokes 1990).

Drainageway vernal pools are located on no particular Plan Area geologic formation, but formed on recent alluvial deposits adjacent to the incised channels of active watercourses. Consequently, Drainageway vernal pools are interspersed throughout the other three vernal pool types present in the Plan Area. Drainageway vernal pools fill and drain rapidly, and may depend on overland runoff and direct precipitation to maintain their hydrology relative to the other vernal pool types (Jones and Stokes 1990). Additionally, the basins of Drainageway vernal pools are often shallow and susceptible to evaporation, or slightly sloped, which encourages drainage. Drainageway vernal pools have an unspecialized flora relative to the other three vernal pool types in the Plan Area (Jones and Stokes 1990).

The four types of vernal pools present in the Plan Area can be further classified by the presence or absence of certain dominant or less abundant vernal pool plant species (Sawyer et al. 2009). Vernal pool community structure (i.e., the type, number, and relative abundance of species) is largely determined by the pool’s physical makeup (e.g., size, depth, substrate, water chemistry) and the pool’s hydrology; different patterns of species dominance and the presence or absence of certain species can be indicative of physical and hydrology differences among vernal pools (Holland and Jain 1988). Vernal pools in the Plan Area exhibit a great variety of size, depth, soil, and water chemistry. Key physical parameters may include pool drainage area, slope, soil type, soil structure and depth, pool size and depth, timing of the pool hydrologic cycle, and pool interconnectivity. In particular, several SSHCP vernal pool Covered Species require large, deep pools that are long lasting to successfully complete their life cycles, including Boggs Lake hedge-hyssop (*Gratiola heterosepala*), Sacramento Orcutt grass (*Orcuttia viscida*), slender Orcutt grass (*Orcuttia tenuis*), vernal pool tadpole shrimp, California tiger salamander, and western spadefoot toad. Other vernal pool Covered Species are found in small to medium-sized "flashy" pools that dry out relatively quickly, but may inundate and dry out several times during the wet season, including Ahart's dwarf rush (*Juncus leiospemus* var. *ahartii*), dwarf downingia (*Downingia pusilla*), and pincushion navarretia (*Navarretia myersii*). For some plants in the latter category, the edges of larger vernal pools may provide conditions equivalent to the smaller, flashy pools. Other Covered Species associated with vernal pools include legenere (*Legenere limosa*), vernal pool fairy shrimp, Ricksecker's water scavenger beetle, most of the bird Covered Species (mostly as foraging habitat), American badger (*Taxidea taxus*), and western red bat (*Lasiurus blossevillii*) (see Table 3-2).

Preserving the full range of physical and hydrologic conditions found in Plan Area vernal pools is necessary to ensure that all vernal pool Covered Species and representative examples of the different Plan Area vernal pool types and existing variation in vernal pool plant and animal associations are considered and protected (Jones and Stokes 1990). By protecting the range of diversity in vernal pool types, the SSHCP can ensure that the entire range of known and unknown ecological and biological values is represented in a Preserve System, and that the intrinsic values of this facet of the region's natural heritage are considered. Preserving the range of plant and animal associations also provides natural laboratories to study the factors influencing the presence or absence of species, migration, and establishment of species, patterns of species dominance, and other phenomena (Jones and Stokes 1990).

Plan Area vernal pools occur in complexes of pools interconnected by intermittent surface swales and by the seasonal perched aquifer that forms between the soil surface and the sub-surface restricting layer. Consequently, the Vernal Pool land covers in the Plan Area cannot be described or analyzed in isolation of their ecologically and hydrologically connected SSHCP land covers of Swale, Valley Grassland, and Stream/Creek (Vernal Pool Invertebrate Habitat (VPIH)). Therefore, in addition to discussing the Vernal Pool land cover individually in SSHCP Chapters 3, 6, and 7, the Plan Permittees also define and discuss an SSHCP Vernal Pool Ecosystem (see Section 3.2.3).

Seasonal Wetland Land Cover

Seasonal Wetland is an ephemeral wetland that ponds for extended periods during a portion of the year, generally the rainy winter season, then dries relatively slowly, typically in the summer and early fall. Seasonal Wetland tends to occur as an isolated wetland within moderate to large depressional features in Valley Grassland; along streams, creeks, and rivers; and along the edges of open water. Seasonal Wetland is often characterized by herbaceous annual and perennial species such as curly dock (*Rumex crispus*) and bulrush (*Scirpus* spp.).

Seasonal Wetland provides habitat for some Covered Species (Table 3-2). The SSHCP does not consider Seasonal Wetland to be suitable habitat for vernal pool crustaceans.

Covered Species associated with the Seasonal Wetland land cover include Bogg's Lake hedge-hyssop, legenere, Sanford's arrowhead (*Sagittaria sanfordi*), California tiger salamander, western spadefoot, giant gartersnake (*Thamnophis gigas*), all of the bird Covered Species (mostly as foraging habitat) except Cooper's hawk (*Accipiter cooperii*), American badger, and western red bat.

Swale Land Cover

The movement of surface water between vernal pools can occur in a network of narrow and intermittent surface "swales" (Solomeshch et al. 2007). Swales are shallow seasonal drainages found in flat to gently rolling Valley Grassland in association with vernal pool complexes, on soils with an impermeable layer (see Section 2.3). Swales convey runoff as shallow, gently sloping ephemeral wetlands during, and for short periods after, winter rainstorms. Soils within the Swale land cover type may remain saturated during the winter and early spring, but dry by summer. Swales are associated with vernal pools and provide intermittent conduits between vernal pools for movement of surface water and propagules of vernal pool plant and animal Covered Species (seeds, cysts, eggs, and spores), and movement of adult California tiger salamanders and western spadefoots. Swales support several native plant species commonly found in vernal pools. Swales also often include smaller shallow depressional features that may pond during the rainy season to provide suitable reproductive habitat for some vernal pool Covered Species, and may be considered vernal pools. Generally, the Swale land cover provides suitable habitat for portions or all of the life cycle of many of the Covered Species that occur in the Vernal Pool land cover types, including Ahart's dwarf rush, dwarf downingia, pincushion navarretia, mid-valley fairy shrimp (*Branchinecta mesovallensis*), vernal pool fairy shrimp, vernal pool tadpole shrimp, Ricksecker's water scavenger beetle, and western spadefoot. In addition, all of the bird Covered Species (except Cooper's hawk and greater sandhill crane (*Grus canadensis tabida*)) use Swale land cover (primarily as foraging habitat), along with American badger and western red bat (see Table 3-2).

The Swale land cover type cannot be adequately described or analyzed separately or in isolation of other ecologically and hydrologically connected SSHCP land covers (i.e., Vernal Pool, Valley Grassland, and Stream/Creek VPIH). Therefore, in addition to discussing the Swale land cover individually in SSHCP Chapters 3, 6, and 7, the Plan Permittees also define, discuss, and analyze a combined SSHCP Vernal Pool Ecosystem (see Section 3.2.3 below).

Stream/Creek Vernal Pool Invertebrate Habitat Land Cover

As discussed below, the larger SSHCP Stream/Creek land cover type includes intermittent and perennial linear water features such as rivers, streams, creeks, and drainages. The SSHCP Stream/Creek VPIH land cover type is typically an intermittent drainage that is vegetated with Valley Grassland plant species and conveys water after rain events (is ephemeral). Unlike the Swale land cover type, the Stream/Creek (VPIH) land cover is less likely to support vegetation characteristic of vernal pools, and the SSHCP does not consider the Stream/Creek (VPIH) land cover habitat for vernal pool plant Covered Species. However, the Stream/Creek (VPIH) land cover is known to provide movement corridors, and may provide suitable habitat for vernal pool crustaceans, including mid-valley fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp, within depressional features of the drainage that pond water between storm events. Western burrowing owl (*Athene cunicularia hypugea*) may also use Stream/Creek (VPIH) habitat. See Figure 3-2 for locations of Stream/Creek (VPIH) habitat.

The Stream/Creek (VPIH) land cover cannot be adequately described or analyzed separately or in isolation of other ecologically and hydrologically connected SSHCP land covers (i.e., the Vernal Pool, Valley Grassland, and Swale land covers). Therefore, in addition to discussing Stream/Creek (VPIH) individually in SSHCP Chapters 3, 6, and 7, the Plan Permittees also define, discuss, and analyze a combined SSHCP Vernal Pool Ecosystem (see Section 3.2.3).

Freshwater Marsh Land Cover

Most of California's freshwater marshes occur in the Sacramento Valley and San Joaquin Delta regions. The majority of Freshwater Marsh in the Plan Area occurs along the perennial Cosumnes River and Deer Creek, and along the margins of streams and open water in the Plan Area. Freshwater Marsh is typically dominated by perennial herbaceous plant species such as cattails (*Typha* spp.), tules (*Scirpus* spp.), and other emergent plant species, and is generally found along the edges of aquatic habitats such as ponds, lakes, and rivers. It is important habitat for western pond turtle (*Actinemys marmorata*), giant gartersnake, northern harrier (*Circus cyaneus*), tricolored blackbird (*Agelaius tricolor*), and western red bat (Table 3-2).

Open Water Land Cover

Open Water includes perennial or features, such as natural or built ponds, lakes, and reservoirs. Open Water may contain no vegetation, or non-rooted aquatic vegetation, such as algae, floating pondweeds, and other plants. Along shorelines, rooted, emergent vegetation may occur, forming Freshwater Marsh. Like Freshwater Marsh, Open Water habitat is used by numerous bird, mammal, amphibian, and reptile species, including several Covered Species, such as western pond turtle, giant gartersnake, tricolored blackbird, and western red bat. The marshy shorelines may be used by tricolored blackbird for nesting colonies (Table 3-2).

The Open Water land cover type is found throughout the SSHCP area. Open Water features are largely unnamed with the exception of Blodgett Reservoir inside the Urban Development Area (UDA) and Rancho Seco Lake outside the UDA.

Stream/Creek Land Cover

Outside of the UDA, the Stream/Creek land cover type includes intermittent and perennial linear water features such as rivers, streams, creeks, drainages, and roadside and irrigation ditches. Within the UDA, this land cover type includes streams identified by the U.S. Army Corps of Engineers. A separate category was created for aqueducts throughout the Plan Area.

The SSHCP Stream/Creek land cover includes rivers such as the Cosumnes River, streams such as Laguna Creek, and smaller intermittent or perennial creeks. The Stream/Creek land cover type was mapped from aerial photographs. Where a river or stream channel was not discernable because of dense over story cover, the centerline of the channel has been approximated and buffered by a width of 6 feet. Polygons of the Stream and Creek land cover occur in Valley Grassland, Blue Oak Woodland, Blue Oak Savanna, Agriculture, and Developed land cover types.

Covered species associated with the Stream/Creek land cover type include Sanford's arrowhead, giant gartersnake, western pond turtle, and western red bat (Table 3-2).

Mixed Riparian Woodland Land Cover

Riparian land covers are associated with Plan Area streams and creeks and typically occur in the zone between the active stream channel and adjacent upland land covers. While "riparian" has various definitions, the SSHCP uses the National Research Council's 2002 definition: "Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas in the Plan Area are adjacent to perennial, intermittent, and ephemeral streams, lakes."

Riparian ecosystems are highly dependent on landscape setting and numerous physical and biotic interactions. Riparian ecosystems provide essential foraging, shelter, and breeding habitat for several of the Covered Species and other native plant and animal species, including both resident and migratory species.

The Mixed Riparian Woodland land cover type is distinguishable by an open canopy layer dominated by tall Fremont cottonwood trees. Beneath this open layer, a moderately dense mid-canopy layer is composed of tree species such as Oregon ash (*Fraxinus latifolia*), Goodding's willow (*Salix gooddingii*), California black walnut (*Juglans californica* var. *hindsii*), valley oak (*Quercus lobata*), and box elder (*Acer negundo*). In some areas, a subcanopy of dense Riparian Scrub dominated by willow species, including arroyo willow and sandbar willow, is present. A discontinuous shrub layer is also present, particularly along the northern boundary of the Plan Area, and includes species such as blue elderberry, Himalayan blackberry, coyote-brush, wild rose, and wild grape. The understory is sparsely to densely vegetated with herbaceous species. Invasive weeds that have colonized portions of the Mixed Riparian Woodland in the Plan Area include tamarisk (*Tamarix* spp.) and giant European reed (*Arundo donax*).

Included in the Mixed Riparian Woodland Land Cover Type are valley oak riparian woodlands. Although they are not a separate land cover type, owing to an inability to distinguish them from other riparian communities, valley oak riparian woodlands are notable as they were once a dominate community along waterways in the Plan Area. Valley oak riparian woodland intergrades with the Valley Grassland land cover type and wooded borders along streams and agricultural fields in the Plan Area. Tree associates in the Plan Area include California sycamore (*Platanus racemosa*), California black walnut, interior live oak (*Quercus wislizeni*), box elder, and blue oak. The shrub understory consists of western poison-oak, blue elderberry, California wild grape, toyon (*Heteromeles arbutifolia*), California coffeeberry, and California blackberry (*Rubus ursinus*). Various sorts of wild oats (*Avena* spp.), brome (*Bromus* spp.), barley (*Hordeum* spp.), ryegrass (*Lolium* spp.), and needlegrass (*Nassella* spp.) dominate the ground cover.

Covered species associated with the Mixed Riparian Woodland land cover type include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, white-tailed kite, and western red bat (Table 3-2).

Mixed Riparian Scrub Land Cover

Mixed Riparian Scrub land cover type is interspersed with Mixed Riparian Woodland in the floodplains of waterways throughout Sacramento County. In the Plan Area, this land cover type consists of an open to dense shrubby thicket dominated by a mixture of sandbar willow (*Salix exigua*), arroyo willow (*S. lasiolepis*), red willow (*S. laevigata*), and immature stands of mixed riparian woodland tree species (see description below). This plant community can also be a subcanopy community in Mixed Riparian Woodland. Though dense stands of Riparian Scrub in the Plan Area typically lack an understory, some of the more open canopy mixed Riparian Scrub stands do support an understory of native and non-native species, including wild rose (*Rosa californica*), wild grape (*Vitis californica*), perennial pepperweed (*Lepidium latifolium*), Himalayan blackberry (*Rubus discolor*), curly dock (*Rumex crispus*), and various non-native grasses.

Covered species associated with the Mixed Riparian Scrub land cover type include valley elderberry longhorn beetle, giant gartersnake, western pond turtle, Cooper's hawk, loggerhead shrike, Swainson's hawk, white-tailed kite, and western red bat (Table 3-2).

Mine Tailing Riparian Woodland Land Cover

The Mine Tailings Riparian Woodland land cover type is distributed among older mine tailings. This land cover type contains species commonly found in Riparian Woodlands and Riparian Scrub habitats, such as Fremont cottonwood (*Populus fremontii*), blue elderberry (*Sambucus mexicana*), willow (*Salix* spp.), and coyote-brush (*Baccharis pilularis*). In the Plan Area, this land cover type can also intergrade with mixed riparian forest along bodies of water.

Covered species associated with the Mine Tailing Riparian Woodland land cover type include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, loggerhead shrike, white-tailed kite, and western red bat (Table 3-2).

Valley Grassland Land Cover

Valley Grassland is by far the most common single land cover in the Plan Area. Including non-habitat land covers, it accounts for about 43% of the land covers in the Plan Area. Valley Grassland, being so widespread throughout the Plan Area, is essential for both the long-term survival of many of the Covered Species and for conserving ecological functions of other land cover types within the Plan Area.

Valley Grassland in the SSHCP Plan Area is an annual herbaceous plant community now characterized mostly by naturalized annual grasses. Generally, its composition in the Plan Area varies with geographic, and land use factors, such as rainfall, temperature, elevation, slope, aspect, grazing, and other herbivory (e.g., livestock, wildlife, rodent, songbird, and insect use), and fire frequency and duration. In the Plan Area, Valley Grassland is dominated by naturalized herbaceous annual forbs, and patches with relatively high proportions of native grasses and forbs.

Valley Grassland in the Plan Area is associated with several natural communities, including vernal pools, and occurs as an understory within Valley Oak Riparian Woodland, Blue Oak Woodland, and Blue Oak Savanna. Valley Grassland also may occur as a co-dominant with perennial grasses within some of the areas mapped as Valley Grassland in the Plan Area. For example, purple needlegrass (*Stipa pulchra*) can be found as the dominant grass (i.e., comprising greater than 20% cover) in small patches along ridgetops of low-lying hills in the eastern portion of Sacramento County.

Valley Grassland supports numerous wildlife species, including several Covered Species. Covered Species associated with Valley Grassland included California tiger salamander, western spadefoot giant gartersnake, western pond turtle, all of the bird Covered Species (except Cooper's hawk), American badger, and western red bat (Table 3-2).

As part of the Vernal Pool Ecosystem mapping unit, Valley Grassland also supports wetland-dependent species (vernal pool crustaceans and plants) by maintaining and moderating hydrology for wetlands that they occupy.

Cropland Land Cover (Row and Field Crops)

Cropland is concentrated in the western part of the Plan Area in the Sacramento River and Cosumnes River floodplains. Cropland includes annual row and field crops (e.g., small grains, corn, tomatoes, melons, peppers, safflower, sunflower) and short-term perennial crops (e.g., asparagus). Rice is a row crop grown in Sacramento County, but seldom in the Plan Area. Small fields of rice have recently been planted on the existing Cosumnes River Preserve.

An important ecological function of Cropland in the Plan Area is to provide rodent and insect prey and plant material forage for a number of the bird Covered Species. Small rodents are important prey for raptors, such as Swainson's hawks, white-tailed kite, and Cooper's hawk. Western burrowing owls consume a mix of small rodents, arthropods, and other small animals. Loggerhead shrikes primarily prey on ground-dwelling insects but also take small rodents. Swainson's hawks switch to a diet of insects after the breeding season. Greater sandhill crane is a winter visitor that forages for seeds and small animals, and tricolored blackbird forages on invertebrates during the nesting season and plant material during the non-nesting season (Table 3-2).

Irrigated Pasture-Grassland Land Cover

Irrigated Pasture-Grassland is scattered throughout much of the Plan Area in relatively small patches. Irrigated Pasture-Grassland is fairly common, but occurs in a scattered distribution generally in the central portion of the Plan Area. The Irrigated Pasture-Grassland land cover includes hay production (alfalfa, clovers, and mixed grasses), seasonal summer pasture for livestock (primarily cattle), and year-round pasture for livestock (primarily cattle or horses). Seasonal pasture appears to be the most common use. Irrigated Pasture-Grassland is typically seeded, cut/grazed, and reseeded on a regular basis on an approximately 5- to 7-year cycle before the fields are left fallow to rest, and the cycle is started over again.

Within the Irrigated Pasture-Grassland land cover type, alfalfa fields provide by far the most productive foraging habitat for raptors and are used by other Covered Species, such as greater sandhill crane, and tricolored blackbird (Table 3-2). As a perennial crop grown for several years before removal and replacement, alfalfa provides good cover for rodents and time for establishment of a good prey base. Farming operations during the growing season consist of periodic flood irrigation and four to six mowings. Both types of operations result in temporary increases in prey availability.

Many of the Covered Species that use Cropland also use Irrigated Pasture-Grassland. Pasture is suitable tricolored blackbird foraging habitat if it is within two miles of a colony nesting site. Greater sandhill cranes use Irrigated Pasture-Grassland for roosting and foraging (Table 3-2).

Orchard Land Cover (Fruit and Nut Orchards)

Orchards are scattered throughout the Plan Area, with the largest concentration along the western boundary of the Plan Area. The Orchard land cover has limited wildlife habitat value (Table 3-2), but provides perches for raptors foraging in adjacent Cropland and Valley Grassland. In particular, larger nut trees and other trees at these edge areas may be used by "sight predators" such as Swainson's hawk for perches to find prey in adjacent fields. Western red bat is known to roost in orchards, including apricot, peach, pear, almond, walnut, and orange trees (Constantine 1959; Pierson et al. 2006) (Table 3-2).

Vineyard Land Cover

Vineyard land cover is located mostly in the southern portion of the Plan Area outside of the UDA. In Sacramento County, vineyards are primarily established for wine grape production, with some minor table grape producers. Vineyards are primarily "clean cultivated," meaning no other vegetation is allowed to grow between the rows or on the edges of fields and irrigation ditches. As such, vineyards typically provide only limited habitat for native plants and wildlife (Table 3-2). However, vineyards using "environmentally friendly" management practices may provide habitat value through use of bat boxes, raptor perches, and owl boxes to encourage presence of these species and reduce insect and predation damage.

Blue Oak Woodland Land Cover and Blue Oak Savanna Land Cover

Blue Oak Woodland and Blue Oak Savanna comprise approximately 5% of the Plan Area, a majority of which is located in the far eastern portion of the Plan Area.

Blue oaks are typically drought-tolerant, and unlike interior live oaks, are deciduous, dropping their leaves during periods of extreme moisture stress. This survival trait may explain the observed patterns of blue oak distribution, with blue oaks occupying drier, shallower, and well-drained soils than interior live oaks or valley oaks (McDonald 1985).

In general, the SSHCP differentiated and mapped Blue Oak Woodland land cover and Blue Oak Woodland Savanna by their tree-cover densities.

Blue Oak Woodland is characterized by greater than 10% tree cover formed primarily by blue oak with other foothill tree species mixed in. Blue Oak Woodland generally has a sparse shrub layer and well-developed Valley Grassland layer, sometimes including vernal pools and other wetland features. Other tree species that may occur in Blue Oak Woodland include foothill pine (*Pinus sabiniana*), interior live oak (*Quercus wislizenii*), valley oak (*Quercus lobata*), and California buckeye (*Aesculus californica*). The shrub layer, where present, only includes scattered individuals of poison oak (*Toxicodendron diversilobum*), and coyote brush (*Baccharis pilularis*). Blue Oak Woodland often has a relatively open canopy, when compared to the riparian land covers present in the Plan Area.

Blue Oak Savanna land cover type is characterized by a sparse (less than 10%) tree canopy structure that ranges from scattered blue oak trees and small clusters of blue oaks, to small areas of blue oak stands. Like Blue Oak Woodland, it generally has little to no shrub layer, but has a well-developed Valley Grassland layer. Blue Oak Savanna is typically transitional between Valley Grassland and Blue Oak Woodland.

Oak Woodland and Savanna provide important cover, nesting, and roosting sites for native bird species, as well as caching sites for acorn storage, for a variety of birds, mammals, and other native species. Covered Species that use Blue Oak Woodland and/or Savanna include American badger, western red bat, Cooper's hawk, western burrowing owl, and white-tailed kite. Where suitable aquatic land cover occurs in association with Blue Oak Woodland and Blue Oak Savanna land cover, California tiger salamander, western spadefoot, and western pond turtle may also occur. Old, large oak trees are of particular habitat value, providing an array of living and dead branches as sites for woodpeckers to excavate cavities and for insect-eaters to forage for larvae and adult insects. Dead branches and trunks are critically important for cavity nesting birds, for mammals as storage sites for acorns, and as perches for sight-dependent predators, such as raptors (Gutierrez and Koenig 1978). The fallen logs of dead oaks provide sustenance and cover for arthropods, fungi, and wildlife, and may potentially extend activity periods for these species in drier climates by retaining soil moisture and providing shade (Giusti et al. 2004).Oak trees produce a critically important food crop, acorns. Acorn production is typically episodic, some years with copious acorn production and other years with minimal acorn production. High yield acorn years appear critical in triggering pulses in invertebrate and vertebrate population sizes (McShea and Rappole 2000; McShea and Schwede 1993). Blue Oak Woodland and Blue Oak Savanna provide different habitat functions for some of the Covered Species. For example, western burrowing owl and American badger may occur in the open savannas but not denser woodlands. White-tailed kites may nest in woodlands and forage in savannas.

Aqueduct Land Cover

The aqueduct land cover type in the Plan Area is represented by the Folsom South Canal.

Disturbed Land Cover

The disturbed land cover type is defined as open-space areas that have been subject to previous or ongoing disturbances such as along roadsides, trails, and parking lots. Scraped or graded land, gravel mining, and waste disposal sites are included in this land cover type. Disturbed land cover type is vegetated with diverse weedy flora. These areas are of special concern as they tend to harbor and facilitate the spread of invasive plant species. Vascular plant species associated with the disturbed land cover typically include Johnson grass, Canadian horseweed (*Conyza canadensis*), milk thistle (*Silybum marianum*), yellow-star thistle (*Centaurea solstitialis*), stinkwort (*Dittrichia graveolens*) and field bindweed (*Convolvulus arvensis*).

High-Density Development Land Cover

The high-density development land cover type includes urban and suburban residential neighborhoods, urban centers, industrial areas, airports, and wastewater treatment plants. Most of this high-density development occurs in the SSHCP UDA in the northwestern portion of the Plan Area.

Low-Density Development Land Cover

The low-density development land cover type consists of relatively sparse residences and other structures, such as farm buildings, and small rural neighborhoods with large individual property sizes per house. Plant nurseries are also included in this category. While the majority of low-density development occurs outside of the UDA, it is found throughout the Plan Area.

Major Roads Land Cover

The major roads land cover type includes linear features with paved surfaces and can vary from large freeways to smaller arterial roads found within urban settings. Smaller roads not mapped as Major Roads were mapped as an element of High-Density or Low-Density Development.

Mine Tailings Land Cover

Mine Tailings Land Cover is defined by the large tailing piles that rise significantly above the surrounding landscape as a result of gold dredging occurring in the early 1900s through approximately 1960. The large tailing piles are composed almost entirely of rounded river rock that was excavated from ancient riverbeds. Most of the mine tailings are associated with historic gold mining are located in the northeastern portion of the Plan Area. Smaller outcroppings of tailings in are often the result of current and recent gravel mining activities. The mine tailings are unvegetated; the SSHCP mapped any woody vegetation observed between tailings piles as the Mine Tailing Riparian Woodland land cover type (see Section 3.2.1).

Recreation/Landscaped Land Cover

The recreation/landscaped land cover type includes gardens, parks, golf courses, off-highway vehicle (OHV) parks, and greenbelts. Most landscaped and recreation areas are planted with non-native grasses, shrubs, and trees. Species composition in urban habitats varies with planting design and climate. Monoculture is commonly observed in tree groves and street tree strips. For example, many of the windbreaks in south Sacramento County are planted with pure stands of eucalyptus, olive (*Olea europaea*) trees, or other hardwoods. Most recreation and landscaped areas are regularly maintained by irrigation, mowing, pruning, or other management techniques.

Not Mapped

There is a small section of the Plan Area along the Sacramento River that was not mapped. This area was not mapped as it is in-between the river side toe of a levee and the center of the river.

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APPENDIX E2

Vernal Pool Watershed Mapping

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MEMORANDUM

To:	U.S. Fish and Wildlife Service
From:	Tyler Friesen, Dudek
Subject:	SSHCP Vernal Pool Watershed Analysis Using LIDAR Data
Date:	February 6, 2014
cc:	Sherri Miller, Terry Adelsbach, Richard Radmacher, Bill Ziebron
Attachment(s):	Figures 1–4; Attachment A, ArcGIS Glossary

LIDAR OVERVIEW – FROM ARCGIS ONLINE RESOURCE CENTER

What Is LIDAR?

Light detection and ranging (LIDAR) is an optical remote-sensing technique that uses laser light to densely sample the surface of the Earth, producing highly accurate x, y, z measurements. LIDAR, primarily used in airborne laser mapping applications, is emerging as a cost-effective alternative to traditional surveying techniques such as photogrammetry. LIDAR produces mass point cloud datasets that can be managed, visualized, analyzed, and shared using ArcGIS.

The major hardware components of a LIDAR system include a collection vehicle (aircraft, helicopter, vehicle, and tripod), laser scanner system, Global Positioning System (GPS) , and inertial navigation system (INS). An INS system measures roll, pitch, and heading of the LIDAR system.

LIDAR is an active optical sensor that transmits laser beams toward a target while moving through specific survey routes. The reflection of the laser from the target is detected and analyzed by receivers in the LIDAR sensor. These receivers record the precise time from when the laser pulse left the system to when it is returned to calculate the range distance between the sensor and the target. Combined with the positional information (GPS and INS), these distance measurements are transformed to measurements of actual three-dimensional points of the reflective target in object space.

LIDAR Laser Returns

Laser pulses emitted from a LIDAR system reflect from objects both on and above the ground surface: for instance, vegetation, buildings, and bridges. One emitted laser pulse can return to the LIDAR sensor as one or many returns. Any emitted laser pulse that encounters multiple reflection surfaces as it travels toward the ground is split into as many returns as there are reflective surfaces.

The first returned laser pulse is the most significant return and will be associated with the highest feature in the landscape like a treetop or the top of a building. The first return can also represent the ground, in which case only one return will be detected by the LIDAR system.

Multiple returns are capable of detecting the elevations of several objects within the laser footprint of an outgoing laser pulse. The intermediate returns, in general, are used for vegetation structure, and the last return for bare-earth terrain models.

Post-Processing LIDAR Data

The point data is post-processed after the LIDAR data collection survey into highly accurate geo-referenced x, y, z coordinates by analyzing the laser time range, laser scan angle, GPS position, and INS information. Additional information is stored along with every x, y, and z positional value. The following LIDAR point attributes are maintained for each laser pulse recorded: intensity, return number, number of returns, point classification values, points that are at the edge of the flight line, RGB (red, green, and blue) values, GPS time, scan angle, and scan direction. These data are typically stored as LAS files. LAS is an industry format created and maintained by the American Society for Photogrammetry and Remote Sensing. LAS is a published standard file format for the interchange of LIDAR data. It maintains specific information related to LIDAR data. It is a way for vendors and clients to interchange data and maintain all information specific to that data.

LIDAR Point Classification

Every LIDAR point can have a classification assigned to it that defines the type of object that has reflected the laser pulse. LIDAR points can be classified into a number of categories including bare earth or ground, top of canopy, and water. The different classes are defined using numeric integer codes in the LAS files.

SSHCP VERNAL POOL WATERSHED ANALYSIS USING LIDAR DATA

Purpose: To identify individual vernal pool watershed boundaries in order to assess potential direct and indirect impacts to aquatic resources contained in existing and planned preserves within the South Sacramento Habitat Conservation Plan (SSHCP) Urban Development Area (UDA).

This analysis uses a similar approach implemented by ECORP Environmental Consulting, conducted for the Cordova Hills development in 2007.

Process

1. Acquire high resolution classified LIDAR data
2. Develop a Digital Terrain Model (DTM) of the UDA
3. Utilize industry standard hydrologic assessment tools to determine hydrologic characteristics of the UDA
4. Divide UDA into sub-areas to facilitate a faster model run time
5. Identify hydrologic boundaries between individual vernal pool features and their watersheds.

Acquire High-Resolution Classified LIDAR Data

LIDAR surveys were conducted for Sacramento County during 2004 and 2007. The County of Sacramento provided Dudek with classified LIDAR data from these surveys. Figure 1 shows the extent of these surveys in relation to the SSHCP plan area boundary and the UDA.

Develop a DTM of the UDA

Using LAS files from both the 2004 and 2007 surveys, Dudek selected all the LAS files that fell within 1,000 feet for the UDA. The distance of 1,000 feet was chosen to incorporate vernal pool feature watersheds that may extend beyond the UDA boundary. Dudek then created a master LAS dataset filtering the classified LAS files to isolate only bare earth returns. These bare earth points were converted in ArcGIS into a raster dataset using 5-foot by 5-foot cell sizes (see Attachment A for a description of raster datasets). A cell size of 5 feet by 5 feet was chosen to capture the maximum amount of vernal pool features with the least amount of interpolation of the LIDAR data. Dudek then created a hydrologically corrected model by filling all sinks in the resulting raster (see Attachment A for a description of the ArcGIS Fill tool). The final product was a hydrologically corrected DTM of the UDA.

Utilize Industry Standard Hydrologic Assessment Tools to Determine Hydrologic Characteristics of the UDA

In order to identify watersheds from the hydrologically corrected DTM, the direction of flow across the DTM was assessed using the flow direction tool in ArcGIS (see Attachment A for a description of the ArcGIS flow direction tool). The result was a master flow direction raster dataset of the UDA. By assessing direction of flow, it is possible to identify the boundaries between watershed (ridges) using previously mapped vernal pool features as pour points.

Divide UDA into Sub-Areas to Facilitate a Faster Model Run Time

The UDA was broken into seven sub areas to facilitate a faster run time of the model. These sub-areas were defined by the boundaries of planned preserves and the entire project boundary of the five major development projects currently proposed within the UDA. These areas are defined as follows:

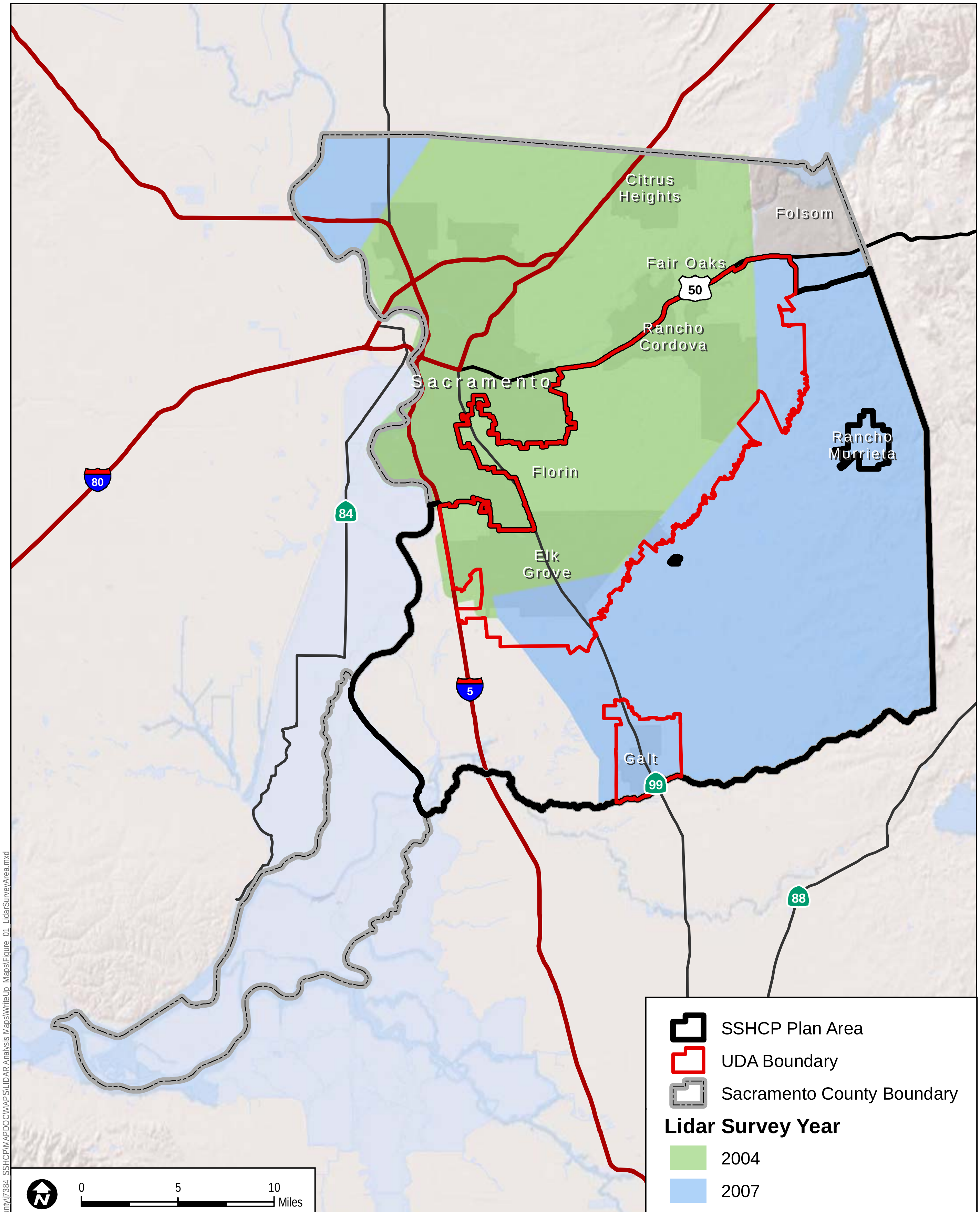
1. Cordova Hills development and adjacent planned preserves
2. Jackson and Newbridge developments and adjacent planned preserves
3. Sun Creek and Arboretum development and adjacent planned preserves
4. Regional Planning Unit (RPU) 1 planned preserves not captured in the above sub-areas
5. RPU 3 planned preserves not captured in the above sub-areas
6. The western portion of Laguna Creek Wildlife Corridor and adjacent planned preserves not captured in the above sub-areas
7. RPU 4 planned preserves not captured in the above sub-areas.

See Figure 2 for a map showing the sub-areas.

All vernal pool features within the boundaries and up to 250 feet outside of these boundaries were analyzed. The flow direction raster was then clipped to within 1 mile of the above 250-foot buffered area. One mile was chosen to analyze vernal pool feature watersheds under the assumption that it would be difficult to near impossible for stakeholders to adjust existing planned conservation boundaries more than 1 mile in order to protect the watershed from indirect effects. See Figure 3 for an example of these areas.

Identify Hydrologic Boundaries Between Individual Vernal Pool Features and Their Watersheds

Once a master flow-direction raster dataset was established, the watershed of each individual vernal pool feature could be determined using the ArcGIS watershed tool (see Attachment A for a description of the ArcGIS watershed tool). Each vernal pool feature from the SSHCP land cover database was converted into its own raster dataset using the same cell size (5 feet by 5 feet) as the input flow direction, using a numeric code as the unique identifier. These data were used as the pour point inputs in the watershed tool. A pour point is defined as the cells above which the contributing area, or catchment, will be determined. A custom script was written using Python programming language to analyze the individual watershed of each pour point feature. The output of this analysis was a raster dataset identifying the contributing area for each vernal pool feature. Each of these raster datasets were converted into polygons and combined to create a master watershed file for each of the sub-areas. With these datasets it is possible to identify the watershed of any given vernal pool feature and all contributing vernal pool watershed (see Figure 4 for an example).



DUDEK

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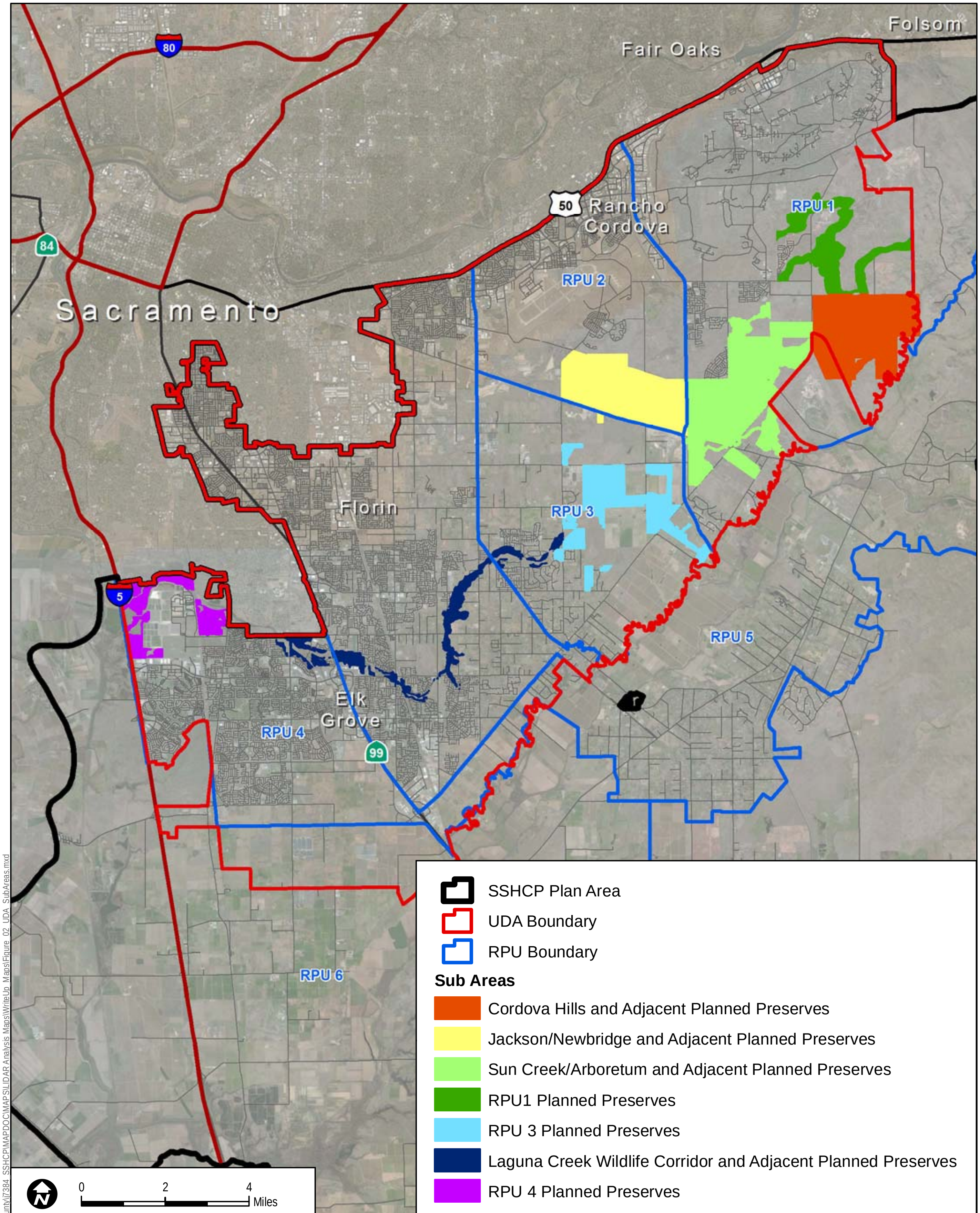
SOURCE: County of Sacramento 2013

FIGURE 1

Sacramento County Lidar Survey Areas

SOUTH SACRAMENTO COUNTY HABITAT CONSERVATION PLAN

Path: Z:\Projects\Sacramento_County\j7384_SSHCP\MAPDOC\MAPS\LIDAR Analysis Maps\WriteUp_Maps\Figure_01_LidarSurveyArea.mxd



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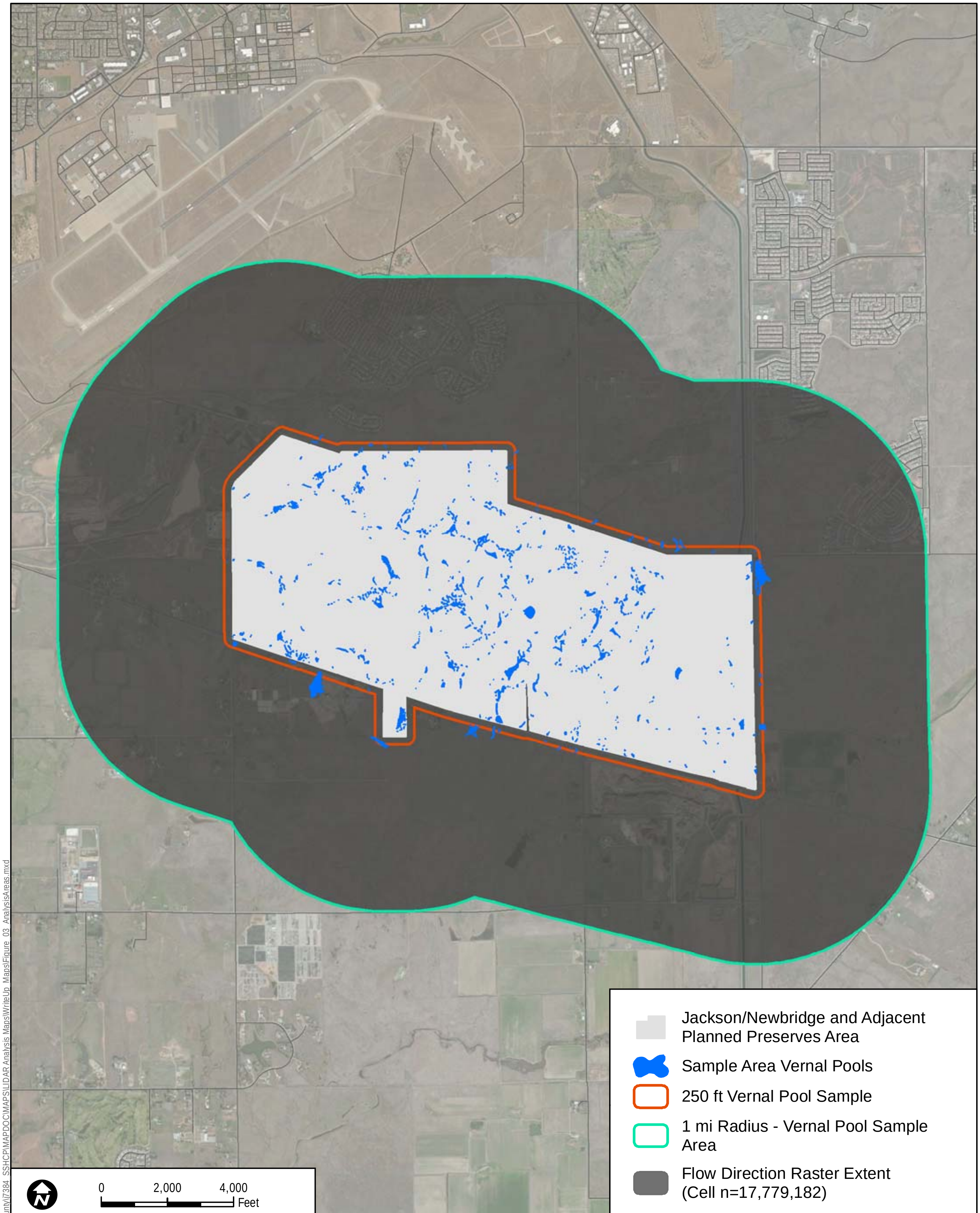
SOURCE: County of Sacramento 2013

FIGURE 2

Study Sub Areas

SOUTH SACRAMENTO COUNTY HABITAT CONSERVATION PLAN



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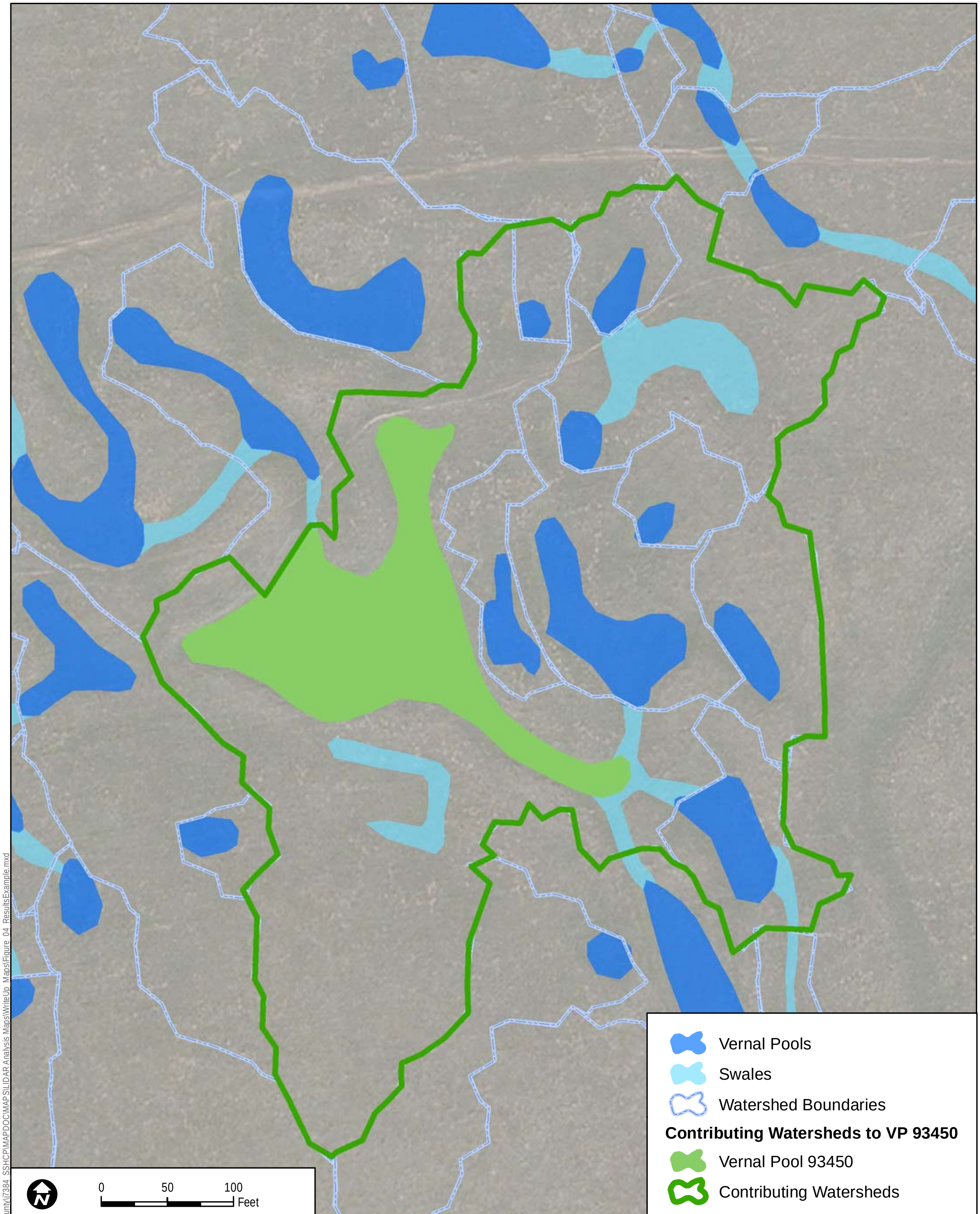
SOURCE: County of Sacramento 2013

FIGURE 3
Watershed Analysis Areas - Jackson and Newbridge Developments and Adjacent Planned Preserves

SOUTH SACRAMENTO COUNTY HABITAT CONSERVATION PLAN

Path: Z:\Projects\Sacramento_County\7384_SSHCP\MAPDOC\MAPS\LIDAR Analysis Maps\WriteUp_Maps\Figure_03_AnalysisAreas.mxd



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SOURCE:Bing 2014, County of Sacramento 2013

FIGURE 4

Watershed Contribution Areas for Vernal Pool 93450

SOUTH SACRAMENTO COUNTY HABITAT CONSERVATION PLAN

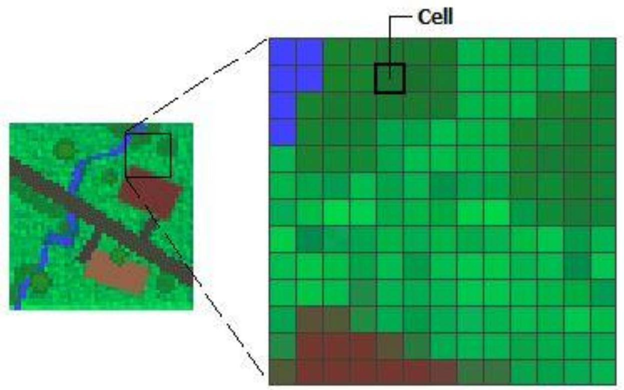
ATTACHMENT A

ArcGIS Glossary

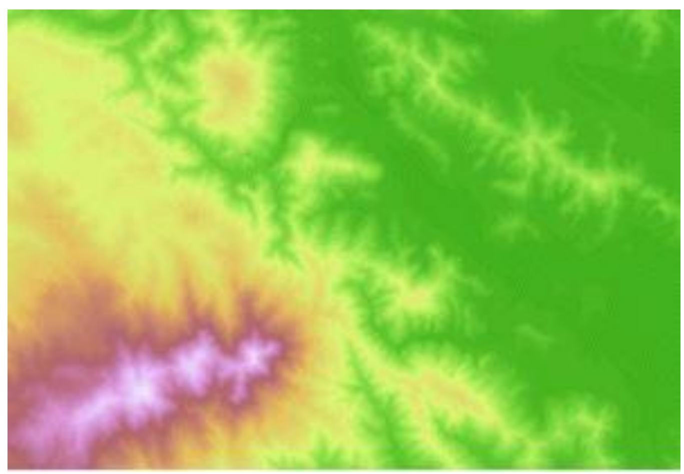
ATTACHMENT A
ArcGIS Glossary

All descriptions are adapted or copied directly from the ArcGIS Online Resource Center.

RASTER DATA



In its simplest form, a raster consists of a matrix of cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information, such as elevation. Rasters are digital aerial photographs, imagery from satellites, digital pictures, or even scanned maps.



Rasters are well suited for representing data that changes continuously across a landscape (surface). They provide an effective method of storing the continuity as a surface. They also provide a regularly spaced representation of surfaces. Elevation values measured from the earth's surface are the most common application of surface maps, but other values, such as rainfall, concentration, and density, can also define surfaces that can be spatially analyzed. The raster below displays elevation—using green to show lower elevation and red, pink, and white cells to show higher elevations.

For more information on raster data please visit this link. http://resources.arcgis.com/en/help/main/10.2/index.html#//009t00000002000000.

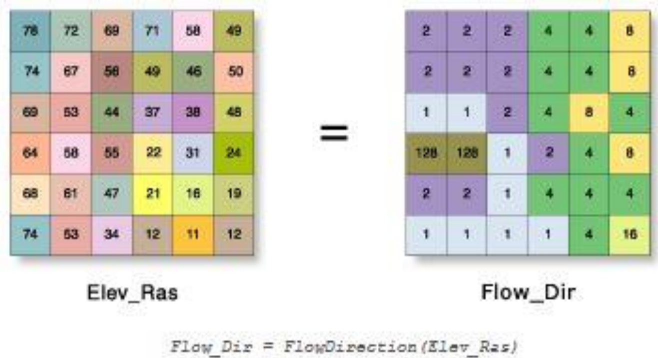
FILL (SPATIAL ANALYST)

Summary: Fills sink in a surface raster to remove small imperfections in the data.

Usage: A sink is a cell with an undefined drainage direction; no cells surrounding it are lower. The pour point is the boundary cell with the lowest elevation for the contributing area of a sink. If the sink were filled with water, this is the point where water would pour out. The output surface raster will have all sinks filled to the limit of the pour point.

FLOW DIRECTION (SPATIAL ANALYST)

Summary: Creates a raster of flow direction for each cell to its steepest downslope neighbor.



Usage:

- The output of the Flow Direction tool is an integer raster whose values range from 1 to 255. The values for each direction from the center are:

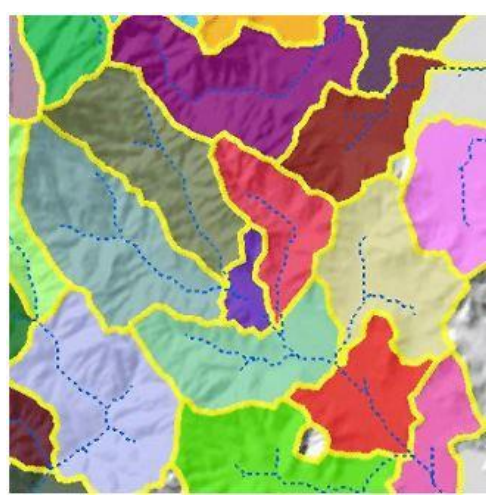
32	64	128
16		1
8	4	2

For example if the direction of the steepest drop was to the left of the current processing cell, its flow direction would be coded as 16.

- If a cell has the same change in z-value in multiple directions and is not part of a sink, the flow direction is assigned with a lookup table defining the most likely direction.
- A cell at the edge of the surface raster will flow toward the inner cell with the steepest drop in z-value. If the drop is less than or equal to zero, the cell will flow out of the surface raster.

WATERSHED (SPATIAL ANALYST)

Summary: Determines the contributing area above a set of cells in a Raster.



Delineating Watersheds: Watersheds can be delineated from a DEM by computing the flow direction and using it in the watershed tool.

To determine the contributing area, a raster representing the direction of flow must first be created with the Flow Direction tool.

You will then need to provide the locations you wish to determine the catchment area for. Source locations may be features, such as vernal pools, dams, or stream gauges, for which you want to determine characteristics of the contributing area. The output is a raster of the watersheds.

The above example shows the result when multiple pour points are defined in the analysis. Because the goal of the SSHCP analysis was to identify the entire vernal pool watersheds independent of all other vernal pool features watersheds were calculated individually with each vernal pool feature as its own pour point resulting in as many runs of the watershed tool as there were vernal pools.

The value of each watershed was taken from the value of the feature pour point data. In the case of the vernal pool watershed analysis the resulting watersheds were coded with the unique vernal pool ID number it corresponds to.

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APPENDIX F

Preserve Documentation Report Template

APPENDIX F
Preserve Documentation Report Template

F.1 Introduction

F.1.1 Purpose

To provide an accurate representation of the physical and biological conditions of the property. The report should provide a description of the general setting, presence and condition of existing improvements, developments and other man-made features, and major biological components and natural resource conservation values associated with the property.

F.1.2 Methods

Data collection methods may include field surveys utilizing Global Positioning System and Geographic Information System resources, aerial photograph interpretation, and queries of existing databases.

F.2 Property Location and Existing Setting

F.2.1 Location of Property

Provide a detailed description of the property location using Township, Range, and Section number(s) from 7.5 minute USGS Topographical Quadrangle maps, as well as approximate distances of boundary lines from Section lines and local landmarks.

F.2.2 Existing Setting

Describe climate and the properties topography, hydrological features, geology, and soil types.

F.2.3 Land Use

Describe the property’s current and historical land uses.

F.2.4 Surrounding Land Uses

Describe the land uses in the immediate vicinity of the property.

F.3 Physical Condition of the Property

Document the location of physical features on the property.

F.3.1 Roads and Utility Lines

F.3.2 Fences, Rock Walls, and Gates

F.3.3 Developed Water Features including Canals, Irrigation Ditches, and Wells

F.3.4 Developed Structures Including Residential Homes, Barns and Other Outbuildings

F.3.5 Miscellaneous Features

F.4 Biological Setting and Condition of the Property

Describe the major terrestrial and aquatic biological communities present on the property. Summarize the conservation value of the preserve and list the special status species that have the potential to occur on the property.

F.4.1 Conservation Values of the Preserve

F.4.2 Terrestrial Communities

F.4.3 Aquatic Communities

F.4.4 Special Status Plant Species

F.4.5 Special Status Reptiles, Amphibians, and Insects

F.4.6 Special Status Fish

F.4.7 Special Status Birds (Non-Raptor)

F.4.8 Special Status Birds (Raptors)

F.4.9 Special Status Mammals

F.4.10 Non-Native Plant Species and Noxious Weeds

F.4.11 Invasive Species and Noxious Weeds

Describe any infestations of invasive species or noxious weeds found on the property and any sign of invasive species or noxious weeds on properties that are immediately adjacent to the property. Identify species and quantify the area impacted by invasive plants or noxious weeds and provide a map depicting exact locations.

F.4.12 Invasive Plants and Noxious Weeds

F.4.13 Invasive Animal Species

F.5 Preparers of Report

List names, addresses, and phone numbers for all preparers.

F.6 Literature Cited

List references and any personal communications that were used in compiling the report

F.7 List of Appendices

Appendix 1- Map Depicting Regional Vicinity

Appendix 2- Map Depicting Property Boundary

Appendix 3- Map Depicting Physical Features Found on the Property

Appendix 4- Map Depicting Location of Soils Units

Appendix 5- Map Depicting Locations of Bio-communities and Species Locations

Appendix 6- Map Depicting Locations of Invasive Species and Noxious Weeds

Appendix 7- Photo Point Locations

Appendix 8- Easement Documentation Photographs

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APPENDIX G

Preserve Management and Monitoring Details

APPENDIX G1

Vernal Pool Monitoring Protocols

APPENDIX G1
Vernal Pool Monitoring Protocols

G1.1 Vernal Pool Monitoring

Long-term monitoring within the South Sacramento Habitat Conservation Program (SSHCP) plan area will provide valuable information on the success of vernal pool conservation. Regional plan area-wide monitoring (monitoring at a landscape scale) is critical for management, including management effectiveness monitoring to evaluate the response of the ecosystem to different management actions. It is critical for understanding (a) status and trends (b) impacts of any management actions and (c) to determine when there is a need for adaptive management. While all management actions should be monitored to some extent, adaptive management is generally the process of experimentally testing the effectiveness and/or feasibility of different management alternatives where the outcome of the management is uncertain (e.g., Williams et al. 2012).

The appropriate sampling design, including survey methods designed to collect large-scale data, is important in designing meaningful monitoring programs. Monitoring and management programs must be approached with attention to:

- appropriateness of selected response variables (e.g., reduction of thatch, water quality, etc.)
- temporal/spatial scales of measurement (i.e., over what time period and where),
- frequency/timing of measurements (e.g., how often and relation to conditions such as rainfall),
- precision and accuracy of measurements,
- ability to detect a change if it happens, and
- fiscal responsibility.

Regional or plan area-wide monitoring must be designed to obtain a statistically rigorous sample that, over time, will result in the ability to monitor the status of the vernal pool in the SSHCP plan area and determine whether the habitat is being adequately conserved by the plan.

G1.1.1 Vernal Pool Habitat Monitoring Goals

VP Monitoring Goal 1: Develop and implement a standardized formal monitoring program that collects data in sufficient detail to evaluate the health of vernal pools.

VP Monitoring Goal 2: Use results of standardized formal monitoring programs to develop adaptive management protocols, identify triggers for adaptive management, and develop pilot studies to fill data gaps and address uncertainties related to adaptive management.

G1.1.1.1 Vernal Pool Plan Area Wide Habitat Conservation

Vernal pools occur in throughout the SSHCP Plan Area. Conservation of the habitat within the Urban Development Area (UDA) is important because it is believed that the highest concentrations of a number of vernal pool species, including vernal pool tadpole shrimp (*Lepidurus packardi*), Sacramento Orcutt grass (*Orcuttia viscida*), and slender Orcutt grass (*O. tenuis*), are located in vernal pools inside the UDA. Conservation of vernal pools outside the UDA is also important because it is the intent of the SSHCP to preserve a wide range of vernal pools over a geographically diverse area. Further, some vernal pool species are either only known from areas outside the UDA, such as California tiger salamander (*Ambystoma californiense*) or most documented occurrences for some species are outside the UDA, including pincushion navarretia (*Navarretia myersii* ssp. *myersii*), vernal pool fairy shrimp (*Branchinecta lynchi*), Ricksecker's water scavenger beetle (*Hydrochara rickseckeri*), and western spadefoot (*Spea hammondii*).

Conservation goals and objectives are found in the conservation strategy for the vernal pools (Chapter 7, Table 7-2). The monitoring protocol intends to monitor the overall Plan's success and whether and how the Plan meets its conservation goals and objectives. The broad SSHCP conservation goal and objectives for vernal pools that will be achieved by the Plan are listed in Table G1-1.

Table G1-1
Vernal Wetlands Biological Goals and Objectives

Overall Biological Goal	Vernal Pool Biological Objectives
Goal 3. Ensure the persistence of each covered species within the Plan Area by preserving, restoring, and creating SSHCP terrestrial and aquatic landcovers throughout the Plan Area to provide suitable breeding, feeding, and/or sheltering habitat for each species minimize habitat fragmentation, and provide habitat connectivity that allows individuals to move and disperse throughout the preserve system.	**Objective VGVP1.** Preserve a minimum of x acres of valley grassland – vernal pool landcover with a minimum of x acres of vernal pools. Up to x acres of vernal pools will be preserved if all estimated impacts occur. The Implementing Entity will prioritize preservation of valley grassland – vernal pool land cover based on the preserve assembly criteria.
	Objective VGVP2. Preserve and maintain enough of the watershed of preserved vernal pools, to maintain the vernal pools' existing hydrological regime and biological functions. This would include a minimum 50-foot setback and a 50-foot buffer at the outer perimeter of each vernal pool preserve within the UDA.
	Objective VP1. Preserve a minimum of x acres of vernal pools within or adjacent to (within one mile of) the Mather Core Area and/or the Cosumnes Rancho Seco Core Area. Up to x acres of vernal pools will be preserved if all estimated impacts occur. Mitigation for vernal pools impacted within a vernal pool Core Recovery Area will occur within or adjacent to a vernal pool core recover area (adjacent is defined as up to one mile from the recovery core area). The Implementing Entity will assure that at least x-acres of vernal pools are preserved within the Mather Core Area, and at least x-acres of vernal pool are preserved within the Cosumnes/Rancho Seco Core Recovery Area.
	Objective VP2. Restore or create a minimum of x acres of vernal pools within or adjacent to (within one mile of) the Mather Core Area and/or the Cosumnes Rancho Seco Core Area. Up to x acres of vernal pools will be restored and/or created if all estimated impacts occur. At least 50 acres will be restored or created within or adjacent to the Mather Core Area.

G1.1.2 Monitoring Questions

Success in meeting the overall conservation goal and objectives listed in Table G1-1 will be determined through monitoring and addressing the following primary questions related to the SSHCP operating conservation strategy for vernal pools:

- What is the historical and current distribution of vernal pools within the SSHCP planning area?
- How many acres of vernal pools (natural and restored and/or created) are preserved, and what is their distribution in the SSHCP Preserve System?
- How stable is vernal pool habitat in the SSHCP Preserve System?
- To what extent do anthropogenic activities threaten vernal pools, and specifically what type of SSHCP covered activities pose the greatest threat?
- To what extent do SSHCP covered activities-related development and altered hydrology in the vernal pool watershed affect the long-term viability of vernal pools in the SSHCP Preserve System?
- Are and what invasive species are impacting vernal pools in the SSHCP Preserve System?
- How successful are vernal pool mitigation sites (natural vs. restored and/or created pools) in the SSHCP Preserve System?
- How is climate change affecting vernal pool ecology in the SSHCP Preserve System?

In addition, the following secondary adaptive management and mitigation questions will also be answered:

- What are the best sites for restoring and/or creating vernal pools in the SSHCP Preserve System?
- What vernal pool restoration and/or creation methods are most successful in re-establishing vernal pools in the SSHCP Preserve System?
- What vernal pool management techniques are most successful in maintaining sustainable vernal pools in the SSHCP Preserve System?

G1.1.3 Monitoring Design

G1.1.3.1 Baseline Survey

There is already considerable baseline information for vernal pools in the SSHCP planning area, including within existing (e.g., South Mather) and planned preservation areas (e.g., Sacramento County Department of Economic Development 2013; Appendices B-1 and B-2 of the Aquatic Resources Plan (ARP)). As news lands are considered for acquisition for the SSHCP Preserve System, they will be surveyed for vernal pool resources which will be mapped to establish to add to the existing baseline dataset. Sites considered for acquisition will be evaluated using several criteria:

- Potential to support vernal pool covered species;
- Supports high density vernal pool complexes;
- Contains large or deep vernal pools;
- Adjacent to currently preserved lands; and
- Located on parcels 20 acres or greater in size and/or occur in larger, open space areas.

While many of the vernal pools in the SSHCP plan area have already been identified (e.g., Sacramento County Department of Economic Development 2013; Appendices B-1 and B-2 of the ARP), it is likely that some have been missed, that new pools have been created, and that some s have been lost since the last vernal pool mapping effort. New initial comprehensive baseline surveys on candidate preserve sites should, to the extent feasible, include mapping of all vernal pools on site (using GPS/GIS technologies) during the wet season when pools are inundated. The surveys should assess habitat quality for both the vernal pool basin and the surrounding watershed.

Site Selection

Long-term monitoring of vernal pools will be conducted in the Preserve System with a sample size of vernal pools large enough to detect trends in important response variables that reflect vernal pool ecological functions (e.g., hydroperiod, occupation by covered species, etc.). Sample sites (or macro-plots) will be selected using stratified random sampling or pseudo-random sampling to ensure a representative set of sample sites. Sampling factors may include geomorphology, soil types, topography, vegetation communities, and proximity to development edges. Sample size will be increased as preserves are added to the system.

The appropriate sample size for each preserve site will be determined as part of the individual management plan for each preserve. The minimum sample size should be based on factors such as the size of the preserve, the number of vernal pool features, the heterogeneity of the preserve (e.g., different soil types or topographic features of the site), and adjacent land uses, and must take into account periodic sampling variability related to annual weather patterns such as drought and El Nino events.

Within each macro-plot, 3 or 4 vernal pools will be selected for long term-monitoring, as described in Section 1.4.

Monitoring Schedule

Monitoring visits should be scheduled consistently to collect compatible and comparable data over time. However, generally it is desirable to collect substantial baseline data in the first few years of a monitoring program to establish the variability of a system. Because vernal pool ecology is strongly tied to annual precipitation, monitoring should attempt to establish baseline conditions through at least one wet-dry cycle. Initially for the first six to eight years, monitoring plots should be visited annually during the wet season to collect baseline data for annual variability. Thereafter monitoring frequency likely could be reduced, such as not more than every three years on average, but with the objective of sampling at least once during different precipitation conditions (i.e., dry, average, and wet) over an eight to ten year period.

The monitoring schedule should also reflect the response variable being monitored and measured. For example, general vegetation conditions in the vernal pool watershed may have relatively low variability and only change significantly over longer time scales, allowing for less frequent monitoring. However, if a site is vulnerable to invasion by fast-colonizing invasive species, more frequent monitoring may be needed.

Monitoring for hydrology will be conducted at least once during three periods within the same monitoring cycle. A monitoring cycle is defined as the wet season from October 16 to April 14 in a given year. The first survey should occur once following inundation (see discussion in Section 1.4). The second survey should occur mid-season once the first floating hydrophytes appear. The third survey should occur during the dry-down phase.

It is likely that new monitoring methods will be developed over time (e.g., automated monitoring for some response variables) and that data compiled and analyzed as part of the SSHCP will bring a better understanding of the effectiveness of current monitoring protocols, including adequate frequency and timing of surveys for the different response variables. As such monitoring schedules will be evaluated at the discretion of the SSHCP Implementing Entity with input from the Technical Advisory Committee (TAC) and modifications will be made when deemed necessary.

Monitoring will only occur on sites that are either controlled by the SSHCP implementing entity, where the implementing entity has a formal agreement such as a conservation easement or on sites owned by parties that agree to work cooperatively with the SSHCP implementing entity.

G1.1.4 Vernal Pool Habitat Monitoring

Goals for the vernal pool monitoring program include:

- Identify vernal pool habitat variables that are correlated with cover species distribution and abundance in the SSHCP Preserve System;
- Identify management actions to maintain or improve vernal pool habitat quality, including upland habitat/watershed and vernal pool basins, in the Preserve System; and
- Identify trends and circumstances in the Preserve System that require adaptive management responses.

Most habitat monitoring should occur concurrently with the wet season invertebrate sampling events. Sites should be surveyed after the first substantial storm event (rainfall greater than 0.15 inch) during the rainy season (October 16 - April 14) to determine whether and when pools have been inundated. According to U.S. Fish and Wildlife Service protocol, a pool is considered to be inundated when it holds greater than 3 cm (1.2 inches) of standing water 24 hours after a rain event. This initial assessment can occur at a representative reference set of vernal pools distributed throughout the Preserve System. After inundation status has been determined, selected pools within each macro-plot should be sampled at least three times during the wet season per monitoring cycle; the first sampling should be conducted approximately one month after inundation; the second sampling should be conducted when the first floating hydrophytes appear; and the third sampling should be conducted during the early stages of drying (but before the pool is completely dry).

Data to be collected in the permanent monitoring plots include:

- Pool location and surface area: the perimeter of each pool should be mapped using GPS technology with reasonable accuracy (e.g., currently 6” to 1’ with standard GPS units).[1]
- Water level: measure the deepest part of the pool using a depth staff permanently installed and secured in the deepest part of the pool.
- Water temperature
- Water quality/chemistry (e.g., alkalinity, conductivity, dissolved ammonium, turbidity, salinity, total dissolved solids, algal blooms): collect water samples using acid washed plastic bottles. Measure samples using a water quality meter and/or sent to a laboratory for analysis.
- Level of habitat disturbance: qualitatively note habitat disturbances including grazing, mowing, OHV activity, impediments, fragmentation, trash/debris etc.

[1] Professional land surveyors could map vernal pools with even greater precision, but 6” to 1’ in considered accurate enough for the vernal pool monitoring program.

- Plant species composition: qualitatively determine plant species composition (wetland and surrounding upland) at each monitoring pool, including dominant, sensitive, indicator and non-native species. Vernal pool tadpole shrimp, for example, are commonly found with plant species that require similar inundation periods (Mediterranean barley, toad rush, false dandelion, and Italian rye grass, coyote thistle, downingia, goldfields, spikerush, wooly-marbles, hair Grass, and aquatic buttercup). Several plant species have incompatible inundation cycles and thus may indicate a lower probability of tadpole shrimp occurrences (e.g., cattails, willow, cottonwood, duckweed, nut grass, Baltic rush, and bullrush).
- Qualitative habitat quality: establish at least two permanent vantage points per pool and take photographs from vantage points during each sampling event.

Because "plot fatigue" can occur when multiple visits are made to the same plot within the same survey season and year after year, surveys should include measure to reduce chronic disturbance. For example, during wet season surveys, disturbance during seining can be avoided by placing rocks to step on in the vernal pool basin.

To prevent cross-sample contamination, samples will be returned to the same pool from which they were retrieved. Also, because vernal pool biota are microscopic and highly vagile, they can inadvertently stick to objects and can easily be transported across vernal pool complexes. Therefore, extra care will be taken to avoid cross-contamination between pools, specifically if multiple pools from multiple complexes are surveyed by the same survey personnel. All equipment will be thoroughly cleaned before visiting a new vernal pool complex. Field vehicles will be restricted to paved roads.

Collection of individuals for purposes of laboratory identification and/or museum vouchers will be discouraged. Monitoring and sampling will be conducted by experienced personnel in possession of a valid U.S. Fish and Wildlife Service 10(a) take/handling permit.

G1.1.5 Vernal Pool Species Monitoring

G1.1.5.1 Vernal Pool Tadpole Shrimp and Vernal Pool Fairy Shrimp Monitoring Goals

Vernal pool monitoring include three goals for vernal pool tadpole shrimp (VPTS) and vernal pool fairy shrimp (VPFS):

VPTS & VPFS Monitoring Goal 1: Develop and implement a standardized formal monitoring program that collects data in sufficient detail to evaluate species trends in presence and abundance within vernal pools currently known to be occupied by VPTS or VPFS.

VPTS & VPFS Monitoring Goal 2: Develop and implement a standardized formal monitoring program that collects data in sufficient detail to evaluate the expansion of VPTS or VPFS into vernal pools previously known not to be occupied by VPTS or VPFS, including both through natural dispersal and colonization and through artificial inoculation implemented as part of an adaptive management strategy.

VPTS & VPFS Monitoring Goal 3: Use results of standardized formal monitoring programs to develop adaptive management protocols, identify triggers for adaptive management, and develop pilot studies to fill data gaps and address management uncertainties before full-scale management is implemented (e.g., does the management work and does it have any unintended adverse consequences?).

G1.1.5.2 VPTS and VPFS Conservation Strategy Goals

Conservation (including management) of the shrimp species within the UDA is important because the UDA supports important vernal pool complexes that are thought to support the highest concentrations of VPTS The VPTS also has slightly different habitat requirements than some other vernal pool crustaceans, with a life cycle that depends on larger or deeper hydrological systems with longer lasting aquatic phases. Most of these pool types occur within the UDA. Most of the documented occurrences for VPFS, however, are outside the UDA, as is a substantial percentage of the VPTS occurrences (see Table 7-5 in Chapter 7 of the SSHCP).

The monitoring protocol for VPFS and VPTS will monitor the overall Plan's success and whether and how the Plan meets its conservation goals and objectives (see Table G1-1 and Table 7-2 in Chapter 7-2).

G1.1.5.3 VPTS and VPFS Monitoring Questions

Success of these conservation strategy for VPTS and VPFS will be determined through monitoring and addressing the following primary conservation and preservation questions:

- What is the historical and current distribution of VPTS and VPFS in the SSHCP Preserve System, and how many and what acreage of occupied pools (natural and restored and/or created) are preserved?
- How stable are the VPTS and VPFS populations over time in the SSHCP Preserve System.
- What habitat covariates are associated with long-term persistence of healthy VPTS and VPFS populations in the SSHCP Preserve System (e.g., vernal pool basin size, vernal pool complex size, upland habitats, hydroperiods, non-natives species, etc.)?

- To what extent do existing and anticipated environmental conditions (e.g., invasive plant and wildlife species, climate change) and covered activities threaten VPTS and VPFS in the Preserve System?
- To what extent do development covered activities and altered hydrology in the vernal pool watershed affect the long-term viability of the VPTS and VPFS populations in the Preserve System?
- How do suitable habitat conditions for VPTS and VPFS differ from those of other large branchiopods species or from one another?
- How successful are vernal pool mitigation sites (including existing natural pools and restored and/or created pools) in the Preserve System?

In addition, the following secondary adaptive management and mitigation questions will also be addressed:

- What are the best sites for re-establishing VPTS and VPFS in the Preserve System?
- What vernal pool restoration techniques are most successful in re-establishing VPTS and VPFS populations in the Preserve System?
- What vernal pool management techniques are most successful in maintaining sustainable VPTS and VPFS populations in the Preserve System?

G1.1.5.4 Baseline Surveys

A representative sample of vernal pools on SSHCP existing preserves will be surveyed for presence of VPTS and VPFS to establish a baseline dataset of the distribution of the two species in the existing preserves. Sample macro-plots will be selected using the stratified random or pseudo-random sampling methods described in Section 1.3.1 for vernal pools in general. These existing preserves baseline surveys for VPTS and VPFS will occur during the wet season when pools are inundated and the species are detectable. Specimens will be collected with dip nets and returned to the same pool immediately after identification.

For new preserve sites, surveys will be conducted for presence of VPTS and VPFS. Depending on the size of the site and variability of the site conditions, surveys may be conducted in a representative sample of vernal pools (e.g., on large sites with many pools) or all the pools (e.g., on small sites or sites with a small number of pools). For new preserve sites being considered for acquisition for the Preserve System, presence/absence surveys may also be conducted as needed in non-randomly selected pools if the randomized selection process appears to omit pools considered to be highly suitable for the species and their omission could result in a false negative finding for the preserve site. That is, a more subjective sampling method may be more appropriate for establishing presence/absence on a candidate preserve site, while random sampling methods are necessary for making probabilistic inferences from monitoring data to larger areas. The main caution is that species occupancy in vernal pools that are selected in a non-random way cannot be used to infer conditions in other vernal pools (e.g., proportion of pools occupied).

G1.1.5.5 Site Selection

Long-term monitoring of VPTS and VPFS will be conducted in the Preserve System with a sample size of vernal pools large enough to detect trends in populations, such as proportion of occupied pools, relative population abundance, etc., as described in Section 1.3.1. It is expected that pilot studies will be needed to establish adequate sample sizes with the statistical power to detect VPTS and VPFS population trends (e.g., what sample size is needed to detect a 25% occupancy/population increase or decrease with 80% power of detection?). Generally, the more variable the sample data are between surveys (which is a problem of detection error), the larger the number of sample sites needed. As the vernal pool monitoring program is fleshed out, reasonable change thresholds (that may trigger management) and the desired power of the statistical tests will need to be determined by the Implementing Entity in consultation with the TAC.

The necessary sample size for each preserve site will be determined as part of the individual management plan for each preserve, but will also need to be coordinated with the overall monitoring program for the Preserve System. For example, if a preserve site supports vernal pool conditions (e.g., hydrology, soils, topography) that are well represented in the Preserve System, relatively few sample sites on the particular site may be needed as part of the Preserve System-wide monitoring program. However, if the site supports a unique or poorly represented type of vernal pool in the Preserve System, more sample sites may be needed to ensure that adequate data for that vernal pool type is being collected. Whatever sampling scheme is implemented on an individual preserve, it will need to serve the dual purpose of (1) monitoring the status of VPTS and VPFS on the particular preserve site (e.g., in order to inform site-specific management), and (2) monitoring the status of the species in the overall Preserve System (e.g., in order to determine whether the operating conservation strategy is meeting the Plan goals and objectives).

G1.1.5.6 Monitoring Schedule

The monitoring protocol designed to address the above questions will include habitat and species-specific monitoring that accommodate the species' different life cycles. While occupancy monitoring ideally is conducted during the wet season, cyst bank status and density monitoring, should it become necessary, is best evaluated during the dry season; hence, monitoring could occur during the wet and dry seasons. However, because cyst bank status is a more intrusive and intensive monitoring method, it is anticipated to play a small role and/or would be used on limited basis to address specific questions (e.g., cyst survival during extended drought periods), as opposed to being implemented on a broad scale. The monitoring schedule should be re-evaluated and adjusted, if necessary, every three to five years to ensure that appropriate data are collected to measure the Plan's conservation goals. This review will be conducted by the Implementing Entity in consultation with the TAC.

Monitoring visits should be scheduled consistently to collect compatible and comparable data over time. Initially for the first six to eight years, monitoring plots should be visited annually during the wet season to collect a rigorous baseline dataset. Thereafter monitoring frequency likely could be reduced, such as not more than every three years on average, but with the objective of sampling at least once during different precipitation conditions (i.e., dry, average, and wet) over an eight to ten year period.

As described in Section 1.3.1, a monitoring cycle is defined as the wet season from October 16 to April 14 in a given year. Generally, three surveys per cycle are conducted at each sample vernal pool, with the first following inundation; the second survey at mid-season once the first floating hydrophytes appear; and the third during the dry-down phase. For VPTS and VPFS, presence/absence surveys will be conducted in the same pools within the macro-plots monitored for general habitat conditions (see Section 1.4). Sampling for VPTS and VPFS will be timed, to the extent feasible, with general surveys, but will also be timed to coincide with the period the species are most readily identifiable in the field (typically January to mid-February). Generally, up to two surveys will be conducted within a monitoring cycle at each sample vernal pool. If both species are detected during the first survey in pool, re-sampling of the same pool is not necessary. If surveys are negative after two sample events, the qualified biologist will have the discretion to conduct additional samples at pools where he/she believes one or both of the species may be present, and for some reason the first two samples were conducted under marginal conditions for detection.

Approximately every 10 years during highly suitable weather patterns (i.e., timing and amount of rainfall), recent aerial photographs or some other remote sensing data (e.g., satellite imagery) will be reviewed and reconnaissance-level surveys will be conducted to update the overall distribution and status of vernal pools in the Preserve System. The purpose of the Preserve System-wide review is to generate any new information about the entire vernal pool system, including those pools that are not included in the statistically-based sampling effort. Depending of the results of the reconnaissance-level surveys, some pools may be targeted for follow-up surveys to determine the status of VPTS and VPFS. For example, good management practices may result in occupancy with VPTS or VPFS where the species had not been found before. Alternatively, anthropogenic influences (e.g., along edges) may have eliminated VPTS or VPFS from previously occupied vernal pools or a vernal pool complex.

G1.1.5.7 VPTS and VPFS Monitoring Protocol

Goals:

- Determine presence/absence of VPTS and VPFS in the Preserve System vernal pools;
- Determine relative abundance (productivity) in vernal pools across the Preserve System;
- Determine species richness and diversity in the Preserve System vernal pools;
- Identify predatory species in the Preserve System vernal pools; and
- Identify factors that may degrade habitat quality of the Preserve System vernal pool.

Wet season sampling is important to understand the status of the species; species occupancy (presence/absence); abundance or productivity; and determine covariates (e.g., habitat conditions, predators). Monitoring will be scheduled as describe in Section 1.5.6. During each survey, representative portions of the pool bottom, edges, and vertical water column shall be adequately sampled using a dip net appropriate for the size of the pool. Net mesh size shall not be larger than (1/8) inch.

A standardized dip net pull will be used for each survey and is defined as extending the net and pulling it back using a sweeping motion intended to sample approximately 4 cubic feet of water.

Information for the following response variables will be collected:

- Species present or absent (in the case of VPTS and VPFS)
- Relative abundance of VPTS and VPFS: the number of individuals of both species captured during each dip net pull. Relative abundance will be assigned according to the following categories.
  - Low = average <1 individual per standardized dip-net pull
  - Medium = average 1-5 individuals per standardized dip-net pull
  - High = average 6-25 individuals per standardized dip-net pull
  - Very High = average >25 individuals per standardized dip-net pull
- Species richness and diversity: number of different taxa (by species, if possible), including the presence of all live stages (tadpole/metamorph/adult) of amphibians.
- Presence of predatory species, including, western spadefoot (also a covered species) and waterfowl and shorebirds.

- Opportunist (mosquito/chironomus) abundance: abundance of invertebrate families least sensitive to changes in water quality and habitat suitability. These may include mosquitoes and chironomid midges of the genus chironomus.
- Presence of trash, algal blooms, trampling, etc. that may degrade habitat quality.

G1.1.5.8 Management for VPTS and VPFS

Management for VPTS and VPFS will include routine preserve management and maintenance and adaptive management. Routine management will include actions expected to benefit VPTS and VPFS, including fencing, signage, patrols, trash removal, public education, and restrictions on public access, etc. Routine management also refers to biologically-based habitat management actions that are known or strongly expected to have a high degree of success. For example, control of certain highly invasive species in the watershed of vernal pools such as yellow starthistle (*Centaurea solstitialis*) that can develop dense stands in grasslands may affect watershed hydrology. While management of habitat factors such as invasives controls can be considered a routine management action, the actual conditions under which controls are implemented and the methods used may be less certain. Where there is uncertainty in the effectiveness or feasibility of a management action(s), or the potential for unintended biological effects (e.g., non-native species used for biocontrol), an adaptive management strategy may be needed.

The conditions under which adaptive management should be applied will need to be determined by the Implementing Entity in consultation with the TAC as the management plan is developed. Some examples of conditions under which adaptive management actions may be triggered as a result of monitoring include the following:

- If VPTS or VPFS occurrences in occupied monitoring pools have declined a certain percent relative to the baseline data and initial monitoring survey results over specified monitoring periods. Pilot studies are needed to determine what percent population changes over what period of time will be detectable with acceptable statistical power <u>and</u> that are biologically significant (i.e., just because a statistically significant change may be detected, it is not necessarily biologically significant).
- Certain preserves are not maintaining populations with routine management relative to adjacent preserves over a specified monitoring period (i.e., the cause of the decline is uncertain.
- Monitoring information indicates that adverse factors relative to VPTS or VPFS health or habitat degradation exist, including disease, predation, algae infestation, etc. than are not amendable to routine management and the most effective management action is uncertain.

- Known or new invasive species are invading and degrading vernal pool habitats despite routine management (e.g., new control methods may need to be tested).

Because adaptive management, by nature, is experimental, management measures will need to be evaluated through pilot studies that test their effectiveness and feasibility, as well identifying any unintended adverse effects, on small scale before they are applied on a large scale. The results of the pilot studies will be evaluated by the Implementing Entity in consultation with the TAC.

The following are examples of potential adaptive management measures:

- Habitat Management:
  - Invasives control: Identify alternative feasible invasive control methods, such as grazing, prescribed burns, herbicides, mechanical removal, biocontrols (e.g., fungi, bacteria, insects). Test selected alternative methods, including different applications of a particular control (e.g., grazing regime or type of grazer). Determine whether and what rate and methods of invasives controls are adequate or most effective for the target species (e.g., fall vs. spring prescribed burns).
  - Thatch management: develop a grazing management plan to control thatch buildup without adversely affecting the vernal pool ecosystem (e.g., Marty 2007). A grazing management plan should, for example, specify the types and stocking rates of livestock (Animal Month Unit, AMU), grazing schedule, and the optimal grazing results (e.g., through the measurements of Residual Dry Matter, RDM). Consider whether fire management may be an alternative effective large-scale method to control thatch without harming the vernal pool ecosystem and the VPTS or VPFS. Identify smaller-scale thatch control methods, such as mowing or weed whacking, where large-scale grazing and/or burns cannot feasibly be applied,
  - Hydrological function and land use: Based on monitoring of hydrological covariates (e.g., watershed condition, hydroperiod, water chemistry) implement measures designed to improve hydrological functions and their effect on VPTS and VPFS. Hydrological studies should be conducted as a pilot program on a subset of monitoring pools (including connected and fragmented pools) to study the effects of management of factors such as surface and subsurface hydrology and vernal pool fragmentation on vernal pool conditions on the status of the species. In addition, existing land use and management practices that may be adversely affecting vernal pool habitat functions (e.g., type and intensity of grazing, pesticide/herbicide/fertilizer use of surrounding land uses, land alterations, flood control, mining operations, contaminated run-off, etc.) should examined and potential management interventions identified and tested.

- Species Management:
  - Predator control: Introduction of the bullfrog (*Rana catesbeiana*) to areas inhabited by the VPTS or VPFS appears to increase predation threats to these species. Although bullfrogs do not establish permanent breeding populations in vernal pools, dispersing immature males may temporarily occupy ephemeral wetlands during the rainy season. Bullfrogs are also extremely difficult to eradicate, because they have no natural enemies and can travel long distances between aquatic habitats. In addition, waterfowl and shorebirds may prey on crustaceans in shallow and clear pools. While waterfowl and shorebird predation is a natural "baseline" condition, in combination with non-native predators such as bullfrogs, predation could severely reduce VPTS or VPFS populations that threaten survival and recovery of the species in the Plan Area. Predator control programs therefore may need to be implemented if monitoring indicates that predation is a substantial threat to VPTS or VPFS populations; e.g., bullfrogs are found in vernal pools. Targeted predator controls programs that do not involve introducing non-native species (e.g., predatory fish), use of toxicants, or draining vernal pools should tested. For example, removal methods such as trapping should be investigated, but such methods would need to avoid take of VPTS and VPFS. See, for example, Louette et al. (2013).
  - Disease control: shrimp species appear to be susceptible to bacterial infections and parasites. Flukes (Trematoda) of an undetermined species have parasitized VPFS at the Vina Plains in Tehama County (USFWS 2005). Microsporiodiosis also is known to affect some fairy shrimp species. The main cause of these diseases is believed to be contaminated water. Treatment of contaminated water sources, including groundwater, is the only known antidote to these types of infections and diseases.
- Information Comparison: compare information from othe vernal pool ecosystems/species and evaluate whether this information is applicable to management of VPTS or VPFS in the SSHCP Plan Area.
- Stewardship program:
  - Re-evaluate success of current land stewardship programs.
  - Re-evaluate access controls; establish new access controls, if necessary.
  - Monitor adjacent land uses and determine the potential effect of these land uses on the health of the vernal pool ecosystem, VPTS and VPFS.

G1.1.5.9 Future Studies/Data Gaps for VPTS and VPFS

As described in Section 1.5.7, dip-netting will be used to assess relative abundance of VPTS and VPFS during baseline studies. However, information about cyst bank densities, population sizes, and population viability would contribute to managing vernal pool ecosystems for these two species, especially with projected climate change that may stress vernal pools and their constituent species in the coming decades. An understanding of the relationship between cyst bank densities and population viability over time, for example, would be extremely helpful in assessing long-term population trends and identifying when management interventions are critically needed.

VPTS and VPFS produce cysts that may remain dormant in vernal pool sediment for many years, and only a fraction of the cysts may hatch even when physical conditions are optimal. It is possible, therefore, for presence/absence surveys to continue detecting fairy shrimps for a period of time even if the population is in decline and viable offspring are no longer produced in a given pool (U.S. Fish and Wildlife Service, Draft Fairy Shrimp Monitoring Plan, 2008).

For these reasons, future studies of VPTS and VPFS may include a study of cysts, as outlined below.

Goals:

- Determine cyst bank density;
- Determine population size; and
- Determine population viability.

Dry season sampling is not required at this time but could become an important tool to monitor the stability and density of the tadpole shrimp cyst bank. Aside from the dry season fairy shrimp sampling protocol presented below, there is no viable population density model/protocol available in California currently available. The dry season fairy shrimp sampling protocol probably is too invasive to be used repetitively at a large-scale during SSHCP monitoring, but potentially could be applied at small scale at targeted populations. Dr. Andrew Bohonak of San Diego State University is currently developing and refining a density-estimating protocol intended to collect data in a rigorous manner while minimizing impacts to vernal pool biota. Density estimation should not be conducted until this protocol has been accepted as appropriate.

If population density measurements should be necessary to evaluate the dynamics of a failing VPTS or VPFS population in an otherwise functioning ecosystem (see adaptive management above), and until Dr. Bohonak's protocol is available, the following dry season sampling protocol may be applicable. Soil sampling should be conducted every three sampling seasons to collect, culture, and analyze cysts. The dry season and wet season sampling cycle should be the same (each dry season sample should be collected in the same year as the wet season sample). Sampling should be conducted per U.S. Fish and Wildlife Service protocol (2001), as follows:

- Soil shall be collected when it is dry to avoid damaging or destroying cysts which are more fragile when wet. A hand trowel or similar instrument shall be used to collect approximately one liter volume sample per pool of the top 1-3 centimeters of pool sediment. Whenever possible, soil samples shall be collected in chunks. The trowel shall be used to pry up intact chunks of sediment, rather than loosening the soil by raking and shoveling which can damage cysts.
- To avoid significantly impacting the sample pools it is recommended that a total of 10 soil samples of approximately 50 ml each shall be taken from each pool (not the 100 ml samples recommended in the U.S. Fish And Wildlife Service protocol), for a total soil sample volume of approximately 500 ml per pool.
- Soil sampling locations should include: 1.) one soil sample taken from the edge of the pool, at least four soil samples shall be taken from equidistant points along the longest transect of the pool; 2.) one soil sample taken from the edge of the pool, at least four soil samples shall be taken from equidistant points along the widest transect of the pool; or 3.) if neither the longest or the widest transect encompasses the deepest part (or parts) of the pool, then at least two soil samples shall be taken from the deepest part (or parts) of the pool.
- Soil sieving should be conducted to extract cysts from soil samples. The soil samples shall not be ground, crushed, or otherwise manipulated in order to expedite the sieving process. A relatively short period of pre-soaking the soil sample may be helpful/necessary in order to facilitate the sieving process. Small aliquots (approximately 50 ml in volume) of soil shall be gently washed with water through a graded series of U.S. standard eight inch soil sieves ending in mesh sizes 300 micron (um), and 150 micron (um).
- Washed and sieved soil fractions from the 300 um and 150 um sieves shall be examined under a dissecting microscope for tadpole shrimp and fairy shrimp cysts. The process shall be repeated until all individual soil samples have been examined. All sieved material shall be processed and dried as quickly as possible, preferably within one hour from the initial wetting.
- Cysts should be removed from the soil, separated by cyst type into labeled vials, allowed to air-dry, and then stored dry.
- Cyst density information for each soil sample location shall be calculated by dividing the total number of cysts recovered by the total amount of soil from the individual aliquots from that soil sample location. Total cyst density information for each soil sample location shall be reported for each species in terms of: none; 1-25 cysts/100 ml soil; 26-

50 cysts/100 ml soil; 51-100 cysts/100 ml soil; 101-199 cysts/100 ml soil; or more than 200 cysts/100 ml soil.

Cysts should be cultured and hydrated and identified to the genus and species level, if possible, to determine the percentage of VPTS or VPFS cysts within the sample.

G1.2 Reference Cited

Louette, G., S. Devisscher, and T. Adriaens. 2013. "Control of Invasive American Bullfrog Lithobates catesbeianus in Small Shallow Water Bodies. European Journal of Wildlife Research 59:105–114.

U.S. Fish and Wildlife Service. USFWS). 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Region 1, U.S. Fish and Wildlife Service, Portland, Oregon.

APPENDIX G2

Functional Survey Groupings

APPENDIX G2
Functional Survey Groupings

Preserve Vernal Pool – Wet Season Surveys

Attribute/Species (Scientific Name)	Survey Type	Survey Window*
Inundation/ponding	Aerial photos/field verification	Winter/Spring
	Plants	
Ahart's dwarf rush (*Juncus leiospermus* var. *ahartii*)	Wet season	February 15 through April 30
Dwarf downingia (*Downingia pusilla*)	Wet season	March 1 through May 31
Legenere (*Legenere limosa*)	Wet season	April 1 through June 30
Pincushion navarretia (*Navarretia myersii* ssp. *myersii*)	Wet season	April 1 through May 31
Boggs Lake hedge-hyssop (*Gratiola heterosepala*)	Wet season	April 1 through July 31
	Wildlife	
Vernal pool tadpole shrimp	Wet season	Wet season – winter/spring
Vernal pool fairy shrimp (*Branchinecta lynchi*)	Wet season	Wet season – winter/spring
Mid-valley fairy shrimp (*Branchinecta mesovallensis*)	Wet season	Wet season – winter/spring
Ricksecker's water scavenger beetle (*Hydrochara rickseckeri*)	Wet season	Winter/spring
California tiger salamander (*Ambystoma californiense*)	Larval surveys – dip netting	March through May
	Adult surveys – drift fences, pitfall traps, night visual	October 15 through March 15
Western spadefoot (*Spea hammondii*)	Larval surveys	October through May

* Survey windows subject to revision.

Preserve Vernal Pool – Dry Season Surveys

Attribute/Species (Scientific Name)	Survey Type	Survey Window
Residual dry matter	Dry season	Fall
	Plants	
Sacramento Orcutt grass (*Orcuttia viscida*)	Dry season	May 1 through June 30
Slender Orcutt grass (*Orcuttia viscida*)	Dry season	May 1 through July 31
Sanford's arrowhead (*Sagittaria sanfordii*)	Dry season	May 1 through September 30

Preserve Riparian Surveys

Attribute/Species (Scientific Name)	Survey Type	Survey Window
CRAM	—	All year
Restoration monitoring	—	All year

Attribute/Species (Scientific Name)	Survey Type	Survey Window
Wildlife		
Cooper's hawk (*Accipiter cooperii*)	Foraging	All year
	Nesting	March 15 through August 15
White-tailed kite (*Elanus leucurus*)	Nesting	March 15 through August 15
Swainson's hawk (*Buteo swainsoni*)	Nesting	March 15 through August 15
Western pond turtle (*Actinemys marmorata*)	Aquatic/basking sites	June through September (sunny days to observe basking)
Giant gartersnake (*Thamnophis gigas*)	Aquatic/basking sites	May 1 through September 30
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	Exit hole surveys	All year

CRAM = California Rapid Assessment Method

Preserve Vernal-Pool Grassland and Valley Grassland Surveys

Attribute/Species (Scientific Name)	Survey Type	Survey Window
Residual dry matter	—	Fall
Wildlife		
Tricolored blackbird (*Agelaius tricolor*)	Foraging	All year
	Nesting	March 15 through June 15
Western burrowing owl (*Athene cunicularia*) (occupied nesting burrows)	Nesting/Wintering	All year
Ferruginous hawk (*Buteo regalis*)	Foraging	November 1 through February 28
Swainson's hawk (*Buteo swainsoni*)	Foraging	March 15 through August 15
Northern harrier (*Circus cyaneus*)	Foraging	All year
	Nesting	March 15 through August 15
White-tailed kite (*Elanus leucurus*)	Foraging	All year
Loggerhead shrike (*Lanius ludovicianus*)	Foraging	All year
	Nesting	February 1 through June 30
American badger (*Taxidea taxus*)	Grassland/savanna	All year
Pallid bat (*Antrozous pallidus*)	Foraging	April through November
Western red bat (*Lasiurus blossevillii*)	Foraging	April through November
Yuma myotis (*Myotis yumanensis*)	Foraging	April through November

Cropland and Irrigated Pasture Preserve Surveys

Attribute/Species (Scientific Name)	Survey Type	Survey Window
Crop type	Mapping/Field Inspection	During growing season
Wildlife		
Greater sandhill crane (*Grus canadensis*)	Foraging – cropland and irrigated pasture grassland	September 1 through February 15
Loggerhead shrike (*Lanius ludovicianus*)	Foraging – cropland and irrigated pasture grassland	All year

Attribute/Species (Scientific Name)	Survey Type	Survey Window
Swainson's hawk (*Buteo swainsoni*)	Foraging – cropland and irrigated pasture grassland	March 15 through August 15
Northern harrier (*Circus cyaneus*)	Foraging – cropland and irrigated pasture grassland	All year
	Nesting – cropland and irrigated pasture grassland	March 15 through August 15
Tricolored blackbird (*Agelaius tricolor*)	Foraging – cropland and irrigated pasture grassland	All year
	Nesting – cropland only	—
Western burrowing owl (*Athene cunicularia*)	Wintering – cropland and irrigated pasture grassland	July 16 through February 14 (non-breeding season)
	Nesting – cropland and irrigated pasture grassland	February 15 through July 15 (breeding season)
White-tailed kite (*Elanus leucurus*)	Foraging – cropland and irrigated pasture grassland	All year
Pallid bat (*Antrozous pallidus*)	Foraging – all agricultural land types, roosting – orchards only	April through November
Western red bat (*Lasiurus blossevillii*)	Foraging – all agricultural lands, roosting – orchards only	April through November

Bat Roost Surveys

Attribute/Species (Scientific Name)	Survey Type	Survey Window
Roost installation inspection	Field verification	Any time
	Wildlife	
Pallid bat (*Antrozous pallidus*)	Roosts	April through November
Yuma myotis (*Myotis yumanensis*)	Roosts	April through November

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APPENDIX G3

Preserve Management Toolbox

APPENDIX G3
Preserve Management Toolbox

G3.1 Introduction

This appendix presents a management "toolbox" that will be used in the development of individual Preserve Management Plans (PMPs). The Implementing Entity will consult this appendix during PMP preparation to identify those management activities that could apply to their parcels to achieve the measureable objectives and other commitments of the South Sacramento Habitat Conservation Plan (SSHCP) Conservation Strategy. The following describes the toolbox of potential land management methods, their potential applications, and potential limitations to provide information for how and why the methods will be applied. These descriptions do not include discussions of detailed management methods such as timing, frequency, or combining methods. Such details will be incorporated into individual PMPs depending on the selected methods. Following the description of land management methods, the methods are presented in a matrix (Table G3-1) that identifies how they might be used to address threats and stressors to SSHCP land cover types and Covered Species habitats.

G3.2 Routine Preserve Maintenance and Land Management

Routine management refers to a variety of Preserve management activities generally expected to benefit Covered Species and their habitats, including fencing, signage, public education, trash and refuse removal, general inspections, patrols, and enforcement. Most of the routine management activities are related to minimizing the effects of adjacent urban development and associated human activities on biological resources within Preserves.

Patrols also are expected to reduce intentional and accidental fire ignitions (e.g., from discarded cigarettes).

Fencing

Installation and regular inspection of fencing and gates, and immediate repair when necessary, is critical to exclude indirect effects such as trash dumping, off-road-vehicle activity, and trespassing on SSHCP Preserves. Fencing maintenance is also critical for control of livestock that will be used for vegetation management. Internal cross-fencing, if desired to more closely control grazing locations, must be carefully considered to ensure that water remains available for livestock and to avoid restrictions on wildlife travel corridors.

Maintain Agricultural Facilities and Structures

Facilities and structures that are necessary for pre-acquisition agricultural operations on a new SSHCP Preserve should be repaired and maintained, and those for which there is no current or anticipated need should be removed or re-used elsewhere within the SSHCP Preserve System.

Abandoned and derelict structures such as sheds and barns may be used by bats for day roosts, including at least two of the covered bat species (pallid bat (*Antrozous pallidus*) and Yuma myotis (*Myotis yumanensis*)). Therefore, these should only be removed or moved elsewhere if they are unoccupied by bats.

Debris and Trash Removal

All Preserves and Preserve parcels and adjoining areas should be regularly inspected for debris and trash accumulation, including that resulting from agricultural operations on Cropland and Irrigated Pasture Preserves. At a minimum, the Implementing Entity will conduct bi-annual cleanup days to remove trash from each SSHCP Preserve, and will coordinate with the county to have illegal dumping cleared from adjacent roadway shoulders.

If there are stockpiles of what must be retained on a Preserve site, they should be on graveled or bare dirt areas that have been pre-treated with herbicides to control weeds.

Methods for Preserve Fire Breaks

Fire breaks adjacent to public roads are required by Plan Area fire protection districts. Districts recommend fire breaks to be 16 feet in width and created using a disk line or scrape line in the spring or early summer after grass growth has slowed. Disked fire breaks are preferred as they will support plants the following year and scraped breaks do not. Internal fire breaks within Preserve units should be phased out. Fire breaks required for prescribed burns should consist of creating a black line around the prescribed burn area.

Methods to Limit Off-Road Travel

The Implementing Entity will limit off-road-vehicle use by Preserve staff on Preserves to during the wet season. When off-road-vehicle use is required for ranching operations, operators will not drive through vernal pools.

Method to Minimize Impacts from Existing Utility Corridors

Holders of utility easements that traverse Preserves will be escorted by Preserve Managers to ensure that their activities remain within the easements and that access routes are consistent with the PMP.

Install and Maintain Appropriate Signage

All SSHCP Preserve parcels will have signs posted along any fenceline and any gate that adjoins a public road or other public area (e.g., public parks). Sign content is at the discretion of the

Implementing Entity depending on the purpose of the sign (e.g., no trespassing, description of the Preserve), but must include a public information telephone number.

G3.3 Habitat Vegetation Management, Thatch Control, and Non-Native Plant Control

Grazing

Grazing management is expected to be a primary habitat management tool on SSHCP Preserves to control vegetation such as annual grass thatch and some invasive weeds. The primary grazers in the Plan Area will be cattle, but targeted grazing may be conducted using sheep and goats depending on the size of the Preserve and the objective of the grazing (e.g., a specific invasive species or an area not available for cattle grazing). Grazing can have beneficial and adverse effects on natural resources in the SSHCP Preserve System depending on factors such as stocking rates and timing of grazing activities, and grazing management will address both types of effects. Over-grazing and large congregations of grazers can have severe effects on vegetation communities, Covered Species habitat, soil conditions, stormwater runoff, and water quality, and a lack of grazing or under-grazing can result in buildup of thatch, which can reduce habitat quality for SSHCP Covered Species, including altering vernal pool hydrology, altering vegetation community composition, and increasing the risk of catastrophic wildfires. Generally, grazing objectives are expressed as the desired residual dry matter (RDM) left after grazing, but may also include objectives related to protecting certain resources (e.g., Riparian zones, Oak Woodland).

Controlled grazing can be a useful management tool for a variety of natural resources. For example, it can be used to control thatch buildup in the Vernal Pool Grassland, Grassland, and Woodland Savanna land covers. Reducing thatch can maintain vernal pool hydroperiods and allow vernal pool species to complete their aquatic life cycle phases. Reducing thatch also improves growth and recruitment of upland plant species such as annual wildflowers and oak trees (as long as trampling or browsing of seedlings and saplings is controlled); reduces the buildup of fuels that increases the chance of catastrophic wildfires; improves overland movement capabilities of species such as California tiger salamander (*Ambystoma californiense*) and western spadefoot (*Spea hammondii*); and encourages use by burrowing species such as California ground squirrel (*Otospermophilus beecheyi*), gopher, and other rodents whose burrows provide refuge or denning habitats for Covered Species such as tiger salamander, western spadefoot, giant gartersnake (*Thamnophis gigas*), and burrowing owl (*Athene cunicularia*), and provides prey for several of the bird Covered Species.

Managed grazing on SSHCP Preserves will be needed to address potential adverse effects of grazing, including impacts on wetland, riparian, and woodland vegetation (e.g., trampling and browsing); soil disturbances; invasive exotic species establishment; and water quality impacts where cattle and other grazers may congregate. These are indicated as “inappropriate grazing” effects in Table G3-1.

Managed grazing to avoid adverse effects includes appropriate stocking rates, seasonal timing of grazing activities, rotational grazing patterns, distributing resources such water and mineral and salt licks to disperse cattle and avoid congregation in sensitive areas (e.g., Wetland and Riparian habitats), and exclusion fences to protect sensitive areas.

Prescribed Burns

Prescribed burns (also called controlled burns) can be used as an alternative to grazing as a Grassland and Vernal Pool Grassland management tool. Prescribed burns may also be used to reduce thatch and reduce fuel loads in Shrub Land cover types. Prescribed burns may improve vegetation communities by reducing total cover (that shades out recruits), removing senescent individuals, controlling pests, and promoting nutrient cycling. It is expected that prescribed burns will primarily be used only in the larger SSHCP Preserves to control thatch, but may also be used as a targeted method to control certain invasive plant species such as medusahead (*Taeniatherum caput-medusae*) and goatgrass (*Aegilops cylindrica*) that are unpalatable to grazers.

Although prescribed burning may be used to control other invasive species, its effectiveness has not been well tested. Factors such as the optimum season(s) to burn and the frequency of burns in the Plan Area need to be investigated. It is unlikely that prescribed burns will be used on a large scale in SSHCP Preserves located in the Urban Development Area because of public safety and air quality concerns, but it may be useful on a smaller scale and/or in more remote areas of the SSHCP Preserve System.

Mowing

Similar to grazing and prescribed burns, mowing may be used to control thatch and invasive species. Mowing generally will be used in the larger-size SSHCP Preserves with Vernal Pool Grassland land cover, and probably will be used on smaller SSHCP Preserves than grazing management and prescribed burning management actions, and where these other land management methods cannot be feasibly used.

Similar to prescribed burning, the optimum seasons and frequency of mowing, and the appropriate mowing heights (e.g., to affect targeted species but avoid inadvertent impacts to species) are resource-specific and will need additional study to understand the most effective applications of mowing.

Manual Removal of Vegetation

Manual removal refers to the use of weed trimmers, raking, hand- or tool-pulling, chainsaws, digging, hand-cutting, and other methods. These typically are used at small scales to target certain vegetation issues. Manual removal may be desirable were large-scale methods could cause substantial damage to sensitive resources such as native riparian species. Raking can be used to reduce thatch in smaller areas where other methods cannot be used, and the other methods are often species-specific removal methods. For example, weed trimmers are effective in cutting back infestations of starthistle (*Centaurea solstitialis*).

Pesticides (Including Herbicides)

As discussed in Chapter 5, pesticide use on SSHCP Preserves is not a SSHCP Covered Activity. However, herbicides may be used for management in targeted situations where potential adverse effects on sensitive resources (e.g., unintended drift, runoff) will not occur and no take of Covered Species is possible. Most of the available herbicides are non-selective for specific types of plants (e.g., glyphosate and paraquat), so they will be limited to targeted situations. Herbicide use is also expensive and labor intensive. Herbicides may be effective when used in conjunction with other removal methods such a "cut-and-spray" of invasive plants. Herbicides will be well-tested at a small scale before applied at a larger scale.

Biological Controls

Biological controls generally refer to use of biological organisms (e.g., pathogens, insects) to control invasive plants and animals. Relatively little is known about effective biological controls for Plan Area management issues, but some research indicates the potential for biological controls for invasive plants such as starthistle, Italian thistle (*Carduus pycnocephalus*), and milk thistle (*Silybum marianum*).

G3.4 Wildlife Management on Preserves

Domestic Animal Control

With the exception of livestock—domestic animals used exclusively in agricultural operations—domestic animals will be prohibited within Preserves. Signs prohibiting the presence of domestic animals within Preserves will be clearly posted along any fenceline and any gate that adjoins a public road or other public area (e.g., public parks). Pet dogs along public roadways or trails crossing or adjacent to Preserves must remain on a leash at all times. The Implementing Entity will monitor for unattended domestic or feral animals that are observed within the Preserves, report the occurrences to the appropriate animal control agencies, and take other necessary steps to legally remove feral animals.

Guard Animals for Herds

Grazing herds (especially sheep, if used) might be protected from naturally occurring predators through use of guard dogs or donkeys. Lethal control of native predator species will not be used on SSHCP Preserves.

Trapping

Trapping refers to a broad set of management tools that may be used to remove invasive wildlife and urban-related predators. For example, brown-headed cowbird (*Molothrus ater*) trapping can be used to reduce nest parasitism; cowbirds are known to parasitize loggerhead shrike (*Lanius ludovicianus*) nests.

Trapping may be used to control bullfrogs (*Lithobates catesbeianus*) and crayfish in aquatic Covered Species breeding habitats.

Trapping may be used to remove certain urban-related non-native predators or non-native pests such as raccoons, opossums, and non-native rats and mice from sensitive areas where they are impacting a SSHCP Covered Species, under the direction or with permission from the California Department of Fish and Wildlife.

Rodent Burrow Management

Burrow management primarily refers to maintaining existing ground squirrel burrows and enhancing burrow availability for use by Covered Species such as California tiger salamander, western spadefoot, giant gartersnake, and burrowing owl. Maintaining and enhancing ground squirrel burrows will be related to other land management activities, such as thatch management. Burrowing mammals tend to be more prevalent where vegetative cover is lower.

Pesticides

The Implementing Entity will ensure that pesticide use will not result in any direct or indirect adverse effects on Covered Species by limiting use of pesticides and controlling application to only where needed. An example of a potential beneficial use of pesticides is Argentine ant control (*Linepithema humile*) (e.g., nest/mound treatments and broadcast application), but only where it can be shown to have no effects on native species, habitats, and other factors such as water quality.

Vector control in Sacramento County refers to mosquito and West Nile virus controls. West Nile virus is known to infect Cooper's hawk (*Accipiter cooperii*) and loggerhead shrike, and raptors such as white-tailed kite (*Elanus leucurus*) could be infected through ingestion of prey such as smaller birds and rodents or directly by bites. Similar to pesticide use on SSHCP Preserves, vector control has potential for both beneficial and detrimental indirect effects on wildlife, including Covered Species. Although controlling mosquitos to reduce the chance of West Nile virus infections will be beneficial to humans, spraying Preserve habitat with pesticides (e.g., Dibrom) can have harmful effects on water quality and potential direct and secondary toxic effects on wildlife. Releasing mosquitofish (*Gambusia affinis*) can also adversely affect Covered Species such as vernal pool invertebrates, California tiger salamander, and western spadefoot.

G3.5 Management of Aquatic Land Covers on Preserves

Sediment Removal

Sediment removal may be a useful management tool for maintaining aquatic land covers and some semi-aquatic Covered Species—such as California tiger salamander and western pond turtle (*Actinemys marmorata*)—that can benefit from deeper water within a ponded area. For example, deeper water may provide tiger salamanders protection from some predatory birds such as herons and urban-related predators such as raccoons. Sediment removal may be conducted in conjunction with draining Emergent Wetland land cover and open water, described below.

Wetland Draining

Draining primarily is a tool for managing bullfrogs, crayfish, and non-native predatory fish in California tiger salamander and western spadefoot breeding habitats. Perennial wetlands (e.g., stockponds) that are suitable for tiger salamander, western spadefoot, and western pond turtle may benefit from periodic draining in the summer/fall to eliminate non-native predators that require aquatic habitat. Also, wetland draining may control excessive emergent wetland vegetation that degrades aquatic habitat for tiger salamander.

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Table G3-1
Threats, Stressors, and Potential Management Methods

Resource	Threats and Management Issues	Potential Management Methods																				
		Vegetation Management and Non-Native Plant Control						*Hydrology Management*		*Wildlife Management*						*Routine Maintenance*						
		Grazing	*Prescribed Burns*	*Mowing*	*Manual Removal*	*Herbicides*	*Biological Controls*	*Sediment Removal*	*Wetland Draining*	*Trapping*	*Pesticides*	*Domestic Animals*	*Vector Control*	*Burrows*	*Guard Animals*	*Fencing*	*Structures*	*Trash Removal*	*Fire Breaks*	*Off-Road Travel*	*Maintain Nature Trails*	*Signage*
Aquatic Habitats and Species																						
Vernal Pool and Vernal Pool Grassland Watersheds, Vernal Pool Species	Thatch	•	•	•	•	•																
	Invasive plants	•	•	•	•	•	•										•	•		•	•	
	Invasive wildlife						•		•	•	•	•				•		•				
	Hydrology	•	•	•	•	•														•		
	Nitrogen deposition		•																	•	•	
	Inappropriate grazing	•										•			•	•	•					
	Human activity											•				•	•	•		•	•	•
	Altered fire regime	•	•	•	•	•												•	•	•	•	•
Other Wetlands	Invasive plants	•			•	•	•										•	•		•	•	
	Invasive wildlife						•		•	•	•	•				•		•				
	Hydrology	•			•	•		•												•		
	Inappropriate grazing	•										•			•	•	•					
Riparian	Invasive plants	•			•	•	•										•	•		•	•	
	Invasive wildlife						•		•	•	•	•				•		•				
	Inappropriate grazing	•										•			•	•	•					
	Hydrology	•			•	•														•		
Valley Grassland	Thatch	•	•	•	•	•																
	Invasive plants	•	•	•	•	•	•											•		•	•	
	Inappropriate grazing	•										•			•	•	•					
	Altered fire regime	•	•	•	•	•												•	•	•	•	•
Amphibians	Thatch	•	•	•	•	•																
	Hydrology	•	•	•	•	•		•												•		
	Emergent vegetation				•				•													
	Invasive plants	•	•	•	•	•	•										•	•		•	•	
	Invasive wildlife						•		•	•	•	•				•		•				
	Inappropriate grazing	•										•			•	•	•					
	Upland refugia	•	•	•	•	•					•			•								
	Human activity											•				•	•	•		•	•	•
	Native predators							•														
	Urban-related predators							•		•		•				•						

Table G3-1
Threats, Stressors, and Potential Management Methods

Resource	Threats and Management Issues	Potential Management Methods																				
		Vegetation Management and Non-Native Plant Control						*Hydrology Management*		*Wildlife Management*						*Routine Maintenance*						
		Grazing	*Prescribed Burns*	*Mowing*	*Manual Removal*	*Herbicides*	*Biological Controls*	*Sediment Removal*	*Wetland Draining*	*Trapping*	*Pesticides*	*Domestic Animals*	*Vector Control*	*Burrows*	*Guard Animals*	*Fencing*	*Structures*	*Trash Removal*	*Fire Breaks*	*Off-Road Travel*	*Maintain Nature Trails*	*Signage*
	Pesticides										•											
	Disease											•										
	Altered fire regime	•	•	•	•													•	•	•	•	•
Semi-Aquatic Reptiles	Thatch	•	•																			
	Hydrology	•	•	•	•	•		•												•		
	Invasive plants	•	•	•	•	•	•										•	•		•	•	
	Invasive wildlife						•		•	•	•	•				•		•				
	Inappropriate grazing	•										•			•	•	•					
	Human activity											•				•	•	•		•	•	•
	Urban-related predators									•		•				•						
	Pesticides										•											
	Altered fire regime	•	•	•	•	•										•		•	•	•	•	•
Upland Habitats and Species																						
Woodland	Thatch	•	•	•	•	•																
	Invasive plants	•	•	•	•	•	•										•	•		•	•	
	Invasive wildlife						•		•	•	•	•				•		•				
	Inappropriate grazing	•										•			•	•	•					
	Hydrology	•	•	•	•	•														•		
Bird Covered Species	Hydrology	•	•	•	•	•														•		
	Invasive plants	•	•	•	•	•											•	•		•	•	
	Invasive wildlife						•			•	•	•				•		•				
	Inappropriate grazing	•										•			•	•	•					
	Dens (burrowing owl)	•	•	•	•	•					•			•							•	
	Human activity											•				•	•	•		•	•	•
	Urban-related predators									•		•				•						
	Pesticides										•											
	Altered fire regime	•	•	•	•	•												•	•	•	•	•
	Disease											•	•									
Mammals	Hydrology	•	•	•	•	•														•		
	Invasive plants	•	•	•	•	•											•	•		•	•	
	Inappropriate grazing	•										•			•	•	•					
	Human activity											•				•	•	•		•	•	•

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Threats, Stressors, and Potential Management Methods

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		Grazing	*Prescribed Burns*	*Mowing*	*Manual Removal*	*Herbicides*	*Biological Controls*	*Sediment Removal*	*Wetland Draining*	*Trapping*	*Pesticides*	*Domestic Animals*	*Vector Control*	*Burrows*	*Guard Animals*	*Fencing*	*Structures*	*Trash Removal*	*Fire Breaks*	*Off-Road Travel*	*Maintain Nature Trails*	*Signage*
	Urban-related predators									•		•				•						
	Pesticides										•											
	Altered fire regime	•	•	•	•	•												•	•	•	•	•
	Disease								•			•	•									

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APPENDIX G4

Management Plan Template

APPENDIX G4
Management Plan Template

(Example- For Discussion Purposes Only)

G4.1 Introduction

G4.1.1 Name and Location of the Property

G4.1.2 General Goals for the Property

G4.1.3 Primary Considerations that Drive Development and Implementation of the Management Plan

G4.1.4 Expected Timeframe for the Management Plan's Implementation

G4.1.5 Parties to Be Involved in Plan Implementation May Be Identified

G4.2 Property Description

G4.2.1 Land Cover Types

G4.2.2 Delineated Jurisdiction Features

G4.2.3 Species Inventory

G4.2.4 Problem Conditions

G4.2.5 Threats to Desirable Attributes

G4.2.6 Potential Ecologic Restoration/Enhancement Opportunities

G4.2.7 Connections

G4.2.7.1 Boundary Descriptions

G4.2.7.2 Access Points

G4.2.7.3 Adjacent Landowners and Land Uses Pertinent to Understanding Management Problem

G4.2.7.4 Priorities to Be Addressed in the Plan

G4.2.7.5 Nearby Preserves Exist that Provide Points of Reference for Activities at the Subject Property

G4.3 Management History

G4.4 Public Use

G4.4.1 Permitted Uses

G4.4.2 Trail Types

G4.4.3 Signage

G4.5 Management Objectives

G4.6 Management Prescriptions

G4.6.1 Management Prescription 1

G4.6.1.1 Person Days Needed

G4.6.1.2 Timing of Activities

G4.6.1.3 Technical Resources

G4.6.1.4 Parties Who Will or Could Be Responsible for Accomplishing the Prescriptions or Parts of Prescriptions

G4.6.1.5 Monitoring and Adaptive Management Plan

G4.6.2 Management Prescription 2

G4.7 Species Monitoring Pan

G4.7.1 Monitoring Schedule

G4.8 Annual Work Plan

G4.9 Management Tools

G4.9.1 Preserve Monitoring Schedule

G4.9.2 Photo-Monitoring Points

G4.9.3 Inventory Responsibilities

G4.9.4 Fire Management Plan

G4.10 Funding or In-Kind Resource Needs

G4.10.1 Working Budget

G4.11 Appendices

G4.11.1 Legal Description, Property Plat, Deed, etc.

G4.11.2 Maps

G4.11.3 Cultural Resources Report

G4.11.4 Verified Wetland Delineation

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APPENDIX H

Implementation Ordinance/Resolution

APPENDIX H

RESOLUTION OF THE BOARD OF SUPERVISORS OF THE COUNTY OF SACRAMENTO TO ESTABLISH PROCEDURES AND REQUIREMENTS FOR IMPLEMENTATION OF THE SOUTH SACRAMENTO HABITAT CONSERVATION PLAN

WHEREAS, the County of Sacramento Board of Supervisors finds that the ecosystems of the County of Sacramento ("County") and/or southern Sacramento County and the vegetation communities and sensitive species they support are fragile, irreplaceable resources that are vital to the general welfare of all residents; these vegetation communities and natural areas contain habitat value which contributes to the region's environmental resources; and special protections for these vegetation communities and natural areas must be established to prevent future endangerment of the plant and animal species that are dependent upon them.

WHEREAS, this Resolution will protect the County's and the region's biological resources, vegetation communities, and natural areas, and prevent their degradation and loss by guiding development outside of important resource areas, and by establishing mitigation standards which will be applied to development projects.

WHEREAS, adoption and implementation of this Resolution will enable the County to achieve the conservation goals set forth in the South Sacramento Habitat Conservation Plan ("SSHCP"), to implement the associated Implementing Agreement executed by the Board of Supervisors on ______________, 2016, and to preserve the ability of affected property owners to make reasonable use of their land consistent with the requirements of the National Environmental Policy Act ("NEPA"), the California Environmental Quality Act ("CEQA"), the Federal Endangered Species Act ("FESA"), the California Endangered Species Act ("CESA"), the Federal Clean Water Act, the Porter-Cologne Water Quality Control Act, California Fish and Game Code Section 1600, and other applicable laws.

NOW, THEREFORE, BE IT RESOLVED AND ORDERED

SECTION I. APPLICATION OF REGULATIONS

Except as provided in Section II, this Resolution shall apply to all land within the County shown on the SSHCP Plan Map, attached as Exhibit "1." Upon application to the County for a development project, an applicant shall be required to comply with the procedures set forth in this Resolution. Upon the County's initiation of a project that is subject to the SSHCP, the County shall be required to comply with the procedures set forth in this Resolution.

SECTION II. EXEMPTIONS

This Resolution shall not apply to the following:

A. The adoption or amendment of the County's General Plan.

B. The adoption or amendment of any land use or zoning ordinance.

C. Any project for which and to the extent that a vesting tentative map pursuant to the Subdivision Map Act, or a development agreement pursuant to Government Code sections 65864 et seq., approved or executed prior to adoption of this Resolution, confers vested rights under the County's ordinances or state law to proceed with the project notwithstanding the enactment of this Resolution. Projects subject to this exemption must comply with all provisions of any applicable state and federal law.

D. Any project for which the Board of Supervisors determines that application of this Resolution would result in the property owner being deprived of all reasonable economic use of the property in violation of federal or state constitutional prohibitions against the taking of property without just compensation.

SECTION III. PROCEDURES

A. The County will be responsible for ensuring that an activity that is covered by the SSHCP ("Covered Activity") that occurs within its jurisdiction, including its own projects, is eligible to use the SSHCP by following the application processing procedures pursuant to Chapter 10 of the SSHCP.

B. Before extending Incidental Take coverage to a project, the County must receive confirmation in writing from the SSHCP Implementing Entity that the proposed species and habitat take is consistent with the SSHCP's "jump-start" and "stay-ahead" requirements pursuant to Chapter 9 of the SSHCP.

C. The County is responsible for ensuring that the proposed project's design and construction is in compliance with SSHCP requirements pursuant to Chapter 10 of the SSHCP, and for ensuring that monitoring of avoidance and minimization measures occur during construction pursuant to Chapter 8 of the SSHCP.

D. The County will collect all information required for the SSHCP annual report for each Covered Activity that it approves.

E. The County will pay SSHCP fees related to its own projects and collect SSHCP fees from third-party project proponents. If a third party project proponent proposes to provide land or a conservation easement instead of paying a fee to satisfy mitigation requirements, the SSHCP Implementing Entity must review the proposed land dedication or the conservation easement for consistency with the conservation strategy outlined in Chapter 7 of the SSHCP.

F. The County will provide the SSHCP Implementing Entity with copies of each approved project application package, whether it is its own application package or a third-party project proponent's.

G. The County will adopt the SSHCP fee as set by the SSHCP Implementing Entity.

H. The County will ensure that Covered Activities that they undertake and Covered Activities conducted by third-party project proponents are consistent with the requirements of the Aquatic Resources Plan.

SECTION IV. DEFINITIONS

For purposes of this Resolution, the following terms shall have the meaning set forth herein:

A. "Plan Area" means the area in which all conservation actions will be implemented and generally where the Plan Permittees have Take Authorization for Covered Species and species habitat resulting from Covered Activities.

B. "SSHCP" means the South Sacramento Habitat Conservation Plan prepared by Plan Permittees as depicted on Figure XX attached to the SSHCP.

C. "SSHCP Plan Map" means the map of the area encompassed by the SSHCP as set forth in the attached Exhibit "1."

D. "Project" means any action or activity that is a Covered Activity as described in Chapter 5 of the SSHCP that are implemented in the Plan Area by the Plan Permittees, or implemented by third parties (e.g. project proponents or private developers) that are subject to the jurisdiction of a Plan Permittee.

On a motion by Supervisor ______________, seconded by Supervisor ______________, the foregoing Resolution was passed and adopted by the Board of Supervisors of the County of Sacramento, State of California this _______ day of ______________ 2016, by the following vote, to wit:

AYES: Supervisors,

NOES: Supervisors,

ABSENT: Supervisors,

ABSTAIN: Supervisors,

RECUSAL: Supervisors,
(PER POLITICAL REFORM ACT (§ 18702.5.))

____
Chair of the Board of Supervisors
of Sacramento County, California

(SEAL)

ATTEST: ________________________
Clerk, Board of Supervisors

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EXHIBIT 1

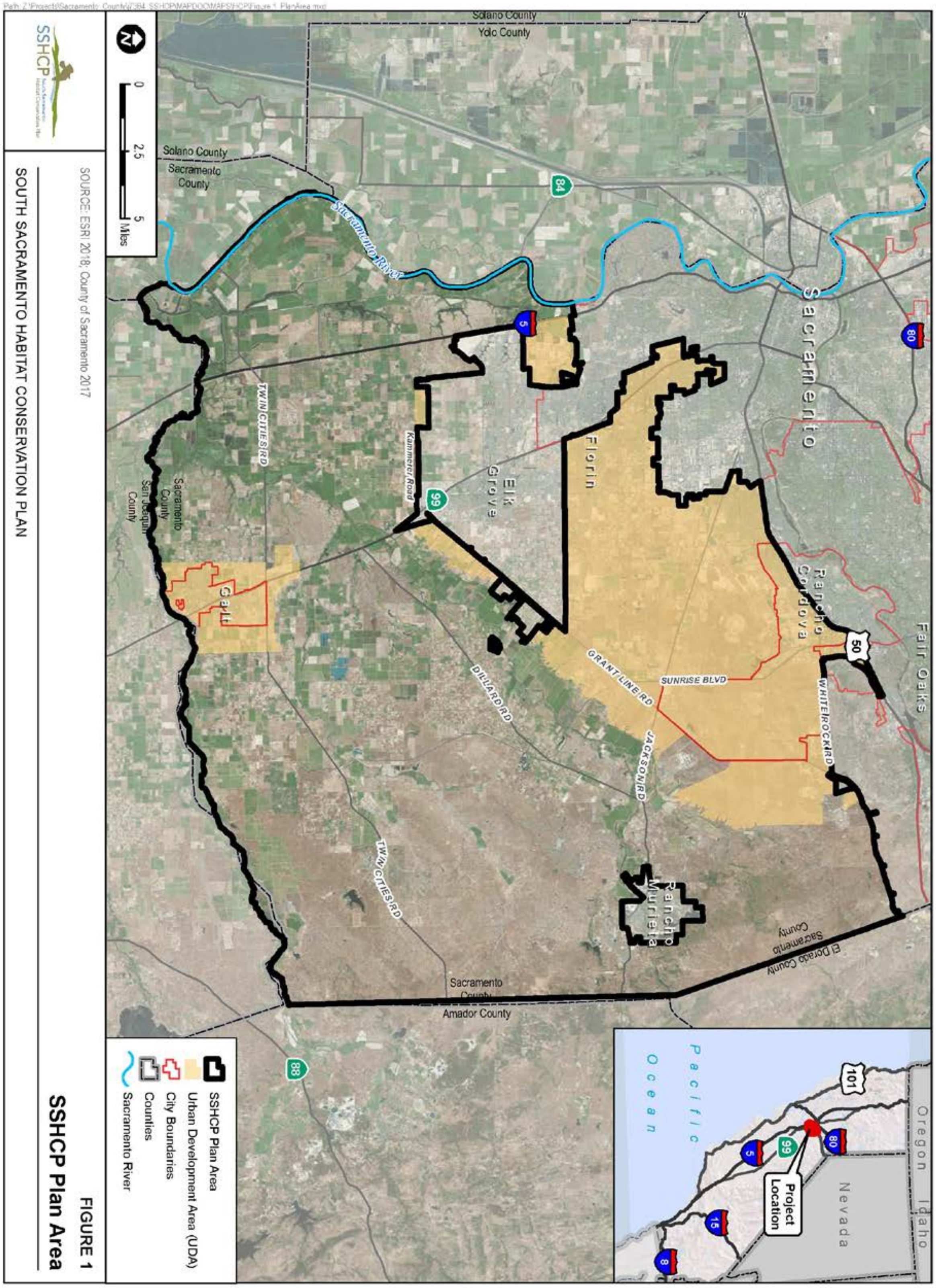


FIGURE 1
SSHCP Plan Area
SOUTH SACRAMENTO HABITAT CONSERVATION PLAN
SOURCE: ESRI 2018; County of Sacramento 2017
SSHCP Plan Area
Urban Development Area (UDA)
City Boundaries
Counties
Sacramento River
0
2.5
5
Miles
Sacramento
Elk Grove
Florin
Rancho Cordova
Fair Oaks
Galt
Rancho Murieta
Solano County
Yolo County
Sacramento County
San Joaquin County
Amador County
El Dorado County
Sacramento River
Kammerer Road
TWIN CITIES RD
GRANT LINE RD
SUNRISE BLVD
WHITE ROCK RD
JACKSON RD
DILLARD RD
Pacific Ocean
Oregon
Idaho
Nevada
Project Location

Recording requested, and when
recorded, return to:

South Sacramento Conservation Agency
Street Address
City, State, Zip
Attn: Executive Director

(space above this line reserved for recorder's use)

SAMPLE CONSERVATION EASEMENT DEED AND AGREEMENT CREATING ENFORCEABLE RESTRICTIONS IN PERPETUITY

CONSERVATION EASEMENT DEED

THIS GRANT DEED OF HABITAT CONSERVATION EASEMENT (the "Grant") is made as of ______ ___, 20XX by and between the _________________________________, a ______________________, as "Grantor" and the South Sacramento Conservation Agency, a California nonprofit public benefit corporation, as "Grantee."

RECITALS

A. Grantor owns real property consisting of approximately _____ acres, in Sacramento County, California, as described in Exhibit A and shown more particularly on the map attached as Exhibit B, attached hereto and incorporated herein, which together with all appurtenances thereto, including without limitation all mineral and mineral rights, if any, and all water and water rights appurtenant to such land (collectively, the "Property").

B. The Property possesses wildlife and habitat values of great importance to Grantor, Grantee, the people of the State of California and the people of the United States. The Property will provide high quality natural habitat for [***specify plant and/or animal species***] and contain [***list habitats; native and/or non-native***], [***include the following phrase only if there are jurisdictional wetlands:*** and restored, created, enhanced and/or preserved jurisdictional waters of the United States]. Individually and collectively, these wildlife and habitat values comprise the "Conservation Values" of the Property.

C. The Property is comprised of open space land, , which also provide essential habitat for South Sacramento Habitat Conservation Plan (SSHCP) Covered Species, and other significant relatively natural habitat and buffer for many species of wildlife.

D. Protection and preservation of the Property, including its wildlife habitat, shall assure that this area and its existing features shall continue to be available for SSHCP Covered Species and other natural habitat values and buffer for wildlife, a significant public benefit by preserving open space against development pressure, and scenic qualities.

E. As fee owner, Grantor owns the affirmative rights to identify, preserve, and protect forever the existing features and Conservation Values of the Property.

F. _____________, a _________, paid for the acquisition of this Conservation Easement Deed for Agricultural Land and Agreement Creating Enforceable Restrictions in Perpetuity from Grantor and provided ___________ Dollars ($_______) in management funds to Grantee to satisfy mitigation requirements imposed by the South Sacramento Habitat Conservation Plan (SSHCP), Plan Participant ______ (the "Plan Participant").

G. The State of California recognizes the public importance and validity of habitat conservation easements by enactment of Section 815 et seq. of the California Civil Code, and Grantee is an entity qualified under such Civil Code provisions to hold conservation easements.

H. Grantee is authorized to hold conservation easements pursuant to California Civil Code §815.3 and, as relevant to tax-exempt non-profit organizations, §501(c)(3) of the Internal Revenue Code.

I. To accomplish all of the aforementioned purposes, Grantor intends to convey to Grantee, and Grantee intends to obtain from Grantor, a Conservation Easement over a portion of the Property (the 'Easement Area"). The Easement Area is more particularly described in Exhibit C attached hereto and incorporated herein and depicted on the map in Exhibit D attached hereto to and incorporated herein (the "Easement Area Map") restricting the use which may be made of the Property to preserve and protect forever the agricultural, open-space, foraging and/or nesting habitat for SSHCP Covered Species and other wildlife habitat and scenic values of the Property.

COVENANTS, TERMS, CONDITIONS AND RESTRICTIONS

For good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, and pursuant to the laws of the United States and the State of California, including California Civil Code Section 815, *et seq.*, Grantor hereby voluntarily grants and conveys to Grantee a conservation easement in perpetuity over the Property.

1. Purposes.

The purposes of this Conservation Easement are to ensure that the Property will be retained forever in its natural, restored, or enhanced condition and to prevent any use of the Property that will impair or interfere with the Conservation Values of the Property. Grantor intends that this Conservation Easement will confine the use of the Property to activities that are consistent with such purposes, including, without limitation, those involving the preservation, restoration and enhancement of native species and their habitats.

2. Easement Documentation Report.

The parties acknowledge that a Preserve Documentation Report (the "Report") of the Property has been prepared by a competent biologist familiar with the environs and approved by Grantor and Grantee in writing, a copy of which is on file with Grantor and Grantee at their respective address for notices, set forth below. Selected portions of the Report are attached hereto as Exhibit C. The parties agree that the Report contains an accurate representation of the biological and physical condition of the Property at the time of this Grant, and of the historical uses of the Property, including historical water uses. Notwithstanding the forgoing, if a controversy arises with respect to the nature and extent of the physical, biological condition of the Property or the permitted historical uses of the Property, the parties shall not be foreclosed from utilizing any and all other relevant documents, surveys or other evidence or information to assist in the resolution of the controversy. The Report includes an aerial photograph where the "Agricultural Area" of the Property is delineated.

3. Grantee's Rights.

To accomplish the purposes of this Conservation Easement, Grantor hereby grants and conveys the following rights to Grantee:

(a) To preserve and protect the Conservation Values of the Property.

(b) To enter the Property at reasonable times, in order to monitor compliance with and otherwise enforce the terms of this Conservation Easement and any Management Plan developed for the Property and to implement at Grantee's sole discretion Management Plan activities that have not been implemented, provided that Grantee shall not unreasonably interfere with Grantor's authorized use and quiet enjoyment of the Property.

(c) To prevent any activity on or use of the Property that is inconsistent with the purposes of this Conservation Easement and to require the restoration of such areas or features of the Property that may be damaged by any act, failure to act, or any use or activity that is inconsistent with the purposes of this Conservation Easement.

(d) To require that all mineral, air and water rights as Grantee deems necessary to preserve and protect the biological resources and Conservation Values of the Property shall remain a part of and be put to beneficial use upon the Property, consistent with the purposes of this Conservation Easement.

(e) All present and future development rights appurtenant to, allocated, implied, reserved or inherent in the Property; such rights are hereby terminated and extinguished, and may not be used on or transferred to any portion of the Property, nor any other property adjacent or otherwise.

(f) Grantee may erect a sign or other appropriate marker in a prominent location on the Property, visible from a public road, bearing information indicating that the environmental and scenic resources of the Property are protected by Grantee. The wording of the information on the sign shall be jointly determined by Grantee and Grantor, but shall clearly indicate that the Property is privately owned and not open to the public. Grantee shall be responsible for the costs of erecting and maintaining its sign or marker.

(g) Subject to Grantor's approval, which approval shall not be unreasonably withheld or denied, Grantee shall have the right to conduct fish, wildlife, plant, and habitat studies on the Property, as well as research and monitoring on the Property, provided that such studies, research, and monitoring shall be carried out in a manner that shall not interfere unreasonably with the permitted use(s) or enjoyment of the Property by Grantor, its successors in interest, or any legally recognized occupant(s) or user(s) of the Property. Any other parties interested in conducting scientific studies on the Property are subject to the approval of Grantor, and such approval shall not be unreasonably withheld or denied.

4. <u>Prohibited Uses</u>.

Any activity on or use of the Property that is inconsistent with the purposes of this Conservation Easement is prohibited. Without limiting the generality of the foregoing, the following uses and activities by Grantor, Grantor's agents, and third parties are expressly prohibited:

(a) Unseasonable watering; use of fertilizers, pesticides, biocides, herbicides or other agricultural chemicals; weed abatement activities; incompatible fire protection activities; and any and all other activities and uses which may impair or interfere with the purposes of this Conservation Easement [***include the following language only if the Management Plan, including any adaptive management measures, specifies such an exception:***], except for [***insert specific exception(s)***] as specifically provided in the Management Plan.

(b) Use of off-road vehicles and use of any other motorized vehicles except on existing roadways [***include the following language only if the Management Plan, including any adaptive management measures, specifies such an exception:***], except for [***insert specific exception(s)***] as specifically provided in the Management Plan.

(c) Agricultural activity of any kind [***include the following language only if the Management Plan, including any adaptive management measures, specifies such an exception:***] except grazing for vegetation management as specifically provided in the Management Plan.

(d) Recreational activities, including, but not limited to, horseback riding, biking, hunting or fishing except for personal, non-commercial, recreational activities of the Grantor, so long as such activities are consistent with the purposes of this Conservation Easement and specifically provided for in the Management Plan.

(e) Commercial, industrial, residential, or institutional uses.

(f) Any legal or de facto division, subdivision or partitioning of the Property.

(g) Construction, reconstruction, erecting or placement of any building, billboard or sign, or any other structure or improvement of any kind [***include the following language only if the Management Plan specifies such an exception:***], except for [***insert specific exception(s)***] as specifically provided in the Management Plan.

(h) Depositing or accumulation of soil, trash, ashes, refuse, waste, bio-solids or any other materials.

(i) Planting, introduction or dispersal of non-native or exotic plant or animal species.

(j) Filling, dumping, excavating, draining, dredging, mining, drilling, removing or exploring for or extracting minerals, loam, soil, sand, gravel, rock or other material on or below the surface of the Property, or granting or authorizing surface entry for any of these purposes.

(k) Altering the surface or general topography of the Property, including but not limited to any alterations to habitat, building roads or trails, paving or otherwise covering the Property with concrete, asphalt or any other impervious material except for those habitat management activities specified in the Management Plan.

(l) Removing, destroying, or cutting of trees, shrubs or other vegetation, except as required by law for (i) fire breaks, (ii) maintenance of existing foot trails or roads, or (iii) prevention or treatment of disease [***include the following language only if the Management Plan specifies such an exception:***]; and except for [***insert specific exception(s)***] as specifically provided in the Management Plan.

(m) Manipulating, impounding or altering any natural water course, body of water or water circulation on the Property, and any activities or uses detrimental to water quality, including but not limited to degradation or pollution of any surface or sub-surface waters [***include the following language only if the Management Plan specifies such an exception:***], except for [***insert specific exception(s)***] as specifically provided in the Management Plan].

(n) Without the prior written consent of Grantee, which Grantee may withhold, transferring, encumbering, selling, leasing, or otherwise separating the mineral, air or water rights for the Property; changing the place or purpose of use of the water rights; abandoning or allowing the abandonment of, by action or inaction, any water or water rights, ditch or ditch rights, spring rights, reservoir or storage rights, wells, ground water rights, or other rights in and to the use of water historically used on or otherwise appurtenant to the Property, including but not limited to: (i) riparian water rights; (ii) appropriative water rights; (iii) rights to waters which are secured under contract with any irrigation or water district, to the extent such waters are customarily applied to the Property; and (iv) any water from wells that are in existence or may be constructed in the future on the Property.

(o) Engaging in any use or activity that may violate, or may fail to comply with, relevant federal, state, or local laws, regulations, or policies applicable to Grantor, the Property, or the use or activity in question.

5. Grantee's Duties.

(a) To ensure that the purposes of this Conservation Easement as described in

Section 1 are being accomplished, Grantee and its successors and assigns shall:

(1) Perform, at a minimum on an annual basis, compliance monitoring inspections of the Property; and

(2) Prepare reports on the results of the compliance monitoring inspections, and provide these reports to the Signatory Agencies on an annual basis.

(b) In the event that the Grantee’s interest in this Conservation Easement reverts to or is transferred to the State of California, CDFW will carry out the tasks specified in Section 4(a) to the extent that funds and staff are available for that purpose. If CDFW determines that it cannot carry out the specified tasks, the Third Party Beneficiaries may identify a replacement Grantee, acceptable to all, and CDFW, subject to obtaining all necessary approvals, will transfer this Conservation Easement to the identified replacement Grantee in compliance with Section 10(a) of this Conservation Easement.

6. Grantor's Duties.

Grantor shall undertake all reasonable actions to prevent the unlawful entry and trespass by persons whose activities may degrade or harm the Conservation Values of the Property or that are otherwise inconsistent with this Conservation Easement. In addition, Grantor shall undertake all necessary actions to perfect and defend Grantee’s rights under Section 3 of this Conservation Easement, and to observe and carry out the obligations of Grantor under the Management Plan.

7. Reserved Rights.

Grantor reserves to itself, and to its personal representatives, heirs, successors, and assigns, all rights accruing from Grantor's ownership of the Property, including the right to engage in or permit or invite others to engage in all uses of the Property that are not prohibited or limited by, and are consistent with the purposes of, this Conservation Easement.

8. Grantee's Remedies.

If Grantee determines that a violation of this Conservation Easement has occurred or is threatened, Grantee shall give written notice to Grantor of such violation and demand in writing the cure of such violation (“Notice of Violation”). If Grantor fails to cure the violation within thirty (30) days after receipt of a Notice of Violation, or if the cure reasonably requires more than thirty (30) days to complete and Grantor fails to begin the cure within the thirty (30)-day period or fails to continue diligently to complete the cure, Grantee may bring an action at law or in equity in a court of competent jurisdiction for any or all of the following: to recover any damages to which Grantee may be entitled for violation of the terms of this Conservation Easement or for any injury to the Conservation Values of the Property; to enjoin the violation, *ex parte* as necessary, by temporary or permanent injunction without the necessity of proving either actual damages or the inadequacy of otherwise available legal remedies; to pursue any other legal or equitable relief, including but not limited to, the restoration of the Property to the condition in which it existed prior to any violation or injury; or to otherwise enforce this

Conservation Easement. Without limiting the liability of Grantor, Grantee may apply any damages recovered to the cost of undertaking any corrective action on the Property.

If Grantee, in its sole discretion, determines that circumstances require immediate action to prevent or mitigate injury to the Conservation Values of the Property, Grantee may pursue its remedies under this Conservation Easement without prior notice to Grantor or without waiting for the period provided for cure to expire. Grantee's rights under this section apply equally to actual or threatened violations of this Conservation Easement.

Grantor agrees that Grantee's remedies at law for any violation of this Conservation Easement are inadequate and that Grantee shall be entitled to the injunctive relief described in this section, both prohibitive and mandatory, in addition to such other relief to which Grantee may be entitled, including specific performance of this Conservation Easement, without the necessity of proving either actual damages or the inadequacy of otherwise available legal remedies. Grantee's remedies described in this section shall be cumulative and shall be in addition to all remedies now or hereafter existing at law or in equity, including but not limited to the remedies set forth in California Civil Code Section 815, *et seq.* The failure of Grantee to discover a violation or to take immediate legal action shall not bar Grantee from taking such action at a later time.

(a) Costs of Enforcement.

All costs incurred by Grantee, where Grantee is the prevailing party, in enforcing the terms of this Conservation Easement against Grantor, including, but not limited to, costs of suit and attorneys' and experts' fees, and any costs of restoration necessitated by negligence or breach of this Conservation Easement, shall be borne by Grantor.

(b) Grantee's Discretion.

Enforcement of the terms of this Conservation Easement by Grantee shall be at the discretion of Grantee, and any forbearance by Grantee to exercise its rights under this Conservation Easement in the event of any breach of any term of this Conservation Easement shall not be deemed or construed to be a waiver of such term or of any subsequent breach of the same or any other term of this Conservation Easement or of any rights of Grantee under this Conservation Easement. No delay or omission by Grantee in the exercise of any right or remedy shall impair such right or remedy or be construed as a waiver.

(c) Acts Beyond Grantor's Control.

Nothing contained in this Conservation Easement shall be construed to entitle Grantee to bring any action against Grantor for any injury to or change in the Property resulting from (i) any natural cause beyond Grantor's control, including, without limitation, fire not caused by Grantor, flood, storm, and earth movement, or any prudent action taken by Grantor under emergency conditions to prevent, abate, or mitigate significant injury to the Property resulting from such causes; or (ii) acts by Grantee or its employees.

(d) Enforcement; Standing.

All rights and remedies conveyed to Grantee under this Conservation Easement shall extend to and are enforceable by the Third-Party Beneficiaries (as defined in Section 15(m)). These enforcement rights are in addition to, and do not limit, the rights of enforcement under the Management Plan. If at any time in the future Grantor uses, allows the use, or threatens to use or allow use of, the Property for any purpose that is inconsistent with or in violation of this Conservation Easement then, despite the provisions of California Civil Code Section 815.7, the California Attorney General and the Third-Party Beneficiaries each has standing as an interested party in any proceeding affecting this Conservation Easement.

(e) Notice of Conflict.

If Grantor receives a Notice of Violation from Grantee or a Third-Party Beneficiary with which it is impossible for Grantor to comply consistent with any prior uncured Notice(s) of Violation, Grantor shall give written notice of the conflict (hereinafter "Notice of Conflict") to the Grantee and Third-Party Beneficiaries. In order to be valid, a Notice of Conflict shall be given within fifteen (15) days of the date Grantor receives a conflicting Notice of Violation, shall include copies of the conflicting Notices of Violation, and shall describe the conflict with specificity, including how the conflict makes compliance with the uncured Notice(s) of Violation impossible. Upon issuing a valid Notice of Conflict, Grantor shall not be required to comply with the conflicting Notices of Violation until such time as the entity or entities issuing said conflicting Notices of Violation issue(s) revised Notice(s) of Violation that resolve the conflict. Upon receipt of a revised Notice of Violation, Grantor shall comply with such notice within the time period(s) described in the first grammatical paragraph of this Section. The failure of Grantor to issue a valid Notice of Conflict within fifteen (15) days of receipt of a conflicting Notice of Violation shall constitute a waiver of Grantor's ability to claim a conflict.

(f) Reversion.

If the Signatory Agencies determine that Grantee is not holding, monitoring or managing this Conservation Easement for conservation purposes in the manner specified in this Conservation Easement or the Management Plan then, pursuant to California Government Code Section 65965(c), this Conservation Easement shall revert to the State of California, or to another public agency or nonprofit organization qualified pursuant to Civil Code Section 815.3 and Government Code Section 65965 (and any successor or other provision(s) then applicable) and approved by the Signatory Agencies.

9. Access.

This Conservation Easement does not convey a general right of access to the public.

10. Costs and Liabilities.

Grantor retains all responsibilities and shall bear all costs and liabilities of any kind related to the ownership, operation, upkeep, and maintenance of the Property. Grantor agrees that neither Grantee nor Third-Party Beneficiaries shall have any duty or responsibility for the operation, upkeep or maintenance of the Property, the monitoring of hazardous conditions on it, or the protection of Grantor, the public or any third parties from risks relating to conditions on the Property. Grantor remains solely responsible for obtaining any applicable governmental permits and approvals required for any activity or use permitted by this Conservation Easement and any activity or use shall be undertaken in accordance with all applicable federal, state, local and administrative agency laws, statutes, ordinances, rules, regulations, orders and requirements.

(a) Taxes; No Liens.

Grantor shall pay before delinquency all taxes, assessments (general and special), fees, and charges of whatever description levied on or assessed against the Property by competent authority (collectively "Taxes"), including any Taxes imposed upon, or incurred as a result of, this Conservation Easement, and shall furnish Grantee with satisfactory evidence of payment upon request. Grantor shall keep the Property free from any liens (other than a security interest that is expressly subordinated to this Conservation Easement, as provided in Section 15(k)), including those arising out of any obligations incurred by Grantor for any labor or materials furnished or alleged to have been furnished to or for Grantor at or for use on the Property.

(b) Hold Harmless.

(1) Grantor shall hold harmless, protect and indemnify Grantee and its directors, officers, employees, agents, contractors, and representatives and the heirs, personal representatives, successors and assigns of each of them (each a "Grantee Indemnified Party" and collectively, "Grantee's Indemnified Parties") from and against any and all liabilities, penalties, costs, losses, damages, expenses (including, without limitation reasonable attorneys' fees and experts' fees), causes of action, claims, demands, orders, liens or judgments (each a "Claim" and, collectively, "Claims"), arising from or in any way connected with: (i) injury to or the death of any person, or physical damage to any property, resulting from any act, omission, condition, or other matter related to or occurring on or about the Property, regardless of cause, except that this indemnification shall be inapplicable to any Claim due solely to the negligence of Grantee or any of its employees; (ii) the obligations specified in Sections 6, 10 and 10(a); and (iii) the existence or administration of this Conservation Easement. If any action or proceeding is brought against any of the Grantee's Indemnified Parties by reason of any such Claim, Grantor shall, at the election of and upon written notice from Grantee, defend such action or proceeding by counsel reasonably acceptable to the Grantee's Indemnified Party or reimburse Grantee for all charges incurred for services of the California Attorney General in defending the action or proceeding].

(2) Grantor shall hold harmless, protect and indemnify Third-Party Beneficiaries and their respective directors, officers, employees, agents, contractors, and representatives and the heirs, personal representatives, successors and assigns of each of them (each a "Third-Party Beneficiary Indemnified Party" and collectively, "Third-Party Beneficiary Indemnified Parties") from and against any and all Claims arising from or in any way connected with: (i) injury to or the death of any person, or physical damage to any property, resulting from any act, omission, condition, or other matter related to or occurring on or about the Property, regardless of cause and (ii) the existence or administration of this Conservation Easement. *Provided, however,* that the indemnification in this Section 10 (b) (2) shall be inapplicable to a Third-Party Beneficiary Indemnified Party with respect to any Claim due solely to the negligence of that Third-Party Beneficiary Indemnified Party or any of its employees. If any action or proceeding is brought against any of the Third-Party Beneficiary Indemnified Parties by reason of any Claim to which the indemnification in this Section 10 (b) (2) applies, then at the election of and upon written notice from the Third-Party Beneficiary Indemnified Party, Grantor shall defend such action or proceeding by counsel reasonably acceptable to the applicable Third-Party Beneficiary Indemnified Party or reimburse the Third-Party Beneficiary Indemnified Party for all charges incurred for services of the California Attorney General or the U.S. Department of Justice in defending the action or proceeding.

(c) Extinguishment.

If circumstances arise in the future that render the preservation of Conservation Values, [***include this phrase only if there are jurisdictional wetlands:*** including wetland functions and values,] or other purposes of this Conservation Easement impossible to accomplish, this Conservation Easement can only be terminated or extinguished, in whole or in part, by judicial proceedings in a court of competent jurisdiction.

(d) Condemnation.

If all or part of the Property is taken in exercise of eminent domain by public, corporate, or other authority so as to abrogate the restrictions imposed by this Conservation Easement, Grantor and Grantee shall join in appropriate actions at the time of such taking to recover the full value of the taking and all incidental or direct damages resulting from the taking. All expenses incurred by Grantor and Grantee in such action shall be paid out of the recovered proceeds. The remaining proceeds shall be divided consistent with the provisions of this Paragraph using the ratio of the value of Grantee's and Grantor's interests that is set forth in subparagraph A above, it being expressly agreed that the Conservation Easement constitutes a compensable property right.

11. Transfer of Conservation Easement or Property.

(a) Conservation Easement.

This Conservation Easement may be assigned or transferred by Grantee upon written approval of the Signatory Agencies, which approval shall not be unreasonably withheld or delayed, but Grantee shall give Grantor and the Signatory Agencies at least sixty (60) days prior written notice of the proposed assignment or transfer. Grantee may assign or transfer its rights under this Conservation Easement only to an entity or organization: (i) authorized to acquire and hold conservation easements pursuant to California Civil Code Section 815.3 and Government Code Section 65967 (and any successor or other provision(s) then applicable), or the laws of the United States; and (ii) otherwise reasonably acceptable to the Signatory Agencies. Grantee shall require the assignee to record the assignment in the county where the Property is located. The failure of Grantee to perform any act provided in this section shall not impair the validity of this Conservation Easement or limit its enforcement in any way. Any transfer under this section is subject to the requirements of Section 12.

(b) Property.

Grantor agrees to incorporate the terms of this Conservation Easement by reference in any deed or other legal instrument by which Grantor divests itself of any interest in all or any portion of the Property, including, without limitation, a leasehold interest. Grantor agrees that the deed or other legal instrument shall also incorporate by reference the Management Plan, and any amendment(s) to those documents. Grantor further agrees to give written notice to Grantee and the Signatory Agencies of the intent to transfer any interest at least sixty (60) days prior to the date of such transfer. Grantee or the Signatory Agencies shall have the right to prevent any transfers in which prospective subsequent claimants or transferees are not given notice of the terms, covenants, conditions and restrictions of this Conservation Easement (including the exhibits and documents incorporated by reference in it). The failure of Grantor to perform any act provided in this section shall not impair the validity of this Conservation Easement or limit its enforceability in any way. Any transfer under this section is subject to the requirements of Section 12.

12. Merger.

The doctrine of merger shall not operate to extinguish this Conservation Easement if the Conservation Easement and the Property become vested in the same party. If, despite this intent, the doctrine of merger applies to extinguish the Conservation Easement then, unless Grantor, Grantee, and the Signatory Agencies otherwise agree in writing, a replacement conservation easement or restrictive covenant containing the same protections embodied in this Conservation Easement shall be recorded against the Property.

13. Notices.

Any notice, demand, request, consent, approval, or other communication that Grantor or Grantee desires or is required to give to the other shall be in writing, with a copy to each of the Signatory Agencies, and served personally or sent by recognized overnight courier that guarantees next-day delivery or by first class United States mail, postage fully prepaid, addressed as follows:

To Grantor:	[Grantee name] [Grantee address] Attn:______________________
To Grantee:	[***insert the appropriate Grantee information:***]

[***Remove/modify the following blocks as appropriate when CDFW or the USFWS are not third-party beneficiaries to the CE.***]

To CDFW:	[Department of Fish and Game] [Region name] Region [REGION ADDRESS] [Attn: Regional Manager]
With a copy to:	Department of Fish and Game Office of General Counsel 1416 Ninth Street, 12th Floor Sacramento, CA 95814-2090 Attn: General Counsel
To USFWS:	United States Fish and Wildlife Service [Field Office name] Field Office [FIELD OFFICE ADDRESS] Attn: Field Supervisor

or to such other address a party or a Signatory Agency shall designate by written notice to Grantor, Grantee and the Signatory Agencies. Notice shall be deemed effective upon delivery in the case of personal delivery or delivery by overnight courier or, in the case of delivery by first class mail, three (3) days after deposit into the United States mail.

14. Amendment.

This Conservation Easement may be amended only by mutual written agreement of Grantor and Grantee and written approval of the Signatory Agencies, which approval shall not be unreasonably withheld or delayed. Any such amendment shall be consistent with the purposes of this Conservation Easement and California law governing conservation easements, and shall not affect its perpetual duration. Any such amendment shall be recorded in the official records of the county in which the Property is located, and Grantee shall promptly provide a conformed copy of the recorded amendment to the Grantor and the Signatory Agencies.

15. Additional Provisions.

(a) Controlling Law.

The interpretation and performance of this Conservation Easement shall be governed by the laws of the United States and the State of California, disregarding the conflicts of law principles of such state.

(b) Liberal Construction.

Despite any general rule of construction to the contrary, this Conservation Easement shall be liberally construed to effect the purposes of this Conservation Easement and the policy and purpose of California Civil Code Section 815, *et seq.* and Government Code Section 65965. If any provision in this instrument is found to be ambiguous, an interpretation consistent with the purposes of this Conservation Easement that would render the provision valid shall be favored over any interpretation that would render it invalid.

(c) Severability.

If a court of competent jurisdiction voids or invalidates on its face any provision of this Conservation Easement, such action shall not affect the remainder of this Conservation Easement. If a court of competent jurisdiction voids or invalidates the application of any provision of this Conservation Easement to a person or circumstance, such action shall not affect the application of the provision to any other persons or circumstances.

(d) Entire Agreement.

This document (including its exhibits and the Management Plan incorporated by reference in this document) sets forth the entire agreement of the parties and the Signatory Agencies with respect to the Conservation Easement and supersedes all prior discussions, negotiations, understandings, or agreements of the parties relating to the Conservation Easement. No alteration or variation of this Conservation Easement shall be valid or binding unless contained in an amendment in accordance with Section 14.

(e) No Forfeiture.

Nothing contained in this Conservation Easement will result in a forfeiture or reversion of Grantor's title in any respect.

(f) Successors.

The covenants, terms, conditions, and restrictions of this Conservation Easement shall be binding upon, and inure to the benefit of, the parties and their respective personal representatives, heirs, successors, and assigns, and shall constitute a servitude running in perpetuity with the Property.

(g) Termination of Rights and Obligations.

A party's rights and obligations under this Conservation Easement terminate upon transfer of the party's interest in the Conservation Easement or Property, except that liability for acts, omissions or breaches occurring prior to transfer shall survive transfer.

(h) Captions.

The captions in this instrument have been inserted solely for convenience of reference and are not a part of this instrument and shall have no effect upon its construction or interpretation.

(i) No Hazardous Materials Liability.

(1) Grantor represents and warrants that it has no knowledge or notice of any Hazardous Materials (defined below) or underground storage tanks existing, generated, treated, stored, used, released, disposed of, deposited or abandoned in, on, under, or from the Property, or transported to or from or affecting the Property.

(2) Without limiting the obligations of Grantor under Section 10 (b), Grantor hereby releases and agrees to indemnify, protect and hold harmless the Grantee's Indemnified Parties (defined in Section 10 (b) (1)) from and against any and all Claims (defined in Section 10 (b)(1)) arising from or connected with any Hazardous Materials or underground storage tanks present, alleged to be present, released in, from or about, or otherwise associated with the Property at any time, except any Hazardous Materials placed, disposed or released by Grantee or any of its employees. This release and indemnification includes, without limitation, Claims for (A) injury to or death of any person or physical damage to any property; and (B) the violation or alleged violation of, or other failure to comply with, any Environmental Laws (defined below). If any action or proceeding is brought against any of the Grantee's Indemnified Parties by reason of any such Claim, Grantor shall, at the election of and upon written notice from the applicable Grantee Indemnified Party, defend such action or proceeding by counsel reasonably acceptable to the Grantee Indemnified Party or reimburse Grantee for all charges incurred for services of the California Attorney General in defending the action or proceeding].

(3) Without limiting the obligations of Grantor under Section 10 (b), Grantor hereby releases and agrees to indemnify, protect and hold harmless the Third-Party Beneficiary Indemnified Parties (defined in Section 10 (b)(2)) from and against any and all Claims arising from or connected with any Hazardous Materials or underground storage tanks present, alleged to be present, released in, from or about, or otherwise associated with the Property at any time, except that this release and indemnification shall be inapplicable to a Third-Party Beneficiary Indemnified Party with respect to any Hazardous Materials placed, disposed or released by that Third-Party Beneficiary Indemnified Party or any of its employees. This release

and indemnification includes, without limitation, Claims for (A) injury to or death of any person or physical damage to any property; and (B) the violation of alleged violation of, or other failure to comply with, any Environmental Laws. If any action or proceeding is brought against any of the Third-Party Beneficiary Indemnified Parties by reason of any such Claim, Grantor shall, at the election or and upon written notice from the applicable Third-Party Beneficiary Indemnified Party, defend such action or proceeding by counsel reasonably acceptable to the Third-Party Beneficiary Indemnified Party for all charges incurred for services of the California Attorney General or the U.S. Department of Justice in defending the action or proceeding.

(4) Despite any contrary provision of this Conservation Easement, the parties do not intend this Conservation Easement to be, and this Conservation Easement shall not be, construed such that it creates in or gives to Grantee or any Third-Party Beneficiaries any of the following:

(A) The obligations or liability of an "owner" or "operator," as those terms are defined and used in Environmental Laws (defined below), including, without limitation, the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (42 U.S.C. § 9601, *et seq.*; hereinafter, "CERCLA"); or

(B) The obligations or liabilities of a person described in 42 U.S.C. § 9607(a)(3) or (4); or

(C) The obligations of a responsible person under any applicable Environmental Laws; or

(D) The right to investigate and remediate any Hazardous Materials associated with the Property; or

(E) Any control over Grantor's ability to investigate, remove, remediate or otherwise clean up any Hazardous Materials associated with the Property.

(5) The term "Hazardous Materials" includes, without limitation, (a) material that is flammable, explosive or radioactive; (b) petroleum products, including by-products and fractions thereof; and (c) hazardous materials, hazardous wastes, hazardous or toxic substances, or related materials defined in CERCLA, the Resource Conservation and Recovery Act of 1976 (42 U.S.C. § 6901, *et seq.*; hereinafter, "RCRA"); the Hazardous Materials Transportation Act (49 U.S.C. §5101, *et seq.*; hereinafter, "HTA"); the Hazardous Waste Control Law (California Health & Safety Code § 25100, *et seq.*; hereinafter, "HCL"); the Carpenter-Presley-Tanner Hazardous Substance Account Act (California Health & Safety Code § 25300, *et seq.*; hereinafter "HSA"), and in the regulations adopted and publications promulgated pursuant to them, or any other applicable Environmental Laws now in effect or enacted after the date of this Conservation Easement.

(6) The term "Environmental Laws" includes, without limitation, CERCLA, RCRA, HTA, HCL, HSA, and any other federal, state, local or administrative agency statute, ordinance, rule, regulation, order or requirement relating to pollution, protection of

human health or safety, the environment or Hazardous Materials. Grantor represents, warrants and covenants to Grantee and Third-Party Beneficiaries that activities upon and use of the Property by Grantor, its agents, employees, invitees and contractors will comply with all Environmental Laws.

(j) Warranty.

Grantor represents and warrants that Grantor is the sole owner of the Property. Grantor also represents and warrants that, [***choose applicable statement:*** there are no outstanding mortgages, liens, encumbrances or other interests in the Property (including, without limitation, mineral interests) which may conflict or are inconsistent with this Conservation Easement ***or*** the holder of any outstanding mortgage, lien, encumbrance or other interest in the Property (including, without limitation, mineral interest) which conflicts or is inconsistent with this Conservation Easement has expressly subordinated such interest to this Conservation Easement by a recorded Subordination Agreement approved by Grantee and the Signatory Agencies].

(k) Additional Interests.

Grantor shall not grant any additional easements, rights of way or other interests in the Property (other than a security interest that is expressly subordinated to this Conservation Easement), nor shall Grantor grant, transfer, abandon or relinquish (each a "Transfer") any mineral, air, or water right or any water associated with the Property, without first obtaining the written consent of Grantee and the Signatory Agencies. Such consent may be withheld if Grantee or the Signatory Agencies determine(s) that the proposed interest or Transfer is inconsistent with the purposes of this Conservation Easement or will impair or interfere with the Conservation Values of the Property. This Section 15(k) shall not limit the provisions of Section 3(d) or 4(n), nor prohibit transfer of a fee or leasehold interest in the Property that is subject to this Conservation Easement and complies with Section 11. Grantor shall provide a copy of any recorded or unrecorded grant or Transfer document to the Grantee and Signatory Agencies.

(l) Recording.

Grantee shall record this Conservation Easement in the Official Records of the County in which the Property is located, and may re-record it at any time as Grantee deems necessary to preserve its rights in this Conservation Easement.

(m) Third-Party Beneficiary.

Grantor and Grantee acknowledge that the [***include the agencies that will be third-party beneficiaries***] (the "Third-Party Beneficiaries") are third party beneficiaries of this Conservation Easement with the right of access to the Property and the right to enforce all of the obligations of Grantor including, but not limited to, Grantor's obligations under Section 15, and all other rights and remedies of the Grantee under this Conservation Easement.

(n) Funding.

Endowment funding for the perpetual management, maintenance and monitoring of the Property is specified in and governed by the South Sacramento Habitat Conservation Plan.

IN WITNESS WHEREOF Grantor has executed this Conservation Easement Deed the day and year first above written.

GRANTOR: [***Notarization Required***]

BY:_______________________________

NAME:____________________________

TITLE:____________________________

DATE: ______________________________

Approved as to form:

South Sacramento Conservation Agency:

BY: ______________________________

(Insert Name)

(Insert Title)

DATE: ____________________________

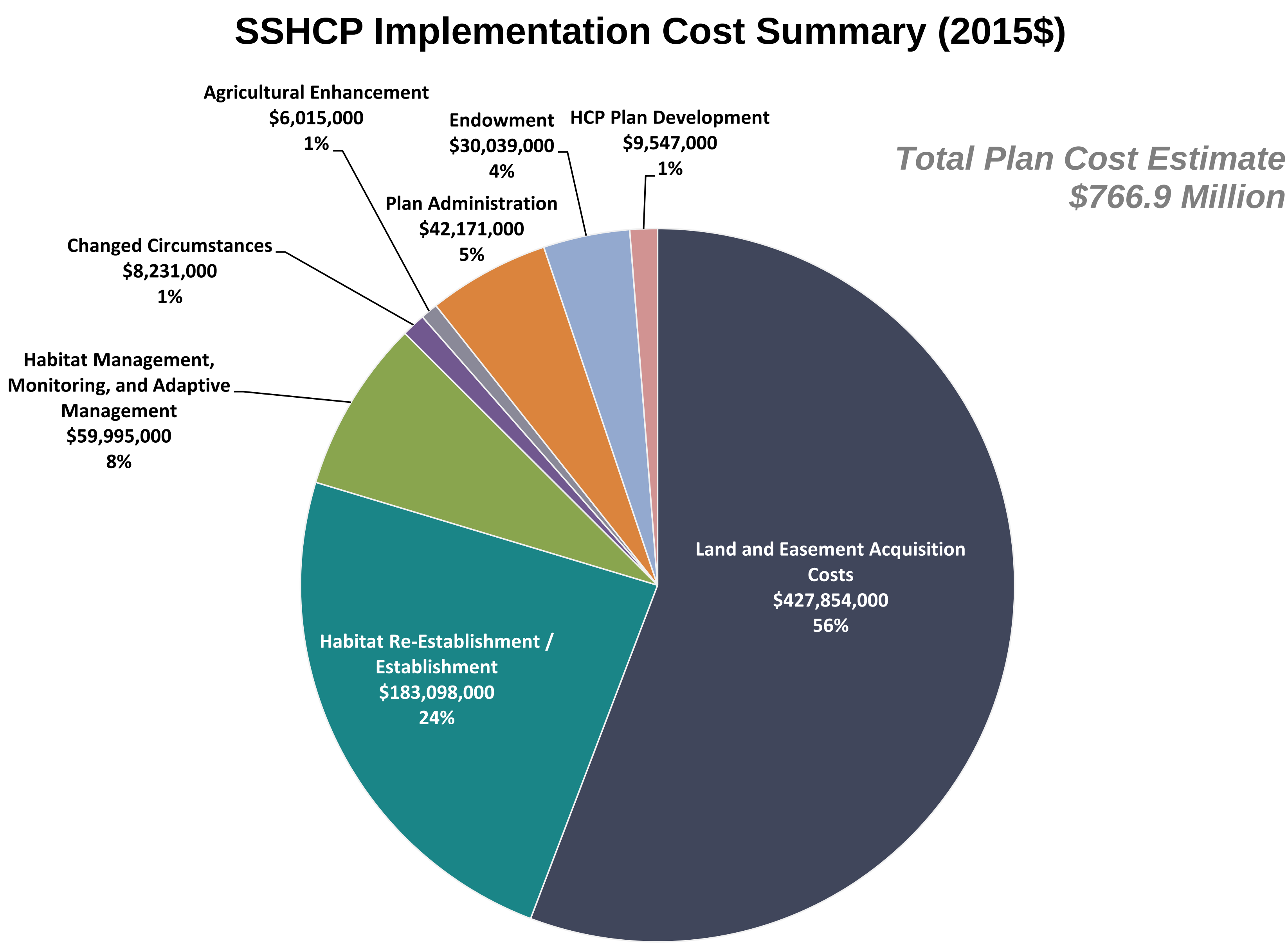
Approved as to form:

BY: ______________________________

(Insert Counsel Name)

APPENDIX I

SSHCP Economic Model



SSHCP Implementation Cost Summary (2015$)
Total Plan Cost Estimate
$766.9 Million
Agricultural Enhancement
$6,015,000
1%
Endowment
$30,039,000
4%
HCP Plan Development
$9,547,000
1%
Plan Administration
$42,171,000
5%
Changed Circumstances
$8,231,000
1%
Habitat Management, Monitoring, and Adaptive Management
$59,995,000
8%
Land and Easement Acquisition Costs
$427,854,000
56%
Habitat Re-Establishment / Establishment
$183,098,000
24%

Figure 1
SSHCP Implementation Cost Summary (2015$)
South Sacramento Habitat Conservation Plan Cost Analysis

Cost Category	Preservation Cost Estimate	Re-Establishment/ Establishment Cost Estimate	Total Cost Estimate	Distribution
Land and Easement Acquisition Costs	$404,519,000	$23,334,000	$427,854,000	55.8%
Habitat Re-Establishment / Establishment	$0	$183,098,000	$183,098,000	23.9%
Habitat Management, Monitoring, and Adaptive Management	$55,538,000	$4,458,000	$59,995,000	7.8%
Changed Circumstances	$7,649,000	$582,000	$8,231,000	1.1%
Agricultural Enhancement	$6,015,000	$0	$6,015,000	0.8%
Plan Administration	$40,094,000	$2,077,000	$42,171,000	5.5%
Endowment	$28,443,000	$1,595,000	$30,039,000	3.9%
HCP Plan Development	$9,077,000	$470,000	$9,547,000	1.2%
Total	**$551,334,000**	**$215,614,000**	**$766,948,000**	**100.0%**

Figure 2
SSHCP Implementation Cost Summary by Land Cover (2015$)
South Sacramento Habitat Conservation Plan Cost Analysis

Land Cover	Perservation Cost Estimate	Re-Establishment/ Establishment Cost Estimate	Total Cost Estimate	Distribution
Agriculture	$155,299,000	$0	$155,299,000	20%
Valley Grassland	$349,072,000	$0	$349,072,000	46%
Vernal Pool	$14,668,000	$61,455,000	$76,123,000	10%
Blue Oak	$989,000	$4,578,000	$5,567,000	1%
Riparian	$12,860,000	$40,336,000	$53,196,000	7%
Mine Tailing Riparian Woodland	$3,048,000	$28,099,000	$31,147,000	4%
Seasonal Wetland	$2,266,000	$12,183,000	$14,449,000	2%
Freshwater Marsh	$3,269,000	$14,127,000	$17,396,000	2%
Swale	$4,309,000	$26,139,000	$30,448,000	4%
Streams/Creeks (VPIH)	$641,000	$2,329,000	$2,970,000	0%
Open Water	$2,991,000	$14,335,000	$17,326,000	2%
Streams/Creeks	$1,922,000	$12,033,000	$13,956,000	2%
Total	**$551,334,000**	**$215,614,000**	**$766,948,000**	**100%**

Figure 3
SSHCP Estimated Fee Levels per Acre of Impact (2015$)
South Sacramento Habitat Conservation Plan Cost Analysis

Land Cover	Preservation Fee	Re-Establishment/ Establishment Fee	Total Fee
Agriculture	$16,212	$0	$16,212
Valley Grassland	$17,704	$0	$17,704
Vernal Pool - Direct	$33,322	$157,982	$191,304
Vernal Pool - Indirect	$33,322	$0	$33,322
Blue Oak	$21,049	$97,396	$118,445
Riparian	$34,477	$108,140	$142,617
Mine Tailing Riparian Woodland	$13,981	$128,896	$142,876
Seasonal Wetland	$22,189	$116,031	$138,220
Freshwater Marsh	$27,851	$111,236	$139,088
Swale - Direct	$19,267	$111,705	$130,972
Swale - Indirect	$19,267	$0	$19,267
Streams/Creeks (VPIH) - Direct	$38,879	$105,860	$144,739
Streams/Creeks (VPIH) - Indirect	$38,879	$0	$38,879
Open Water	$21,160	$92,483	$113,643
Streams/Creeks	$16,592	$102,849	$119,441

Figure 4
SSHCP Impacts and Mitigation Requirement Summary by Land Cover (Acres)
South Sacramento Habitat Conservation Plan Cost Analysis

	Impacts		Ratio Equivalence		Conservation Acreage		
Land Cover	**Direct**	**Indirect**	**Preservation Ratio**	**Re-Establishment/ Establishment Ratio**	**Preservation**	**Restoration/ Creation**	**Total**
Agriculture	9,696	0	1.0	0.0	9,696	0	9,696
Valley Grassland	22,014	0	1.0	0.0	22,014	0	22,014
Vernal Pool	389	94	2.0	1.0	966	389	1,355
Blue Oak	47	0	1.0	1.0	47	47	94
Riparian	373	0	2.0	1.0	746	373	1,119
Mine Tailing Riparian Woodland	218	0	1.0	1.0	218	218	436
Seasonal Wetland	105	0	1.0	1.0	105	105	210
Freshwater Marsh	127	0	1.0	1.0	127	127	254
Swale	234	44	1.0	1.0	278	234	512
Streams/Creeks (VPIH)	22	4	1.0	1.0	26	22	48
Open Water	155	0	1.0	1.0	155	155	310
Streams/Creeks	117	0	1.0	1.0	117	117	234
Total	**33,497**	**142**			**34,495**	**1,787**	**36,282**

Figure 5
SSHCP Conservation Summary by Land Cover (Acres)
South Sacramento Habitat Conservation Plan Cost Analysis

Land Cover	Preservation Required	Preserve Dedications[1]	HCP Land Acquisition: Net Preservation	HCP Land Acquisition: Re-Establishment/ Establishment	HCP Land Acquisition: Total
Agriculture	9,696	143	9,553	0	9,553
Valley Grassland	22,014	3,142	18,872	0	18,872
Vernal Pool	966	120	846	389	1,235
Blue Oak	47	0	47	47	94
Riparian	746	0	746	373	1,119
Mine Tailing Riparian Woodland	218	0	218	218	436
Seasonal Wetland	105	4	101	105	206
Freshwater Marsh	127	12	115	127	242
Swale	278	73	205	234	439
Streams/Creeks (VPIH)	26	11	15	22	37
Open Water	155	18	137	155	292
Streams/Creeks	117	2	115	117	232
Total	**34,495**	**3,523**	**30,972**	**1,787**	**32,759**

[1] Preserve dedications include 1,850 acres of "hardline preserve" and an additional 1,673 acres from within the UDA.

Figure 6
SSHCP Fee Title and Easement Acquisition Summary by Land Cover (Acres)
South Sacramento Habitat Conservation Plan Cost Analysis

Land Cover	Fee Title Acquisitions		Easement		
	Acres	Percentage	Acres	Percentage	Total
Agriculture	1,797	19%	7,757	81%	9,553
Valley Grassland	4,930	26%	13,941	74%	18,872
Vernal Pool	590	48%	645	52%	1,235
Blue Oak	64	68%	30	32%	94
Riparian	522	47%	597	53%	1,119
Mine Tailing Riparian Woodland	252	58%	184	42%	436
Seasonal Wetland	143	69%	64	31%	206
Freshwater Marsh	200	83%	42	17%	242
Swale	297	68%	143	32%	439
Streams/Creeks (VPIH)	37	100%	0	0%	37
Open Water	203	69%	90	31%	292
Streams/Creeks	138	59%	94	41%	232
Total	**9,173**	**28%**	**23,586**	**72%**	**32,759**

Figure 7
SSHCP Acquisition Land Cost Estimate by PPU (2015$)
South Sacramento Habitat Conservation Plan Cost Analysis

	Fee Title Acquisitions			Easement Acquisitions			
PPU	**Acres**	**Avg. Per-Acre Cost Estimate**	**Total Cost**	**Acres**	**Avg. Per-Acre Cost Estimate**	**Total Cost**	**Acquisition Cost Estimate**
PPU 1	1,302	$28,172	$36,669,096	0	$22,538	$0	$36,669,096
PPU 2	0	$0	$0	0	$0	$0	$0
PPU 3	1,048	$31,621	$33,123,967	0	$25,297	$0	$33,123,967
PPU 4	348	$26,379	$9,172,431	0	$21,103	$0	$9,172,431
PPU 5	403	$10,606	$4,273,774	2,283	$8,485	$19,374,442	$23,648,216
PPU 6	1,412	$12,963	$18,300,550	8,000	$9,074	$72,592,182	$90,892,732
PPU 7	2,348	$9,074	$21,300,754	13,303	$7,259	$96,563,419	$117,864,173
PPU 8	303	$53,284	$16,152,412	0	$42,627	$0	$16,152,412
N/A	223	$42,781	$9,550,744	0	$34,225	$0	$9,550,744
Restoration	1,787	$10,881	$19,443,719	N/A	N/A	N/A	$19,443,719
Total	**9,173**	**$18,314**	**$167,987,447**	**23,586**	**$7,993**	**$188,530,043**	**$356,517,490**

Figure 8
SSHCP Acquisition Total Cost Estimate (2015$)
South Sacramento Habitat Conservation Plan Cost Analysis

Cost Item	Assumption	Total Land Cost Estimate
Base Land Acquisition Cost	See **Figure 7**	$356,517,000
Transaction Costs	5 percent of Base Cost	$17,826,000
PDR (Preserve Documentation Record Review)	$189 per acre	$6,204,000
Site Improvement Costs	$257 per acre	$8,411,000
Contigency	10 percent	$38,896,000
Total Land Cost		**$427,854,000**

Figure 9
SSHCP Land Acquisition Summary by PPU (Acres)
South Sacramento Habitat Conservation Plan Cost Analysis

PPU	Agriculture	Valley Grassland	Vernal Pool	Blue Oak	Riparian	MTRW	Seasonal Wetland	Freshwater Marsh	Swale	VPIH	Open Water	Streams/ Creeks	Total
PPU 1	1	1,206	56	0	0	2	0	0	16	13	8	0	1,302
PPU 2	0	0	0	0	0	0	0	0	0	0	0	0	0
PPU 3	162	786	29	12	13	0	0	7	16	2	18	2	1,048
PPU 4	17	222	2	0	22	0	21	58	1	0	5	0	348
PPU 5	369	1,848	19	0	351	0	20	3	7	0	20	50	2,686
PPU 6	8,228	640	27	0	349	0	25	41	10	0	49	43	9,412
PPU 7	529	13,914	713	35	3	216	29	6	151	0	37	19	15,650
PPU 8	247	50	0	0	0	0	4	0	1	0	0	0	303
N/A	0	206	1	0	8	0	1	0	3	0	1	2	223
Restoration	0	0	389	47	373	218	105	127	234	22	155	117	1,787
Total	**9,553**	**18,872**	**1,235**	**94**	**1,119**	**436**	**206**	**242**	**439**	**37**	**292**	**232**	**32,759**

Figure 10
SSHCP Re-Establishment / Establishment Cost Estimate (2015$)
South Sacramento Habitat Conservation Plan Cost Analysis

Land Cover	Restoration Acreage	Per-Acre Cost Estimate[1]	Per-Acre Cost w/ Contingency 10%	Re-Establishment/ Establishment Cost Estimate	Regulatory Compliance Cost Estimate 20%	Total Cost
Vernal Pool	389	$106,000	$116,000	$45,314,000	$9,063,000	$54,377,000
Blue Oak	47	$60,000	$66,000	$3,102,000	$620,000	$3,722,000
Riparian	373	$68,000	$74,800	$27,957,000	$5,591,000	$33,549,000
MTRW	218	$84,000	$92,400	$20,110,000	$4,022,000	$24,132,000
Seasonal Wetland	105	$74,000	$81,400	$8,561,000	$1,712,000	$10,273,000
Freshwater Marsh	127	$70,000	$77,000	$9,847,000	$1,969,000	$11,816,000
Swale	234	$71,000	$78,100	$18,234,000	$3,647,000	$21,881,000
VPIH	22	$66,000	$72,600	$1,607,000	$321,000	$1,929,000
Open Water	155	$56,000	$61,600	$9,595,000	$1,919,000	$11,514,000
Streams/Creeks	117	$64,000	$70,400	$8,254,000	$1,651,000	$9,904,000
Total	1,787			**$152,581,000**	**$30,516,000**	**$183,098,000**

[1] Includes planning and design, construction cost, and O&M costs (for initial 5 years). Also reflects success rates ranging from 65 percent to 90 percent.

Figure 11
SSHCP Management and Monitoring Cost Estimate (2015$)
South Sacramento Habitat Conservation Plan Cost Analysis

Land Cover	Management		Monitoring		Total Cost
	Acres	Cost	Acres	Cost	
Agriculture	2,327	$2,386,973	9,696	$3,575,400	$5,629,122
Valley Grassland	8,770	$8,995,136	22,014	$29,168,550	$36,907,853
Vernal Pool	742	$705,598	1,355	$1,795,375	$2,450,391
Blue Oak	66	$60,663	94	$124,550	$182,535
Riparian	552	$512,537	1,119	$1,482,675	$1,969,612
Mine Tailing Riparian Woodland	262	$237,007	436	$577,700	$808,477
Seasonal Wetland	150	$138,431	210	$278,250	$410,292
Freshwater Marsh	214	$201,100	254	$336,550	$525,221
Swale	376	$352,546	512	$678,400	$1,010,557
Streams/Creeks (VPIH)	48	$46,034	48	$63,600	$105,918
Open Water	225	$208,365	310	$410,750	$609,122
Streams/Creeks	144	$131,247	234	$310,050	$437,389
Total	**13,875**	**$13,975,639**	**36,282**	**$38,801,850**	**$51,046,489**
Contingency		$1,397,564		$5,820,278	$7,217,841
Total w/ Contigency		**$15,373,203**		**$44,622,128**	**$59,995,330**

Figure 12
SSHCP Plan Administration Cost Estimate (2015$)
South Sacramento Habitat Conservation Plan Cost Analysis

Cost Item	Total	Average Annual Cost
Staff and Board Compensation[1]	$23,497,115	$469,942
Office and Equipment Costs	$1,913,100	$38,262
Additional Overhead, Professional Services, Other Costs	$12,926,750	$258,535
Total	**$38,336,965**	**$766,739**
Contingency	$3,833,697	$76,673.93
Total	**$42,170,662**	**$843,413**

[1] Assumes 3.0 Full Time Equivalent (FTE) staff at Implementing Entity from Year 5 onwards. Assumes 2.5 FTE in Year 1.

Figure 13
SSHCP Ongoing Costs and Endowment Cost Estimate (2015$)
South Sacramento Habitat Conservation Plan Cost Analysis

Land Cover	Management	Monitoring	Agricultural Enhancement	Admin	Total Annual
Agriculture	$20,371	$70,325	$77,567	$108,197	$276,459
Valley Grassland	$66,126	$551,525	$139,413	$236,681	$993,744
Vernal Pool	$5,447	$33,475	$6,450	$14,365	$59,737
Blue Oak	$1,775	$6,625	$298	$2,843	$11,541
Riparian	$2,128	$21,275	$5,971	$9,130	$38,504
Mine Tailing Riparian Woodland	$1,279	$8,625	$1,837	$3,701	$15,442
Seasonal Wetland	$2,090	$8,475	$636	$3,637	$14,837
Freshwater Marsh	$816	$3,725	$423	$1,599	$6,563
Swale	$2,230	$10,825	$1,428	$4,645	$19,128
Streams/Creeks (VPIH)	$1,072	$3,575	$1	$1,534	$6,182
Open Water	$523	$3,875	$897	$1,663	$6,958
Streams/Creeks	$205	$2,925	$944	$1,255	$5,329
Annual Legal Defense Allowance					$109,082
Total Annual					**$1,563,508**
Year-50 Endowment Requirement					**$52,116,926**
Year 1-50 Cumulative Interest Earnings					**$22,078,352**
Net Funding Required for Endowment					**$30,038,574**

Figure 14
SSHCP Other Costs and Assumptions (2015$)
South Sacramento Habitat Conservation Plan Cost Analysis

Cost Item	Cost	Assumptions
Agricultural Enhancement Costs	$6,014,525	$10 per acre per year over 23,586 easement acres
Changed Circumstances	$8,230,639	Adds 10% to the cost of habitat management and 15% to the cost of habitat monitoring
HCP Plan Development	$9,546,963	Reimbursement of $6.0 million plan preparation cost, financed with interest over the 50-year permit term

APPENDIX J

Voluntary Additional Conservation

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Voluntary Additional Conservation

J.1 Introduction

The purpose of this appendix is to identify voluntary conservation actions that if implemented can supplement the South Sacramento Habitat Conservation Plan (SSHCP) Conservation Strategy. This supplementary conservation has the potential to benefit certain SSHCP Covered Species, other native species in the Plan Area that are not Covered Species, and some key natural communities. It also provides assistance to sustainable agriculture and the overall ecological functions of the rural landscape in the Plan Area. These supplemental conservation actions complement and reinforce the SSHCP Conservation Strategy and provide further benefits to the plan.

These supplemental conservation actions only take place as outside funding is available. It is expected that a non-profit group will be formed by local stakeholder groups to support fundraising and implementation of these voluntary conservation actions. The non-profit group will annually report supplementary conservation activities and planned activities to the SSHCP Implementing Entity for tracking purposes.

The supplemental conservation actions do not compete with, or impede, the SSHCP Conservation Strategy or use any development fees collected for SSHCP Covered Activities. The SSHCP's Technical Advisory Committee (see Chapter 9 of the SSHCP) verifies that individual actions do not compete with the SSHCP's acquisition needs for mitigation. Supplemental conservation actions only involve landowners wishing to sell conservation easements or otherwise participate, and existing farming and ranching activities continue on new conservation easements. Any conservation actions implemented on these conservation easements would be complementary to existing farming and ranching activities.

J.2 Supplemental Habitat Conservation

J.2.1 Northeast Sector of Plan Area

Protect 8,000 acres of the total oak woodland, oak savanna, and grassland[1] in the northeast portion[2] of the Plan Area. This provides conservation of habitats in an area that will receive little protection through the SSHCP Conservation Strategy as it lacks any significant populations of Covered Species. It includes grasslands with deeper soils that may be suitable for badger (*Taxidea taxus*), foraging ferruginous hawk (*Buteo regalis*), and western burrowing owl (*Athene cunicularia*). It also might benefit species not covered by the SSHCP, such as the golden eagle (*Aquila chrysaetos*), merlin (*Falco columbarius*), long-eared owl (*Asio otus*), and sharp-shinned hawk (*Accipiter striatus*).

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1 Includes wildflower field habitats.
2 South of White Rock Road, north of Meiss Road, and east of the Urban Services Boundary (USB).

J.2.2 Lands West of Interstate 5

Protect 300 acres of irrigated pasture and grasslands west of Interstate 5, especially lands within the Stone Lakes National Wildlife Refuge Acquisition Boundary. This supplemental conservation occurs primarily on lands below sea level to avoid competition with the SSHCP Conservation Strategy. This may benefit greater sandhill crane (*Grus canadensis tabida*), Swainson's hawk (*Buteo swainsoni*), and other SSHCP Covered Species, as well as several species that are not covered by the SSHCP (e.g., American peregrine falcon (*Falco peregrinus anatum*), short-eared owl (*Asio flammeus*), merlin, sharp-shinned hawk, white-faced ibis (*Plegadis chihi*)).

J.2.3 Cropland Upland Habitat for Greater Sandhill Cranes

Conserve 2,000 acres of upland habitat adjacent to floodplain areas used by greater sandhill cranes for roosting and foraging refugia during a lower Cosumnes River flood event. These are areas outside of sandhill crane modeled habitat, as shown on Figure 3-22 in Chapter 3 of the SSHCP.

J.3 Wildlife Movement Corridors

Conserve lands outside of the Urban Development Area (UDA) to create additional wildlife corridors beyond what is already required in the SSHCP. For each wildlife corridor, it is necessary to conserve sufficient land so that the corridor will function. It is not necessary to protect all the land in a corridor, although it is necessary to avoid a complete break of a corridor by a permanent, incompatible land use.

J.3.1 East–West Wildlife Movement Corridors

Establish two east–west corridors south of the Cosumnes River between the vernal pool grasslands landscape in the east county and the farmland landscape in the southwest portion of the Plan Area, with an average width of 1,000 feet.

J.3.2 North–south Farmland Wildlife Movement Corridor

Establish one wildlife movement corridor joining agricultural lands north and south of the Cosumnes River, with an average width of 1,000 feet.

J.3.3 East County Corridor

Establish one wildlife movement corridor stretching from White Rock Road to the San Joaquin County line and also connecting with rural lands in El Dorado County just north of the Cosumnes River and also with Amador County. Much of this corridor is already protected (e.g., Howard

Ranch) or will be protected through the northeast sector habitat conservation mentioned previously (see Section J.2.1).

J.4 Additional Habitat Re-establishment and Establishment

J.4.1 Riparian Habitat in Southern Plan Area

Re-establish or establish 500 acres of riparian habitat, including mixed-riparian woodland, valley oak woodland, and mixed riparian scrub along streams in the southern part of the Plan Area, west of the vernal pool grasslands; areas that were historically riparian woodland and scrub. This may benefit SSHCP Covered Species such as the Swainson's hawk and Cooper's hawk, as well as additional species such as the yellow-breasted chat (*Icteria virens*) and least Bell's vireo (*Vireo bellii pusillus*). The re-establishment will not compete with the SSHCP Conservation Strategy, which will be focused on the Cosumnes River Corridor.

J.4.2 Hedgerows in Cropland

Establish an additional 10,000 linear feet of hedgerows in cropland beyond what is already required in the SSHCP.

J.5 Voluntary Species Management Measures

The following suggests supplemental conservation actions for tricolored blackbird (*Agelaius tricolor*) and the western burrowing owl.

J.5.1 Tricolored Blackbird

The tricolored blackbird population has been surveyed frequently in Sacramento County. During the 1990s, it was discovered that population levels had diminished greatly. By 1999, a number of sites that had colonies year after year were no longer occupied and there were no large (15,000–20,000 bird) colonies surveyed (Cook 1999). Later surveys, from 2008 to 2014, also show a low number of birds until 2014, when there was a relatively large increase from the prior three survey periods, but still below historical averages when compared to surveys conducted in the 1990s (see Table J-1).

In 2014, Sacramento County had over 20% of the entire, state-wide population at the time of the late April survey. Many of the Plan Area colony sites are within the SSHCP UDA (Meese 2014) particularly in the Jackson, Bradshaw, and Grant Line Road area, where they were found nesting in Himalayan blackberries (*Rubus armeniacus*) (Witham, pers. comm. 2015).

Table J-1
Historical Breeding Tricolored Survey Results from Sacramento County

Year	Number of Birds
1992	86,142
1993	64,510
1994	96,365
1997	32,387
1999	16,671
2008	3,551
2011	6,105
2014	29,272

Sources: Cook 1999; Meese 2014; Witham, pers. comm. 2015.

The SSHCP has objectives for conservation of acres of modeled foraging habitat. In addition, there is an objective to conserve, within the SSHCP Preserve System, at least five extant colony sites occupied in recent years, to protect one colony site prior to the take of a colony site, to establish two new potential colony sites for every colony site that is taken, to conserve at least one "large" colony site that has supported a minimum of 1,500 birds, and to experiment on ways to protect colony sites from predation.

The voluntary measures in this appendix go beyond these SSHCP objectives. In addition, they recognize that while many active colonies over the last few years have been located within the UDA, the potential for long-term conservation within this boundary is very limited. Ultimately, the landscape within the UDA will be built out except for approximately 7,500 acres of Vernal Pool Grassland preserves, stream corridors, and few additional landscape linkages. Therefore, the long-term focus for conservation is outside the UDA, including some historic sites that still possess water sources and adequate foraging habitat.

The voluntary conservation measures include conserving and establishing at least 30 existing or potential colony sites with suitable nesting substrates outside the UDA and by the last 5 years of the permit period, maintain an annual average of 50,000 breeding birds within the SSHCP Preserve System.

J.5.2 Western Burrowing Owl

In the Plan Area most sightings of western burrowing owl occur form within the UDA and there are very few recent (2014 and 2015) breeding season sightings. Within the UDA occurrences of western burrowing owl are known from the Cordova Hills Master Plan project area, the Regional San. Bufferlands and in and around the Mather Field area. The SSHCP database includes all known occurrence information (Figure 3-27 in the SSHCP). Some occurrences have been recorded from outside the UDA; however the vast majority of the SSHCP Plan Area outside of the UDA has not been surveyed for owls. It is thought that many of the occurrences outside of the UDA are wintering only and there are indications that western burrowing owl are absent altogether from seemingly suitable grassland sites where ground squirrels are active (Gardner, pers. comm. 2014).

The SSHCP Conservation Strategy for the western burrowing owl includes the protection of seven sites known to support western burrowing owl, management to enhance habitat, establishment of ground squirrel colonies, and possible use of artificial burrows. Additional management actions include providing the short vegetation height required by the owls and provision of artificial sentinel perches.

The voluntary conservation measures include conserving, on average, at least 60 breeding pairs by the last 5 years of the permit period.

J.5.3 Other Species

Determine additional management measures required for other Covered Species, such as the northern harrier (*Circus cyaneus*) and loggerhead shrike (*Lanius ludovicianus*), as well as additional at-risk species, using the latest scientific and management research and modifying over time as knowledge improves.

J.6 Develop a Program to Assist and Encourage Sustainable Agriculture Practices

Work with area farmers, the Natural Resources Conservation Service, and others to encourage and financially assist sustainable agricultural practices, including provision of native pollinator food sources and refugia. Provide incentives to farmers to maintain the cropland mosaic that is important for sandhill crane, Swainson’s hawk, and other Covered Species. Work to minimize impacts on sandhill crane and Swainson’s hawk from agricultural operations.

J.7 Develop and Implement an Outreach, Education and Stewardship Program

The purposes of this program are to build long-term support for the SSHCP, to provide volunteer support for habitat establishment and re-establishment projects and a docent program, and to develop a “citizen scientists” project to assist with the SSHCP monitoring program (Chapter 8 of the SSHCP). It will include field trips for elected officials and their staff, members of various organizations, and interested citizens.

J.8 References

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APPENDIX K

Project-Specific Avoidance and Minimization Measures

APPENDIX K
Project-Specific Avoidance and Minimization Measures

At the time of SSHCP completion, five separate Master Plans or Specific Plans for urban development were under preparation or had recently been approved by a Local Land Use Authority within the SSHCP Plan Area (see Section 5.2.1.3 and Section 5.5.1). For purposes of this discussion, the terms "Master Plan" and "Specific Plan" are synonymous. Because these Master Plans were being processed concurrently with the development of the SSHCP, these Master Plans were designed to comply with SSHCP permit application requirements, including the SSHCP Avoidance and Minimization Measures described in Chapter 5. In addition, each Master Plan was designed to include on-site preserve(s) that are consistent with the SSHCP Conservation Strategy as depicted in Figure 7-2, *Existing Preserves and SSHCP Planned Hardline Preserves*.

It must be noted however, that SSHCP Avoidance and Minimization Measures as described in Chapter 5 were written to apply to a broad range of projects and it may not always be feasible for every project to apply each SSHCP Avoidance and Minimization Measures as written. In some instances, variances to the SSHCP Avoidance and Minimization Measures were requested by the Third-Party Project Applicant representing the Master Plan. Variances were accommodated only when necessary and only when the variance would not have a significant impact on the integrity of the Preserve System.

Two of the five Master Plan projects, Cordova Hills and SunCreek, were approved by a Local Land Use Authority prior to completion of the SSHCP. As such variances for these projects are well understood. Three of the Master Plan projects, Arboretum, Jackson Township and NewBridge are still in various stages of planning and review. As these Plans progress additional variances may be given to these Master Plan projects where necessary and only when the variance would not have a significant impact on the integrity of the Preserve System.

This Appendix provides a brief description of each Master Plan project followed by a description of any variances from SSHCP Avoidance and Minimization Measures that have been granted to the project.

Arboretum Specific Plan

The proposed Arboretum Specific Plan encompasses approximately 1,349 acres and is located in the eastern portion of the UDA within the City of Rancho Cordova. The Specific Plan is bound by Kiefer Boulevard on the north, Jackson Highway on the south, Grant Line Road on the east, and Sunrise Boulevard on the west. The current Arboretum Specific Plan description includes residential, commercial, office, mixed use and public/quasi-public uses that total approximately 722 acres; recreation uses of approximately 55 acres; and major roadways of approximately 86 acres. The Specific Plan area may provide for the construction of up to 5,000 residential dwelling units at a net density of 9.3 units per acre.

In addition to the developed acres described above, the site will also contain approximately 254 acres of on-site preserve as required by the SSHCP Conservation Strategy (Chapter 7). These acres are a land donation/in lieu of SSHCP mitigation fees as described in Chapter 9.

The Arboretum Specific Plan does not require any variances from the SSHCP avoidance and minimization measures at this time.

Cordova Hills Specific Plan

The approved Cordova Hills Specific Plan encompasses approximately 2,668 acres and is located in the eastern portion of the UDA within the unincorporated portion of Sacramento County. The Specific Plan is bound by Glory Lane to the north, by parcel boundaries that are adjacent or are proximal to the County's Urban Services Boundary to the south, by parcel boundaries that are adjacent or are proximal to Carson Creek to the east and Grant Line Road to the west. The current Cordova Hills Specific Plan description includes residential, commercial, office, and quasi-public uses that total approximately 1,296 acres; a University/College Campus Center of 223 acres; and open space, recreation, buffer land and agricultural uses of 656 acres. The Specific Plan Area may provide for the construction of up to 8,000 residential dwelling units at various densities.

In addition to the developed acres described above, the site will also contain approximately 493 acres of on-site preserve as required by the SSHCP Conservation Strategy (Chapter 7). These acres are a land donation/in lieu of SSHCP mitigation fees as described in Chapter 9.

Specific variances from SSHCP Avoidance and minimization measures for Cordova Hills include the following:

EDGE-3 (Preserve Setbacks): There are instances within the 50' setback where the hardpan will be impacted due to compliance with the American Disabilities Act and for footing of arched culverts at various locations. In these instances, variances from AMM Edge-3 are allowed. The 50' edge condition will only be established adjacent to the Plateau Preserve, Central Drainage Preserve, Carson Creek Preserve, and University Preserve.

EDGE-7 (Hardpan/Duripan Protection): Cordova Hills has two variances from this AMM: 1) Two water transmission mains (16" and 24") would be constructed within the North Loop Road right-of-way through the Plateau Preserve north of North Loop Road; and 2) a water transmission main and a sewer force main will be placed along Town Center Boulevard within the southern portion of the Plateau Preserve. These sections of pipeline would puncture the hardpan. A clay-bentonite soil mix will be backfilled into the trench up to the level of the top of the duripan once the pipelines are in place.

ROAD-2 (Wildlife Crossing Structures): Cordova Hills has three variances to AMM Road-2 where a dry crossing cannot be provided due to grading and spacing constraints. Two culvert crossing along North Loop Road and one at the intersection of University and Grant Line will not contain a dry crossing due to grading and spacing constraints.

TCB-1 (Tricolored Blackbird Surveys): Cordova Hills has conducted surveys for special-status species and tri-colored blackbirds were not detected. No further surveys for tri-colored blackbirds are required.

BAT-1 (Winter Hibernaculum Surveys): Cordova Hills has conducted bat hibernaculum surveys. Bat hibernaculum is in the form of large trees, bridges, and old buildings, none of which are present on site. No further surveys for tri-colored blackbirds are required.

Jackson Township Master Plan

The proposed Jackson Township Master Plan encompasses approximately 1,391 acres and is located in the center of the UDA. The proposed Master Plan is bound by Kiefer Boulevard on the north, Jackson Highway on the south, Excelsior Road on the east and on the west by parcel boundaries that are proximal to the east side of Eagles Nest Road.

The current Jackson Township Master Plan description includes residential, commercial, office, mixed use and public/quasi-public uses that total approximately 813 acres; open space, recreation, and agricultural uses of approximately 263 acres; and roadways will account for approximately 90 acres. The current Master Plan area may provide for the construction of up to 6,143 residential dwelling units at various densities.

In addition to the developed acres described above, the site will also contain approximately 225 acres of on-site preserve as required by the SSHCP Conservation Strategy (Chapter 7). These acres are a land donation/in lieu of SSHCP mitigation fees as described in Chapter 9.

STREAM-5 (Design for Stream Channel Re-Routing, Widening or Deepening): Jackson Township will re-route, widen and deepen that portion of Elder Creek that runs through their property. While Jackson Township will comply with AMM Stream-5, it is noted that Elder Creek will be used for stormwater drainage and maintenance for the channel will be required. As the Jackson Township Master Plan progresses, conditions will be included that address this issue.

NewBridge Specific Plan

The proposed NewBridge Specific Plan encompasses approximately 1,095 acres and is located in the center of the UDA within the unincorporated portion of Sacramento County. The Specific Plan is bound by Kiefer Boulevard to the north, Jackson Highway to the south, Sunrise

Boulevard to the east and on the west by parcel boundaries that are proximal to the west side of Eagles Nest Road. The NewBridge Specific Plan application includes residential, commercial, office, mixed use, and public quasi-public uses of approximately 585 acres; and open space and recreation of approximately 111 acres. The Specific Plan area may provide for the construction of up to 2,975 residential dwelling units at various densities.

In addition to the developed acres described above, the site will also contain approximately 101 acres of on-site preserve as required by the SSHCP Conservation Strategy (Chapter 7). These acres are a land donation/in lieu of SSHCP mitigation fees as described in Chapter 9.

The NewBridge Specific Plan does not require any variances form the SSHCP avoidance and minimization measures at this time.

SunCreek Specific Plan

The approved SunCreek Specific Plan encompasses approximately 1,265 acres and is located in the eastern portion of the UDA within the City of Rancho Cordova. The Specific Plan is bound by Jackson Highway on the north, Douglas Road on the south, Grant Line Road on the east, and Sunrise Boulevard on the west. The SunCreek Specific Plan includes residential, commercial, office, mixed use and public/quasi-public uses that total approximately 816 acres; open space and recreation uses of approximately 136 acres; and roadways will account for approximately 108 acres. The Specific Plan area may provide for the construction of up to 4,698 residential dwelling units at various densities.

In addition to the developed acres described above, the site will also contain approximately 205 acres of on-site preserve as required by the SSHCP Conservation Strategy (Chapter 7). These acres are a land donation/in lieu of SSHCP mitigation fees as described in Chapter 9.

EDGE-3 (Preserve Setbacks): There are instances where the 50’ setback cannot be accommodated due to agreements that were made prior to completion of the SSHCP between the project applicant, local land use authorities and state and federal regulatory agencies. In these instances, variances from AMM Edge-3 are allowed. Although a few wetland setback areas fall short of the minimum buffer requirement, the overall Project design satisfies the HCP’s goals because the distance between the Preserve’s aquatic features (i.e. vernal pool habitat, Waters of the United States, etc.) and the proposed Covered Activities or impacts generally exceeds the 50 foot requirement. Furthermore, The SunCreek Specific Plan Area designed its open space areas, setbacks, and adjacent land use designations to minimize indirect impacts to the maximum extent possible. The aforementioned data on wetland and watershed relationships indicate that the watersheds preserved on SunCreek’s are sufficient to maintain the wetlands’ functions and values.

EDGE-7 (Hardpan/Duripan Protection): Sun Creek has two variances from this AMM: 1) where utility trenches (i.e. sewer, drainage, water or dry utilities) will run through the preserve on the Shalako property and 2) where utility trenches (i.e. sewer, drainage, water or dry utilities) will run through the preserve setback on the Jaeger Ranch property. These utility trenches will puncture or disrupt the soil hardpan or duripan. A clay-bentonite soil mix will be backfilled into the trench up to the level of the top of the duripan once the utilities are in place.

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APPENDIX L

SSHCP Preserve Design

APPENDIX L
Preserve Design

The proposed approach for determining areas to be targeted for preserve establishment under the South Sacramento Habitat Conservation Plan (SSHCP) is based on land cover types present, known occurrences of covered species within the Plan Area, and known presence of suitable habitat for covered species. Preserves within the Plan Area will be designed, established, and managed according to the following established principles of ecology and conservation biology. These principles are summarized in Table 1 and their applicability to the SSHCP is explained below.

Table 1
Preserve Design Guiding Principles

Goal	Effect	Poor	Good	Example
Minimize Fragmentation	Fragmentation disrupts movement and lowers species diversity.			Roads bisecting preserves can prevent movement between preserves.
Minimize Edge Effects	Non-compatible uses adjacent to preserves lowers habitat values and species abundance/diversity.			Feral cats from residential development dramatically reduce song bird populations.
Establish Connectivity	Linking preserves allows for increased movement amongst interacting landscapes.			A corridor between grasslands and a lake allows species to utilize both habitats.
Establish Buffers	Buffers help reduce edge effects to protect preserve integrity.			A vegetate buffer absorb pollutants to protect waterways.
Maximize Heterogeneity	Preserves with greater mix of habitats tend to support greater biodiversity.			An oak preserve with a stream may support greater biodiversity than an oak preserve without a stream.
Protect Watersheds	Preserving watersheds helps maintain hydrologic stability and water quality.			Nutrients from landscaping upstream flows into the preserve and harms species.
Maximize Population	Larger populations are less vulnerable to disease and local disturbances.			If 10% of a populations is resistant to a disease, 10 individuals will not persist, but 20 may.
Maintain Distribution	Allows species to repopulate after disturbances, protects metapopulations and genetic variation.			Individuals in one preserve are able to repopulate another after a fire.

Source: Sacramento County

Minimize Preserve Fragmentation

Along with outright habitat conversion, habitat fragmentation is a leading cause of biodiversity reduction on both local and regional levels. By definition, habitat fragmentation results in a habitat type being reduced in size and more isolated from adjacent areas of similar habitat types.

The more isolated a given habitat type (and associated species), the more difficult it becomes for those species to migrate, escape harsh conditions and exchange genetic information.

As land use within the HCP area changes over time, areas currently characterized by intact habitat will inevitably become fragmented as parcels change ownership or are divided, resulting in the presence of smaller, separate patches of habitat when compared with current conditions. Some of these patches will be located adjacent to urban areas, agricultural settings, or roadways. Others patches will become isolated and remain as small "islands" in the landscape. Fragmented habitats can have a number of negative effects on species movement. For instance, roads or other barriers can impede or prevent movement of a species across part of its range. Individuals that are forced to disperse across urban or agricultural topography are directly threatened by predation and harsh environmental conditions. Fragmentation can increase distances between suitable patches of habitat, altering movement of dispersal-limited organisms (e.g., seeds, cysts, eggs, juveniles). Patch size, number, and degree of isolation can all have an effect on the movement of organisms between patches (Molles 1999).

Fragmentation not only disrupts movement, it can also alter ecosystem dynamics, especially when corridors are located next to human development, or when natural disturbance patterns (e.g., fire, water flow, erosion patterns) are altered. This can disrupt the "patch mosaics" seen on the unfragmented landscape. Fragmentation also decreases the diversity of animals in an area, including birds, bees and beetles. Some of these decreases may significantly affect ecosystem processes such as pollination and decomposition (Molles 1999).

Species richness is also affected by fragmentation, decreasing as habitat patches ("islands") become smaller and more isolated. Species richness on islands (and in habitat patches) is a balance between immigration and extinction of species. Immigration rates are influenced by the distance from the source of immigrants, while extinction rates are mostly determined by "island" size (MacArthur and Wilson 1967). Plant and animal species that require the frequent exchange of genetic material to re-colonize extirpated populations are especially affected by fragmentation and subsequent isolation of habitat patches. The ability of subpopulations to move between patches is important in the persistence of some species, especially those in "sink" populations, small groups that, left alone, would probably go extinct (Molles 1999). Isolated subpopulations are particularly susceptible to genetic disorders and lower reproductive success caused by inbreeding. This can lead isolated populations to become more vulnerable to local extinction as a result of stochastic events (Ellstrand and Elam 1993).

When habitat is fragmented, the remaining patches are affected by the changes in the physical environment along the perimeter, such as differences in hydrology, light intensity, temperature and wind speed. This "edge effect" (change in the physical nature of the habitat) can extend into the remnants of intact habitat, degrading them as well and reducing their effective area. Edge effects are explained in more detail in Section 2.1.2.

Obviously, minimizing habitat fragmentation and emphasizing the preservation of larger, intact areas are crucial conservation goals for any conservation effort. However, if preservation of landscape level preserves is impracticable, then clustering habitat fragments across the landscape can ameliorate some of the negative effects on movement associated with smaller, fragmented habitats (Kareiva and Wennergren 1995). This allows the fragments to achieve greater species diversity by increasing dispersal opportunities. It is crucial to note though, that the covered species vary greatly in their ability to traverse non-natural areas between preserves (e.g., western burrowing owl [*Athene cunicularia hypugea*], western spadefoot [*Spea hammondii*], and Sacramento Orcutt grass [*Orcuttia viscida*]).

L.1 Minimize Edge Effects

The long-term biological viability of preserves, stream corridors and landscape linkages will be affected by adjacent land use. When the adjacent land uses are different from each other, such as a housing development or a busy road next to a habitat preserve, they will likely have negative impacts on the conservation land. These impacts may include light and noise pollution, vibration, alterations to hydrology, water pollution, illegal dumping of rubbish and toxic chemicals, spread of invasive non-native plants and presence of pets which may adversely affect native species. These impacts are known as edge effects and result in the outermost parts of a preserve or a landscape linkage being adversely affected by these and other external factors. The interior parts of a preserve or landscape linkage, where the edge effects are much less, is known as interior habitat as opposed to edge habitat.

Preserves with a high perimeter to area ratio will have greater edge effects, thus offering less protection to species targeted for conservation. This means that habitat within a single large preserve experiences less edge effect than the same amount of habitat encompassed by a number of smaller preserves. The lower quality of edge habitat makes it harder for many native species to survive. For example, altered hydrology will decrease the habitat quality of vernal pools. The presence of domestic cats or other pets will reduce the reproductive success of ground-nesting birds, including western burrowing owls, and reduce the population of small mammals that are food for native predators. Some animals are adversely affected by traffic noise. Weedy plants and feral animals more easily invade fragmented habitats with edges adjacent to human activities and invasive non-native plants may out-compete the existing vegetation of a preserve. Edge-loving predators benefit from increase in edges, while edge-avoiding species are negatively affected by such an increase.

Different negative edge effects permeate into preserves, stream corridors and landscape linkages to different extents. There is widespread acceptance that a setback width of 100 to 200 feet will protect a stream from runoff water pollution, provided that the ground in the setback contains native vegetation. However, most studies of this effect have been carried out in the eastern and Pacific Northwest portions of the U.S., typically in forested landscapes. A 100 foot wide buffer of hardpan grassland soil such as exists in the SSHCP grassland areas, probably does not provide an adequate setback to filter runoff water pollution when already saturated by previous rains. It is also noted that setbacks sufficient in size to absorb nutrients are often insufficient in size to provide adequate wildlife habitat. For example, the impacts caused by domestic cats may well reach beyond the size of a setback buffer established to protect water quality. Numerous giant garter snakes (*Thamnopsis gigas*) in Yolo County have been killed by domestic cats at locations up to two miles from the closest urban development (see giant garter snake species account, Appendix A). Busy roads in Europe disturb grassland bird species up to a distance of 1.3 miles.

Maximizing the interior/edge ratio of a preserve will reduce these negative edge effects as it will maximize the percentage of a preserve that is interior habitat. A circular preserve has the highest interior/edge ration and the highest percentage of interior habitat. In contrast, a long, thin preserve may be entirely edge habitat. The design of preserves must seek to avoid the latter shape.

Additional key features for vernal pool grassland preserves within the Urban Development Area (UDA) are:

- Wherever possible include entire subwatersheds within the preserve. This minimizes the area experiencing negative hydrologic effects from adjacent lands;
- Wherever possible include a setback area beyond the subwatershed boundary; and
- Where a subwatershed is bisected by the preserve boundary, apply specific preserve design measures such as vegetated swales to prevent runoff from an adjacent site with incompatible land use such as a road into the preserve.

The major landscape scale vernal pool grassland preserves outside the UDA will be large enough for the edge habitat to be a very small percentage of the total preserve acreage, providing that incompatible uses such as housing do not occur as non-preserve “islands” within the preserve. The latter phenomenon could have a severe negative impact on the biological value of these preserves.

Stream corridors are by definition long and thin. Preserve areas along streams must be wide enough to include an adequate setback that protects the waterway, the riparian vegetation and important upland sites such as giant garter snake refugia from adverse edge effects.

Landscape linkages between preserves may also be long and thin due to previously existing development or land use designations in the preserve area. In determining the minimum width of a landscape linkage it is necessary to consider which species are likely to use the linkage corridor for dispersal, how they tend to disperse and how extensive the edge effects is expected to be given adjacent land uses. The minimum widths for landscape linkages described in Chapter 7 of the SSHCP take into account the need to provide interior habitat, balanced with the local land use scenario and the acreage requirement for an individual linkage.

In addition, it is possible to reduce negative edge effects by guiding land use decisions and resulting design in areas immediately adjacent to preserves. The application of "green" site sensitive design requirements to adjacent development will help reduce edge effects. These requirements may include measures such as placing small streets rather than backyards next to preserves, fencing that precludes movement of domestic animals into preserves, landscaping guidelines that prohibit use of known invasive species, and strict avoidance of any stormwater or summer-watering runoff from developed areas into preserves (see Chapter 6 of the SSHCP).

L.2 Establish Connectivity between Preserves

Blocks of habitat that are connected by natural linkages or corridors such as drainages and associated riparian corridors, swales, topographical depressions, ridgelines and other linear vegetated areas (grasslands, woodlands, some agriculture areas), can provide terrestrial corridors (linkages) to other areas of suitable habitat that have been otherwise isolated by fragmentation.

Habitat corridors have been defined in a variety of ways; in simplest terms, corridors are narrow strips of land that differ from the matrix situated on either side (Forman and Gordon 1986). In terms of ecological function, corridors may be defined as linear areas of vegetation that facilitate the movement of plants and animals between other habitat patches (Merriam 1984). In some cases, the corridor may itself provide habitat for an adapted assemblage of plants or animals, and only a dispersal route for others (Rosenberg et al. 1997). For example, a seasonal drainage may provide habitat that will only support a non-specialized assemblage of non-native annual grasses and invertebrates that are more characteristic of a disturbed seasonal wetland, or emergent marsh. Yet this same seasonal drainage may convey seeds and cysts (eggs) of more specialized vernal pool organisms from a source vernal pool complex to another sink vernal pool complex. The vernal pool organisms themselves do not complete their life cycle within the drainage, but individuals, seeds, or cysts may pass from one vernal pool complex to the other through it.

Some corridors provide for movement (linkages), but do not necessarily provide suitable habitat for any of the species moving through them. Example of these includes concrete underpasses under freeways or roads, clear cuts, agricultural areas, roadways, railroads, fence lines, utility corridors, disturbed/modified greenways, and golf courses.

It is thought that in the absence of movement of genetic material, small, isolated populations are more affected by stochastic events, more prone to inbreeding depression and therefore more vulnerable to extinction. These population and genetic aspects as they relate to the value of movement corridors is highly disputed for various reasons (Simberloff et al. 1992).

Movement corridors are used differently by different species, depending on their home ranges, seasonal distributions, food supplies, hibernation needs, reproduction needs, species behavior, and the type and location of the corridor being used. For example, coyotes (*Canis latrans*) and bobcats (*Lynx rufus*) have larger home ranges and will move larger distances in a given time frame than raccoons, skunks, California tiger salamanders (*Ambystoma californiense*) or a western spadefoots (*Spea hammondii*). In addition, some species move on a daily basis (bobcats and coyotes), while other species may migrate only seasonally (e.g., California tiger salamander and western spadefoot). Some observations about wildlife corridors indicate that larger species are more commonly recorded in corridors than smaller ones (Lindenmayer and Nix 1993).

Although corridors can have many ecological benefits, there are also disadvantages associated with corridors (Simberloff et al. 1992). Corridors can facilitate the spread of invasive species, disease and fire at faster rates than would occur without connections between fragmented habitats. Since corridors are often narrow and linear in nature, they typically experience a high degree of edge effects and are more likely to be dominated by a non-native herbaceous understory. They also may be more likely to harbor a higher number of predators (both native and non-native), and may even act like biological sinks. These effects are amplified when corridors are adjacent to urbanized development.

In general, corridors should be wide, continuous, natural, and structurally diverse as opposed to narrow, fragmented, unnatural, and with low structural diversity. Multiple corridors are better than a single corridor and corridors should connect to natural habitats outside of the Plan Area where appropriate (LGIEN 2001).

The SSHCP recognizes that both corridors (habitat corridors such as riparian areas and seasonal drainages) and biological movement linkages (grassland areas that provide connections between vernal pool/grassland preserves) are a necessary component of the overall Conservation Plan. The SSHCP also recognizes that not all covered species will equally benefit from a particular configuration of connective corridors and landscape linkages. For instance, a landscape linkage dominated by annual grassland and with a low density of vernal pool or swale habitat will provide very little value to the majority of vernal pool species. Such a landscape linkage may however, provide important value to other wildlife species, particularly upland reptiles (lizards and snakes), small and medium-sized mammals (including bats) and perhaps some species of birds.

L.3 Establish Buffers

In addition to properly designed preserve areas, buffers should be established around the preserve systems because they reduce the adverse effects of adjacent urban and agricultural land uses. Preserves located close to urban areas are particularly vulnerable to edge effects and anthropogenic alternations of the preserved ecosystem (e.g., changes in hydrology, trash dumping, foot and bicycle traffic, and the invasion of exotic species). Buffers between developed and preserved lands can help ameliorate these negative effects and ensure ecological function is maintained in the preserve as a whole.

Simply defined, buffers are strips of land that are permanently covered with vegetation (NRCS 2001). Buffers can be planted windbreaks, hedgerows, grassed waterways, filter strips, and fenced areas around waterways that exclude livestock. Buffers can act as filters, absorbing various pollutants, trapping sediments, and, in the case of vernal pool preserves, absorbing or redirecting summer irrigation run-off. Well-designed buffers can also provide habitat for some wildlife species and beneficial insects.

Although there is general agreement that buffers are beneficial, there are no biological criteria for "standard" buffer widths because they vary for different impacts, species, habitat and local conditions. Fixed-width buffers are more efficient from a design or planning viewpoint and tend to be adopted as "regulatory standard", but biologists recommend buffers of varying widths depending on individual situations and ecosystem function. In general, narrower buffers are not as effective as wider buffers.

While buffers are an important component of all preserves within the preserve system, they may be even more important to smaller satellite preserves, which are more susceptible to edge effects than larger preserves. Therefore, isolated vernal pool preserves in the SSHCP should be surrounded by buffers of maximum possible width to minimize adverse effects from adjacent land uses and to ensure continued ecosystem function to the greatest extent possible. As preserves are acquired, buffers will be established within the existing footprint of the preserve. Acquisition of additional land beyond the preserve footprint is not required for a buffer.

L.4 Maximize Heterogeneity within Preserves

Habitat heterogeneity is important to consider in the design of the SSHCP Preserve System. Heterogeneous habitats generally support greater biodiversity. In addition, they are more likely to be ecologically complex and may be more resilient over time.

Heterogeneity should be considered at multiple spatial scales i.e., it can be assessed on a regional, local and site-specific scale. By maximizing preservation of habitat heterogeneity at all of these scales, the likelihood of capturing the full range of ecosystem functions and services needed for the long term survival of covered species is maximized, and the likelihood of long term preservation of biodiversity is enhanced.

An additional consideration in preserve design is heterogeneity arising from juxtaposition of one habitat with other habitat types. For example, vernal swales, seasonal drainages and emergent marshes may interact ecologically with vernal pools in a given landscape setting, e.g., through hydrological connection, dispersal and source-sink dynamics of organisms, and habitat support for foraging or prey organisms. Similarly, the presence of corridors, ridges, and other physical features likely contribute to habitat heterogeneity on a broad scale.

L.5 Protect Watersheds

The protection of watersheds is an important principal for design, establishment, and management of preserves for a number of reasons related to habitat function, hydrologic stability, and water quality.

Since hydrologic regimes are often the main factor in determining the presence of certain wetland flora and fauna, those features of the landscape that support the hydrology of a given wetland feature are of principal importance to maintain in establishing and managing preserves targeting the preservation of wetland dependent species. Hydrology of wetland features may depend on the presence of intact soil profiles in adjacent and upslope positions, intact swale and seasonal drainage morphology in the surrounding landscape, and surface and subsurface flows from upslope positions. Sufficient sub-watershed area should be preserved so that natural sources of surface and sub-surface water influx and outflow remain intact, potential development-related increases in surface runoff are minimized, and point and non-point sources of water pollution are avoided (e.g., runoff from roads, roofs, paved surfaces, utility pipes, landscaped areas, etc.).

The specific hydrologic relationships that may exist between a single wetland feature and its surrounding and underlaying soils, between it and adjacent wetland features, and between the wetland complex and surrounding uplands are ultimately too complex to empirically measure and describe for purposes relating to the SSHCP. The likelihood of long-term habitat stability and long term survival of wetland dependent species is maximized however, if all preserves are designed to protect entire sub-watersheds that support wetland features, wherever possible.

L.6 Maximize Population Size

It is generally accepted concept of population ecology that larger plant and wildlife populations tend to be more stable in the long-term, and less vulnerable to extirpation, compared with smaller populations and/or simpler, less extensive meta-population complexes. For purposes of the SSHCP, population size is defined as the number of interbreeding individuals within a single habitat unit (e.g., number of individuals of a given vernal pool species within a single vernal pool), or the number of interbreeding sub-populations within a given geographic setting (e.g., the number of genetically interrelated vernal pools within a complex or the number of genetically interrelated vernal pools among complexes). At both scales of consideration, bigger populations are preferable for a number of reasons.

Depending on the breeding system of the organism in question, larger populations tend to possess higher genetic diversity, which can buffer the population against negative demographic trends, including genetic bottlenecks, genetic drift, and inbreeding depression. Through higher levels of genetic diversity, larger populations may also be more pre-adapted to cope with changing environmental conditions. Empirical determination of patterns of genetic diversity is technically complex and cost prohibitive for the number of species and at the scale of the SSHCP. Designing preserves to encompass large populations, and management of these preserves to support large populations maximizes the likelihood that maximum genetic diversity is captured.

In addition, populations comprising a larger number of individuals, or a larger number of sub-population components are more likely to persist through local stochastic disturbances (e.g., drought, flood, fire, pollution spill, disease, noxious weed infestations, introduction of feral predators, adverse grazing regimes, negative demographic shifts, etc.) than smaller populations.

L.7 Maintain Species Distribution Across Their Native Range

It is important to consider and maintain the local, regional and range wide distribution of a covered species during landscape-scale conservation planning, for long-term species viability. The most apparent benefit of maintaining a species' full range is assurance that stochastic disturbances (e.g., drought, flood, fire, pollution spill, disease, noxious weed infestations, introduction of feral predators, dramatic demographic shifts, etc.) that may cause extinctions are limited to localized sub-populations and that the species may persist in portions of its range that escaped the disturbance. Unaffected populations might also serve as sources for natural re-colonization or active restoration of extirpated populations. Species that are highly restricted in their range, either naturally or as a result of human activity, are more vulnerable to extinction over the long-term.

Maintenance of a species' full range also helps assure preservation of genetic diversity that may be a requisite for long-term vigor and adaptation to changing environmental conditions (e.g., climate change, introduction of new pathogens, etc.). The genetic makeup of a given species is the sum of the combined genetic pool of its various populations. Different populations located apart from one another tend to experience different selective pressures over time. As a consequence, geographically separate populations may exhibit differing genetic diversity, including unique variants of genetically fixed adaptive traits. For example, populations that have evolved in the drier and harsher portions of a species' overall range might harbor genetic traits that pre-adapt those populations to long-term drought cycles.

In addition, maintaining the full range of a species increases the likelihood of capturing persisting meta-population dynamics and other landscape-scale ecological phenomena (ecosystem functions). This includes a higher probability of long-distance dispersal of individuals (and genes) between sub-populations, populations and meta-populations, if both small and large-scale species distribution patterns are maintained. Another important consideration is that preservation of the full geographic range of all endemic species within a region and between regions further ensures that landscape-scale habitat relationships and requirements of other species are met. The attractiveness of particular landscapes to waterfowl migrating along the Pacific Flyway is of particular importance. If populations of species are lost in significant portions of their ranges because of habitat loss, migratory patterns of the waterfowl may change, thus affecting the dispersal potential and long-term population dynamics of other species located in the region (Silveira 1998; USFWS 2005).

L.8 Maximize Preserve Size

In general, larger preserves are preferable to smaller ones for a variety of reasons that relate to ecological complexity, habitat support value, and long-term habitat sustainability. Larger preserves are more likely to be ecologically stable through time (Leidy and White 1998).

Establishment of larger preserves increases the likelihood that habitat variability is encompassed. Multiple landforms, multiple soil associations, and multiple habitat types are all more likely to be present in large contiguous areas, than they are in small isolated preserves. In general, greater habitat diversity is associated with greater biodiversity and more complex trophic relationships (food web). Larger preserves may also support larger and more complex meta-populations of plants and animals. Larger populations and more complex meta-populations are more likely to capture overall genetic diversity and spatial patterns of genetic diversity across the landscape. These larger, more complex populations are also more resilient to local extirpations resulting from chance events (floods, erosion/sedimentation, unfavorable grazing regimes, pathogens, predators, toxic spills, etc.). Larger preserves also result in less habitat fragmentation, and afford greater insulation from edge effect. Since larger preserves may more easily encompass more intact watersheds, the integrity of unaltered hydrological cycles is better assured.

The practicalities of vegetation management are also more favorable in larger preserves. Upland vegetation management options, including viable livestock grazing operations and controlled fire regimes are easier to implement on larger preserves than they are on small isolated preserves that are surrounded by development.

In all cases, preserves established as part of the SSHCP will be made as large as possible. However, it is important to note that smaller preserves can possess significant conservation value. It is also recognized that within the Plan Area rare species are found within urban settings where the opportunity to set aside large preserves no longer exists. In these cases, the application of adaptive management will help ensure the survival of these species in small preserves and will maintain the integrity of the ecological functions of the preserves in the long term.

L.9 Conservation of Ecological Functions and Values

Ecological functions are an array of biological and physical functions that different habitat provide, while ecological values are the values of these functions to society. Some ecological functions, such as providing habitat for animals and plants, are common to all habitat types in the Plan Area. Each of these habitat types is characterized by a variety of structural features, varying patterns across the landscape, and ecological processes that contribute to ecological functions of the habitat. Ecological processes include movement of energy and nutrients through food-webs, and the cycling of chemical constituents through soil, water and air.

Several habitat types in the Plan Area provide ecological functions related to flood control. Streams are the conduit for moving storm-water through the Plan Area and into the major rivers. Seasonal wetlands adsorb floodwaters and reduce the amount of water flowing down streams during storms. Riparian vegetation reduces the flow rate of the storm run-off, allowing more time for groundwater recharge. In addition, wetlands and riparian areas improve stream water quality by removing pollutants and reducing non-point source pollution run-off. All of these functions provide direct benefits to human communities in the Plan Area.

The SSHCP conserves and, in some cases enhances, ecological functions and values through the variety of measures including preserve acquisition, habitat restoration, and habitat enhancement. The direct conservation of functioning stream corridors, seasonal wetlands and vernal pool wetlands will ensure that ecological functions of major portions of the Plan Area continue to exist. Restoration of riparian vegetation along several key reaches of streams in the Plan Area will improve the overall ecological functions of stream corridors, while restoration of highly degraded historic vernal pool areas outside the UDA will contribute to compensation for loss of vernal pools within the take area. Several agricultural conservation measures will reduce non-point source water pollution and provide native habitat patches for beneficial insects and other features. Enhancements of upland and aquatic habitats will improve a variety of ecological functions.

The conservation strategy provides for the conservation of habitat and species, as well as ecological functions at the landscape scale. This approach helps to maximize the level of ecological functioning of the entire Plan Area. For example, the conservation of large vernal pool grassland areas ensures adequate habitat for species that utilize both vernal pools and the surrounding upland habitat, for pollinators of vernal pool plant species and for larger animals that have important roles in the overall ecological functions of vernal pool grasslands. This approach allows for the loss of vernal pools in lower quality habitat areas within the UDA, as well as a small amount of loss in high-quality areas. Coupled with a "no net loss of wetlands" requirement, this landscape-level approach provides for more effective conservation of vernal pool functions and values than a project-by-project approach consisting of avoidance, mitigation and compensation measures. While the project-by-project approach can result in a higher level of vernal pool avoidance on a particular project site, it is likely to result in establishment of small preserves subject to relatively large edge effects from adjacent non-compatible uses, and is unlikely to achieve the conservation of very large vernal pool landscapes that fully conserve ecological functions.

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