11 CHANGED AND UNFORESEEN CIRCUMSTANCES – ASSURANCES

This chapter discusses the assurances requested by the Permittees that will accompany the federal Endangered Species Act (ESA) Section 10(a)(1)(B) permits issued by the U.S. Fish and Wildlife Service (USFWS) and assurances that will be provided to private landowners within the Plan Area. This chapter also provides a discussion of projected effects of climate change in California, qualitatively assesses the relative vulnerability of the South Sacramento Habitat Conservation Plan (SSHCP) Covered Species to climate change in the Plan Area, and discusses how climate change was considered in the Conservation Strategy.

11.1 Assurances for Private Landowners

11.1.1 Willing Sellers

As discussed in Chapter 9, land will only be acquired by the Implementing Entity for the SSHCP Preserve System from willing sellers. The SSHCP Preserve System has enough flexibility that any one parcel of land is not required to satisfy the SSHCP Conservation Strategy.

The SSHCP Plan Permittees may enter into option agreements with key landowners to ensure that large tracts of land can be acquired that fulfil the SSHCP Conservation Strategy, including Preserve acquisitions for the "jump-start" and "stay-ahead" provisions. In the unlikely event that there are no willing sellers, the SSHCP Implementing Entity will consider amending the SSHCP, adjusting the development fees, or modifying other aspects of the SSHCP, as described in Chapter 9. The SSHCP cannot be amended to eliminate this willing sellers' clause or do anything that would force or otherwise require a landowner to sell land or easements to the SSHCP Implementing Entity.

11.1.2 Land or Easement Acquisition Pricing

The acquisition costs for land of a particular cover type will reflect the going market rate based on comparable lands. The SSHCP development fees that are collected will reflect the current market rate for land with similar habitat values needed for mitigation. Covered Activity development fees will be sufficient to purchase the needed Preserve land at the market rate. It is recognized, however, that development fees may not always be adequate at the time land is available for purchase. The SSHCP has provisions to address this issue, should it arise, including the jump-start and stay-ahead provisions (Chapter 10). In the unlikely event that there are no willing sellers, the SSHCP Implementing Entity will consider amending the SSHCP, adjusting the development fees, or modifying other aspects of the SSHCP, as described in Chapter 9.

11.1.3 No Use of Eminent Domain

As discussed in Chapter 9, the Implementing Entity will not use condemnation or eminent domain to acquire property.

11.1.4 No Change of Land Use or Zoning Designations

The SSHCP cannot require the local Land Use Authority Permittees to change land use or zoning designations to accommodate the SSHCP Conservation Strategy. Under the SSHCP, all landowners retain the right to apply for permits, rezones, or any other entitlements allowed under the local jurisdiction's policies and regulations.

11.1.5 Good Neighbor Program

The SSHCP requires the acquisition, preservation, re-establishment/establishment, and management of species habitat. Such actions may result in the expansion (colonization or increased numbers) of some Covered Species populations on private property adjacent to Preserves, potentially restricting the activities or increasing management costs for adjacent landowners. In recognition of this potential effect, the SSHCP offers a Good Neighbor Program that allows the SSHCP Implementing Entity to extend incidental take coverage to landowners that are adjacent to SSHCP Preserves and meet certain conditions as described in this section.

The SSHCP Good Neighbor Program extends Incidental Take Permit (ITP) coverage for willing participants on an "opt-in" basis for all agricultural lands within 0.5 mile of any land or property acquired as part of the SSHCP Preserve System. This opt-in approach allows for landowners to willingly participate in the Good Neighbor Program. Landowners that do not seek to participate in the program will not be required to do so. Incidental take coverage can only be extended to eligible parcels or portions of parcels within the Plan Area. The program does not provide for incidental take of existing populations of Covered Species prior to the establishment of a Preserve.

The Good Neighbor Program is described as follows:

- Agricultural lands within 0.5 mile of SSHCP Preserve boundaries can apply to the Implementing Entity for incidental take of federally listed Covered Species under the SSHCP's Section 10(a)(1)(B) ITP if such lands become inhabited by SSHCP Covered Species as a result of implementing the SSHCP, the land owner has applied for inclusion in the Good Neighbor Program, and the incidental take is in compliance with other applicable state and federal regulations (e.g., Migratory Bird Treaty Act, Clean Water Act, California Fish and Game Code).

- Incidental take coverage will be offered to neighboring land owners that are in active agricultural production, including ranching, at the time that an SSHCP Preserve is established and only on lands that are within the Plan Area. Incidental take coverage will not be offered to lands devoted to non-farmland or ranching purposes at the time the nearby Preserve is established.
- For purposes of the SSHCP, agricultural activities include crop production, animal production, forage production, and ranching activities in which usual and customary agricultural practices are occurring at the time the neighboring SSHCP Preserve is established. If agricultural lands used for crop production lie fallow in accordance with normal crop rotation practices at the time the neighboring Preserve is established, those lands will be considered to be actively used for agricultural purposes. Incidental take coverage shall continue, subject to the terms and conditions of the SSHCP, the Implementing Agreement, and the ITPs, for as long as the neighboring lands are actively used for agricultural purposes as defined here and the SSHCP ITPs remain in effect. Take coverage does not include conversion of agriculture to other land uses.
- Upon establishment of an SSHCP Preserve, the Implementing Entity will send a letter to each neighboring landowner with property that is located within 0.5 mile of the Preserve boundary and are actively used for agricultural purposes as defined in this section. The letter will explain the SSHCP Good Neighbor Program, including the landowner's potential eligibility for incidental take coverage under the program. Landowners who are interested in receiving incidental take coverage shall respond to the Implementing Entity and request coverage within 30 days of confirmed receipt of the notification.
- Prior to extending incidental take coverage, the Implementing Entity will determine the baseline conditions of the property by conducting a survey of the property. Upon completion of the surveys, a biological report will be prepared that documents the areas and resources of the property that are eligible for incidental take coverage under the program. Costs to prepare surveys and the biological report are the responsibility of the landowner. Biological reports will be reviewed by the Implementing Entity and the USFWS for adequacy.
- A change of ownership of land enrolled in the Good Neighbor Program requires the new landowner to notify the Implementing Entity and to sign a Certificate of Inclusion in order to continue coverage. No new surveys are required as long as the original agricultural practices described in the original Certificate of Inclusion are maintained by the new landowner.

Incidental take coverage ends when the SSHCP Permit Term expires. The Implementing Entity will maintain a record of all correspondence and Certificates of Inclusion sent to neighboring landowners under this policy, as well as signed Certificates of Inclusion returned by landowners.

On an annual schedule, the Implementing Entity will notify the USFWS of the number, location, and size of neighboring lands entered into the Good Neighbor Program. Copies of the Certificates of Inclusion will be provided to the Wildlife Agencies upon request.

Process for Entering Into the Good Neighbor Program

Generally, the steps are as follows:

1. The landowner contacts the Implementing Entity to express interest.
2. The Implementing Entity, with the aid of the property owner, collects information, including but not limited to a map of the property, proposed activities on the property, a description of the possible incidental take that may be caused by the landowners activities, and any other pertinent information.
3. The Implementing Entity conducts species surveys and land cover type surveys for the property.
4. The Implementing Entity prepares a biological report that describes the baseline conditions for the property to be enrolled in the Good Neighbor Program. Baseline conditions include a description of habitat for Covered Species (extent and quality), records of Covered Species on the subject property, and observations of Covered Species on the property.
5. Based on the information provided by the property owner and information gathered during site visits, the Implementing Entity develops a draft Good Neighbor Agreement.
6. Once the Good Neighbor Agreement is finalized, the property owner is issued a Certificate of Inclusion, and incidental take coverage will be extended to the qualifying landowner.

11.1.6 Public Notification of Land Acquisitions

All landowners within 0.5 miles of a property that is being proposed for preservation by the SSHCP must be notified of the impeding action to preserve the property. The notice must be sent at least 15 days prior to the Implementing Entity's Board meeting at which the proposal to preserve the property is being heard. At a minimum, the notice must include the date, time, and location of the Implementing Entity's Board hearing and a map that shows the proposed Preserve in relation to properties that are within 0.5 miles of the proposed Preserve property.

SSHCP Preserve acquisitions in fee title and easement are privately negotiated between landowners and the SSHCP Implementing Entity. The parties will privately settle on appropriate terms of a fee title or conservation easement acquisition, continued management of the property, possible improvements to the property, and any potential issues associated with the property title

among other procedural steps necessary for a transaction. Once terms have been agreed to between the parties, the Technical Advisory Committee must approve the transaction (see Chapter 9, Section 9.3.4).

11.1.7 Easement Acquisitions

The acquisition of easements is the preferred method for establishing the SSHCP Preserve system outside of the Urban Development Area (UDA). As described in Chapter 9, 85% of the Preserve system outside of the UDA will be established via easement acquisitions. Easement acquisitions are preferred by the Implementing Entity because easements maintain private ownership of lands and generally cost less to acquire. Fee title acquisitions will be allowed if there are no willing sellers of an easement. However, property purchased in fee title due to the unavailability of easement options may be sold back to a private landowner after an easement is established.

11.1.8 No Public Access to Conservation Easements Held by Private Landowners

It is not the intent of the Implementing Entity to allow general public access on conservation easements that are part of the SSHCP Preserve System. Public access to private lands managed under the SSHCP could conflict with ongoing agricultural or other operations and could pose a safety risk to the public. Public access to lands under conservation easements could also pose a risk of unwanted trespass onto adjacent privately held lands. Generally, the Implementing Entity will leave decisions regarding public access up to the landowner but will restrict access through the conservation easement where that access may conflict with the conservation goals of the site. All conservation easements will provide access for the Wildlife Agencies' and Implementing Entity's biologists to conduct management and biological monitoring necessary for compliance with the SSHCP's Monitoring Program and Preserve System Management Program.

11.2 Assurances to the Permittees – The No Surprises Rule

The federal No Surprises Regulation was established by the Secretary of the Interior on March 25, 1998. It provides assurances to Section 10 permit holders that no additional money, commitments, or restrictions of land or water will be required should unforeseen circumstances requiring additional mitigation arise once the permit is in place. The No Surprises Regulation states that if a Permittee is properly implementing an HCP that has been approved by USFWS, no additional commitment of resources, beyond that already specified in the plan, will be required. The Permittees request regulatory assurances (No Surprises) for all Covered Species in the Plan.

The federal No Surprises Rule (63 FR 8859) and associated amendments to federal regulations (50 CFR 17.3, 17.22, and 17.32) refined the concepts of "changed and unforeseen

circumstances" in HCPs, and describe potential future responsibilities based on whether changes in circumstances could have reasonably been foreseen and addressed by an HCP.

11.2.1 Changed Circumstances

Changed circumstances are defined under the federal "No Surprises" Rule (63 FR 8859) and at 50 CFR 17.3 as:

> "Changed circumstances means changes in circumstances affecting a species or geographic area covered by a conservation plan that can reasonably be anticipated by plan developers and the USFWS and that can be planned for (e.g., the listing of a new species, fire, flood, or other natural catastrophic event in areas prone to such events)."

Accordingly, these regulations require that potential changed circumstances be identified in the Plan along with remedial measures that would be taken to address these changes. The changed circumstances that could arise in the Plan Area have been identified and are described below.

A changed circumstance is a change in the circumstances affecting a Covered Species or their habitats that can be reasonably anticipated and that allows a plan to be developed in advance to accommodate the change. Changed circumstances are identified and planned for by the Plan Permittees. Anticipating and addressing these changed circumstances adds to the conservation value of the SSHCP by reducing the potential risks associated with the changed circumstance and will ensure that the Plan's Biological Goals and Measurable Objectives will be met (Chapter 7). It also provides the Permitting Agencies with assurance that the Implementing Entity is prepared to take certain remedial actions to address a changed circumstance if such an event occurs, and provides assurances to the Permitting Agencies that the SSHCP economic analysis and funding program (Chapter 12) includes adequate funding to deal with the identified changed circumstances.

If a changed circumstance occurs within the Plan Area as defined by these sections, the Implementing Entity will convene the Technical Advisory Committee (TAC) to discuss the changed circumstance if necessary. The Implementing Entity will remediate the effects of the changed circumstances, as described for each changed circumstance in Sections 11.2.2 to 11.2.9, and will report to the TAC on its actions. As necessary, the Implementing Entity will begin implementing a remediation action without awaiting notice from the TAC.

Pursuant to the No Surprises Rule, if such changed circumstances were provided for in the SSHCP and they occur during the Permit Term, implementation of their remedial measures is required. If additional conservation and mitigation measures are deemed necessary to

respond to changed circumstances and were provided for in the Plan's operating conservation program,[1] the Permittees will implement the measures specified in the SSHCP (50 CFR 17.22 and 17.32). The Implementing Entity will maintain sufficient financial reserves to fund all remedial actions as they arise.

If additional conservation and mitigation measures are deemed necessary to respond to changed circumstances and such measures were not provided for in the Plan's operating conservation program, the USFWS will not require any conservation and mitigation measures in addition to those provided for in the Plan, without the consent of the Permittees, as long as the Plan is found to be properly implemented[2] (50 CFR 17.22 and 17.32).

11.2.2 Unforeseen Circumstances

Unforeseen circumstances are also defined under the federal "No Surprises" Rule (63 FR 8859) and at 50 CFR 17.3 as follows:

> "Unforeseen circumstances means changes in circumstances affecting a species or geographic area covered by a conservation plan that could not reasonably have been anticipated by plan developers and the Service at the time of the conservation plan's negotiation and development, and that result in a substantial and adverse change in the status of the covered species."

Unforeseen circumstances are events affecting a species or geographic area covered by the SSHCP that could not reasonably have been anticipated by the participants during the development of the SSHCP and that result in a substantial and adverse change in the status of a Covered Species.

If unforeseen circumstances do arise during the SSHCP Permit Term, and if additional conservation and mitigation measures are deemed necessary to respond to the unforeseen circumstance, the USFWS and the Implementing Entity would work together to identify opportunities to address the unforeseen circumstance. The USFWS "may require additional measures of the Permittees where the Plan is being properly implemented, but only if such measures are limited to modifications within conserved habitat areas, or to the Plan's operating conservation program[3] for the affected species, and the additional measures maintain the original terms of the conservation plan to the maximum extent possible. However, any additional conservation and mitigation measures required by the

[1] Operating Conservation Program means any conservation plan, Implementing Agreement, and permit whose commitments and provisions have been or are being fully implemented by the Permittee (50 CFR 17.3)

[2] A "*properly implemented conservation plan"* means all SSHCP, Implementing Agreement, and permit commitments and provisions have been and are being fully implemented by the Permittees (50 CFR 17.3).

[3] An "*operating conservation program"* means those conservation management activities that are expressly agreed upon and described in the Plan or its Implementing Agreement, if any, and which are to be undertaken for the affected species when implementing an approved conservation plan, including measures to respond to changed circumstances.

USFWS to address unforeseen circumstances will not involve the commitment of additional land, water, or financial compensation, and will not require additional restrictions on the use of land, water, or other natural resources otherwise available for development or use under the original terms of the Plan unless the Implementing Entity consents" (see the No Surprises Rule and permit regulations 50 CFR 17.22(b)(5) and 17.32(b)(5).

The USFWS will "have the burden of demonstrating that unforeseen circumstances exist, using the best scientific and commercial data available." A finding of unforeseen circumstances must be clearly documented and based upon reliable technical information regarding the status and habitat requirements of species affected by the unforeseen circumstances. The USFWS will consider, but not be limited to, the following factors:

- Size of the current range of the affected covered species;
- Percentage of range adversely affected by the Plan;
- Percentage of range conserved by the Plan;
- Ecological significance of that portion of the range affected by the Plan;
- Level of knowledge about the affected covered species and the degree of specificity of the species' conservation program under the Plan; and
- Whether failure to adopt additional conservation measures would appreciably reduce the likelihood of survival and recovery of the affected species in the wild.

If a finding of unforeseen circumstances is made by the USFWS and additional conservation and mitigation measures are required, the Implementing Entity will work with the TAC to appropriately redirect SSHCP resources to address the unforeseen circumstances, consistent with 50 CFR 17.22(b)(5)(iii)(B) and with 50 CFR 17.22(b)(5)(iii)(B).

The No Surprises Rule "does not limit or constrain the USFWS, or any other Federal, State, local, or Tribal government agency, or any private entity, from taking additional actions at its own expense to protect or conserve a SSHCP Covered Species." This means the USFWS or other entities can intervene on behalf of a species at their own expense at any time and be consistent with the assurances provided to the Permittees under the No Surprises Rule.

Also, "nothing in the No Surprises Rule prevents the USFWS from asking the Permittees to voluntarily undertake additional mitigation on behalf of the affected species." If unforeseen circumstances do arise during the SSHCP Permit Term and the Permittees would like to undertake additional conservation and mitigation measures to respond to the unforeseen circumstance (e.g., human zombie apocalypse destroys Implementing Entity staff), the Permittees may request an amendment to the Plan (see Chapter 9).

11.3 Climate Change

Effective HCPs must anticipate and mitigate a wide range of current and potential threats to species. A growing body of research describes the potential effects of climate change on species and ecosystems. Because HCPs are tasked with the conservation of U.S. endangered species over significant time horizons (often in perpetuity), the effectiveness of HCPs may be reduced if plans do not account for climate change. The No Surprises clause that precludes the retroactive adjustment of HCP conservation commitments (USFWS and NOAA 1998) makes the consideration of climate change in HCP development critical (Bernazzani et al. 2012).

11.3.1 Projected Climate Change and Effects in California

The SSHCP Conservation Strategy was developed with consideration of projected future effects of climate change as identified in the *2009 California Climate Adaptation Strategy* (CAS) (California Natural Resources Agency 2009), Our Changing Climate (California Energy Commission and California Natural Resources Agency 2012), Safeguarding California: Reducing Climate Risk (California Natural Resources Agency 2014), the U.S. Bureau of Reclamation (2014), and the Capital Region Climate Readiness Collaborative (2014). The physical effects of climate change identified in these resources include the following, which are assumed as changed circumstances in the SSHCP:

- Temperature rise:
  - 2.1 degrees Fahrenheit (°F) to 4.5°F by 2050; 3.6°F to 7.8°F by 2100
  - More pronounced warming in summer than winter
  - More pronounced warming inland than in coastal areas
  - All models predict increased temperatures, with level of greenhouse gas emissions the biggest uncertainty.
- Extreme weather events:
  - More frequent and longer heat waves
  - More frequent and more intense wildfires
  - Prolonged drought
  - Increased winter and spring flooding due to more rain relative to snow, and earlier snowmelt.

- Precipitation changes:
  - 12% to 35% reduction by 2050
  - High uncertainty due to different models of where and how much snowfall and rain patterns will change
    - 11 of 12 precipitation models show overall decreases in rainfall in Northern California (12% to 35%)
    - More water will fall as rain than as snow, affecting runoff patterns (earlier snowmelt).
- Earlier spring and summer seasons, later fall and winter seasons
- Sea level rise:
  - 12 to 18 inches by 2050; 21 to 55 inches by 2100
- Generally hotter and drier conditions.

Potential future climate change impacts in the Plan Area include warmer temperatures, altered precipitation (changes in the timing, intensity, location, amount, and variability of precipitation); reduction of average annual snowpack and changes in the timing of snowmelt; seasonal shifts and lengthening of the growing season; and long-term changes in watershed vegetation. The potential effects of such changes, both directly from climate change and indirectly from more frequent and intense wildfires, include alterations in runoff patterns, hydrology, vegetation communities, microclimates, and microhabitats. Although these types of impacts are expected to occur, the existing climate change models require further calibration to estimate local impacts, determine variability of precipitation, and predict timing of extreme events. The changing patterns of rain and snowfall, however, are difficult to predict at a local or regional level due to natural variability and complex climatic and non-climatic interactions of temperature, wind, evapotranspiration rates, and other factors. However, the present state of knowledge can inform that future temperatures and precipitation may look very different from the past, even with little change in total annual precipitation levels in the six-county Sacramento region. It is important to note that yearly temperature and precipitation estimates conceal precipitation events that will vary throughout the year (Phurisamban 2014).

11.3.2 Climate Change and SSHCP Covered Species

The SSHCP Conservation Strategy and Preserve System Management and Monitoring Program were designed to provide assurances that Biological Goals and Measurable Objectives for Covered Species will be achieved under climate change changed circumstances (Section 11.4.4). To accomplish this, the Permittees first identified the Covered Species most at risk from climate change. Information compiled in the species accounts (Appendix B), as well as the best available climate change literature for the Sacramento Valley, was evaluated in the context of several

factors to assess the relative sensitivity of the Covered Species to climate change in the SSHCP. Factors considered generally following Gardali et al. (2012) and include the following:

- Habitat specialization and changes in habitat suitability: Species with generalized habitat requirements are more likely to tolerate a greater degree of climate change-induced habitat alterations than habitat specialists, and especially specialists occupying habitats most likely to be affected by climate change (e.g., riparian and wetland systems).
- Physiological tolerances: Species with high sensitivity to temperature, precipitation, moisture, or other climatic variables are more likely to be affected by climate change.
- Migratory status: Migratory species that depend on seasonally appropriate environmental conditions (e.g., environmental cues or triggers) are sensitive to factors that can affect survival and reproduction, such as food availability and temperature regimes.
- Dispersal ability: Species with limited dispersal capabilities, such as speed and distance of dispersal movements, are less likely to adapt to rapidly changing environmental changes.
- Changes in food availability: Species that depend heavily on seasonally or environmentally determined food resources or predator–prey relations (e.g., insect blooms tied to temperature) are more likely to be affected by climate change.
- Changes in extreme weather: Species sensitive to weather extremes such as prolonged drought or unusually high temperatures that affect both habitat and/or individuals directly (i.e., physiological tolerances) are more likely to be affected by climate change.

The results of this evaluation are summarized in Table 11-1. For each of the factors in the table, a general sensitivity ranking of Low, Medium, or High is assigned, or NA (not applicable) is assigned if the factor does not apply to the species. Available information for the species to support the rankings is provided. A general conclusion about the species' likely overall sensitivity to climate change in the Plan Area is also provided. The context of the Table 11-1 analysis is primarily the Plan Area and not the species' range-wide distributions.

For example, species that use oak woodlands, such as Cooper's hawk (*Accipiter cooperii*), may be considered vulnerable to climate change if wildfires become more frequent and intense and degrade or eliminate woodlands in the Plan Area. However, some climate models predict overall increases in oak woodlands in other areas of California, so at a statewide level, woodland species would not be as vulnerable to climate change, even though species distributions may change. So while a species such as Cooper's hawk may not be considered vulnerable statewide, its occurrence and distribution in the Plan Area could be adversely affected by consequences of future climate change. Consequently, some of the sensitivity conclusions for certain avian species in the Plan Area may not agree with statewide vulnerability assessments for birds made by Gardali et al. (2012). For example, of the 128 avian taxa Gardali et al. (2012) identified as vulnerable to climate

change in California, the only SSHCP avian Covered Species on the list is Swainson's hawk (*Buteo swainsoni*)—a Climate Priority 2 species according to Gardali et al. (2012). This species was ranked as having low–medium sensitivity in Table 11-1. Overall, six of the nine avian Covered Species in the Plan Area were ranked by the Permittees as having at least a low–medium sensitivity to climate change. Also, Gardali et al. (2012) note that their assessment was scaled to California and may not identify vulnerable taxa at a smaller scale.

More complex interactions or indirect relationships between climate change and other threats and stressors generally are not considered in the Table 11-1 analysis because they are often speculative. For example, severe drought may reduce the need for mosquito controls, which may reduce the proliferation of mosquitofish, which is a predator of fairy and tadpole shrimp (*Branchinecta lynchi* and *Lepidurus packardi)*, western spadefoot (*Spea hammondii*), and California tiger salamander (*Ambystoma californiense*), or the use of insecticides, which can adversely impact water quality, prey, or have direct toxic effects on wildlife.

Table 11-1
Evaluation and Ranking of Covered Species Sensitivity to Climate Change

Covered Species	Habitat Specialization/Habitat Changes	Physiological Tolerance	Migratory Status	Dispersal Ability	Changes in Food Availability	Changes in Extreme Weather	Overall Sensitivity Ranking
Ahart's dwarf rush	High Sensitivity: Vernal pools and swales. Habitat could be hydrologically altered by climate change.	Medium Sensitivity: as annual it can tolerate periods of drought. Environmental conditions for germination (e.g., water temperature) unknown.	NA	Medium Sensitivity: natural seed dispersal likely via flowing water, waterfowl, hooves and legs of livestock but also found to colonize artificial features including created vernal pools, stock pond and reservoir margins, ditches, and other excavated or scraped depressions. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	NA	High Sensitivity: sensitive to prolonged drought or altered precipitation patterns that could affect hydrology.	Medium-High
Boggs Lake hedge-hyssop	Medium Sensitivity: Vernal pools and seasonal wetlands. Could be hydrologically altered by climate change.	Medium Sensitivity: as annual it can tolerate periods of drought. Environmental conditions for germination (e.g., water temperature) unknown.	NA	Medium Sensitivity: natural seed dispersal likely via flowing water, waterfowl, hooves and legs of livestock but also found to colonize artificial features including created vernal pools, stock pond and reservoir margins, ditches, and other excavated or scraped depressions. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	NA	Medium Sensitivity: may be sensitive to prolonged drought but also occurs in artificial habitats including created vernal pools, stock pond and reservoir margins, ditches, and other excavated or scraped depressions.	Medium
Dwarf downingia	Medium Sensitivity: Vernal pools and swales. Margins of larger or deeper vernal pools and the seasonally fluctuating vernal pool-like edges of more severely inundated systems. Habitat could be hydrologically altered by climate change.	Medium Sensitivity: as annual it can tolerate periods of drought. Environmental conditions for germination (e.g., water temperature) unknown.	NA	Medium Sensitivity: natural seed dispersal likely via flowing water, waterfowl, hooves and legs of livestock. Evidence of long distance dispersal in the species. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	NA	Medium Sensitivity: may be sensitive to prolonged drought but also occurs in artificial habitats such as stock ponds and more severely inundated systems.	Medium
Legenere	Medium Sensitivity: Vernal pool and seasonal wetlands. Strict endemic of the vernal pool hydrologic cycle in well-developed vernal pools.. Habitat could be hydrologically altered by climate change.	Medium Sensitivity: as annual it can tolerate periods of drought. Environmental conditions for germination (e.g., water temperature) unknown.	NA	Medium Sensitivity: natural seed dispersal likely via flowing water, waterfowl, hooves and legs of livestock. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	NA	Medium Sensitivity: may be sensitive to prolonged drought but also occurs in artificial habitats such as stock ponds and along margins of more permanent water bodies.	Medium
Pincushion navarretia	High Sensitivity: Vernal pools and swales. Habitat could be hydrologically altered by climate change.	Medium Sensitivity: as annual it can tolerate periods of drought. Environmental conditions for germination (e.g., water temperature) unknown.	NA	Medium Sensitivity: natural seed dispersal likely via flowing water, waterfowl, hooves and legs of livestock. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	NA	High Sensitivity: sensitive to prolonged drought or altered precipitation patterns that could affect hydrology.	Medium-High
Sacramento Orcutt grass	Medium Sensitivity: Vernal pools; larger, deeper pools with more extreme inundation regimes. May germinate in years of marginal precipitation. Habitat could be hydrologically altered by climate change.	Medium Sensitivity: sensitive to temperature regime. Germination requires cold stratification followed by increasingly warm fluctuating diurnal temperatures and the presence of symbiotic aquatic fungi (*Alternaria* sp., *Curvilaria* sp.). However, matures in hotter and drier late spring and summer and possesses the C4 photosynthetic pathway and Krantz Anatomy which allows it to exchange atmospheric gasses with increased efficiency and concomitant reduction in water loss to evaporative transpiration.	NA	Medium Sensitivity: low natural dispersal capability but may be transported by livestock. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	NA	High Sensitivity: one of the more specifically adapted Orcutt species, inhabiting the more well-developed of vernal pools, and one of the least likely to germinate during years with marginal precipitation.	Medium-High

Table 11-1
Evaluation and Ranking of Covered Species Sensitivity to Climate Change

Covered Species	Habitat Specialization/Habitat Changes	Physiological Tolerance	Migratory Status	Dispersal Ability	Changes in Food Availability	Changes in Extreme Weather	Overall Sensitivity Ranking
Slender Orcutt grass	Medium Sensitivity: Vernal pools; larger, deeper pools with more extreme inundation regimes. May germinate in years of marginal precipitation. Habitat could be hydrologically altered by climate change.	Medium Sensitivity: sensitive to temperature regime. Germination requires cold stratification followed by increasingly warm fluctuating diurnal temperatures and the presence of symbiotic aquatic fungi (*Alternaria* sp., *Curvilaria* sp.). However, matures in hotter and drier late spring and summer and possesses the C4 photosynthetic pathway and Krantz Anatomy which allows it to exchange atmospheric gasses with increased efficiency and concomitant reduction in water loss to evaporative transpiration.	NA	Medium Sensitivity: low natural dispersal capability but may be transported by livestock. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	NA	Medium Sensitivity: adapted to more extreme inundation regimes and may germinate in years with marginal precipitation.	Medium
Ricksecker's water scavenger beetle	High Sensitivity: Vernal pool and swale with sufficient hydroperiod to support lifecycle (minimum 18 days). Habitat could be hydrologically altered by climate change.	Medium Sensitivity: late instar larvae leave pool when temperatures increase and construct burrows in moist habitat for 2-4 day pupation period, depending on temperature. Then fly to different vernal pool for mating.	NA	High Sensitivity: adults fly to different vernal pools for mating and likely sensitive to habitat fragmentation. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	Medium Sensitivity: predatory as larvae and omnivorous as adults, with larvae indiscriminately attack anything their size or smaller. Adults feed on common frog-fruit (*Phyla nodiflora*), and dead insects and tadpoles.	Medium Sensitivity: eggs may be desiccation-resistant and lay dormant in the pool bottom. Need at least 18-day hydroperiod, but may be able to withstand drought periods.	Medium-High
Mid-valley fairy shrimp	Medium Sensitivity: Vernal pool and swale. Require cold winter waters for hatching and growth, typically appearing after the first frosts; optimal habitat includes abbreviated hydroperiod. Habitat could be hydrologically altered by climate change.	High Sensitivity: requires cold winter waters for hatching and growth; maturity rate related to temperature. May be sensitive to shifting/rising temperature patterns; e.g., warmer temperatures in late winter/early spring.	NA	Medium Sensitivity: cysts may be dispersed through predator wastes, wind, and mud carried on feet of animals, including livestock. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	Low Sensitivity: omnivorous, indiscriminately filters particles from the water column, including bacteria, unicellular algae, and micrometazoa. Also rasps periphyton from sticks, stems and slender leaves.	Medium Sensitivity: survive as cysts during dry periods and droughts. Can reach maturity in as little has 4 days, indicating relatively less sensitivity to drought conditions.	Medium
Vernal pool fairy shrimp	Medium Sensitivity: Vernal pool and swale vernal swale. Require cold winter waters for hatching and growth. Habitat could be hydrologically altered by climate change.	High Sensitivity: requires cold winter waters for hatching and growth; maturity rate related to temperature. May be sensitive to shifting/rising temperature patterns; e.g., warmer temperatures in late winter/early spring.	NA	Medium Sensitivity: cysts may be dispersed through predator wastes, wind, and mud carried on feet of animals, including livestock. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	Low Sensitivity: omnivorous, indiscriminately filters particles from the water column, including bacteria, unicellular algae, and micrometazoa. Also rasps periphyton from sticks, stems and slender leaves.	Medium Sensitivity: survive as cysts during dry periods and droughts. Can reach maturity in as little has 6 days under high temperatures, indicating relatively less sensitivity to drought conditions.	Medium
Vernal pool tadpole shrimp	High Sensitivity Vernal pool and swale; typically larger, deeper pools. Habitat could be hydrologically altered by climate change.	High Sensitivity: requires cold winter waters for hatching and growth; maturity rate related to temperature. May be sensitive to shifting/rising temperature patterns; e.g., warmer temperatures in late winter/early spring.	NA	Medium Sensitivity: cysts may be dispersed through predator wastes, wind, and mud carried on feet of animals, including livestock. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	Low Sensitivity: omnivorous, consuming live invertebrates, amphibian larvae, or carrion. Also filter detritus for micrometazoa.	High Sensitivity: survive as cysts during dry periods and droughts. Require at least 19 days to reach maturity so may be more vulnerable to shortened hydroperiods resulting from less rainfall and/or increased temperatures.	Medium-High

Table 11-1
Evaluation and Ranking of Covered Species Sensitivity to Climate Change

Covered Species	Habitat Specialization/Habitat Changes	Physiological Tolerance	Migratory Status	Dispersal Ability	Changes in Food Availability	Changes in Extreme Weather	Overall Sensitivity Ranking
Sanford's arrowhead	Medium Sensitivity: Seasonal wetlands, freshwater marsh, open water, streams and creeks; includes man-made marsh habitats; observed water depths of 4 inches to 2 feet; potential preference for relatively shallow margins of deeper marsh systems. Habitat could be hydrologically altered by climate change.	Medium Sensitivity: dormant rhizome and associated tubers/corms allow it to persist within the submersed substrate through the dormant winter season; seed ecology, germination or seedling growth and vegetation growth unknown.	NA	Medium Sensitivity: have a wide distribution and capable of long-distance dispersal via water courses (e.g., floodwaters carrying tubers, rhizomes, fruits and seeds), migratory waterfowl, muskrats, and beavers. Ability to disperse could be limited by loss and fragmentation of suitable habitat.	NA	Low Sensitivity: occurs in relatively broad range of wetland habitats and is able withstand drought periods and occurs in seasonal and perennial wetlands and artificial or otherwise maintained irrigation, drainage, or flood control conveyances. Can be an aggressive spreader under good growing conditions.	Medium
Valley elderberry longhorn beetle	Medium Sensitivity: Depends on host plant elderberry (*Sambucus* spp.) for life cycle. General habitats include mine tailing riparian woodland, valley oak riparian woodland, mixed riparian woodland, and mixed riparian scrub where elderberry occurs. Although associated with moist habitats, elderberry is not an obligate wetland species and can tolerate drier conditions. However, suitable beetle habitat still requires that host plants are within matrix of other continuous to semi-continuous riparian vegetation. Habitat therefore could be hydrologically altered by climate change.	Unknown.	NA	High Sensitivity: very limited dispersal capability. Adults move less than 164 feet (50 meters) from emergence sites. Limited ability to shift range in response to climate change, particularly if suitable elderberry patches were reduced in size and amount and separated by longer distances.	High Sensitivity: timing of adult emergence closely to elderberry flowering between March and mid-May. Adults live only for a few days to a few weeks, mating and feeding on elderberry leaves, flowers, and nectar. Tight coupling between adult emergence and flowering of elderberry indicates that any asynchrony of this relationship due to climate change could adversely affect reproduction by species.	High Sensitivity: extreme weather conditions may disrupt synchrony of emergence and flowering of host plant.	High
California tiger salamander	High Sensitivity: Foraging – Vernal pool, seasonal wetlands and streams/creeks. Breeding – vernal pool and seasonal wetlands, that require inundation of 60–94 days after eggs hatch to complete metamorphosis; larvae develop faster in smaller, more rapidly drying pools. However, strong positive correlation between inundation period and total number of metamorphosing juveniles. Larvae die if pool dries before completion of metamorphosis. Generally reproductive output for species is low. Breeding habitat therefore could be hydrologically altered by climate change. Aestivation – blue oak woodland and savanna, and valley grassland that is less likely to be affected by climate change.	Medium Sensitivity: no specific information for species, but eggs subject to desiccation.	Low Sensitivity: short-distance breeding migrations occur between breeding sites and adjacent upland areas. These short-distance migrations are unlikely to be affected by climate change.	Medium Sensitivity: post-metamorphic dispersers may move to different ponds and may be sensitive to habitat fragmentation and isolation exacerbated by climate change.	Low Sensitivity: larvae omnivorous, feeding feed on zooplankton, small crustaceans, and aquatic insects. Post-metamorphs and adults prey on earthworms, snails, insects, fish, and even small mammals.	High Sensitivity: adults may forego breeding in drought years. During drier years males and female spend less time at breeding sites. Also, reproductive output and juvenile recruitment is naturally low, so likely sensitive to environmental stochasticity and potential extirpations at isolated sites.	Medium-High
Western spadefoot	High Sensitivity: Breeding – Vernal pool, swale, seasonal wetlands, open water, and streams/creeks that require at least 21 days of inundation for metamorphosis; reduced	High Sensitivity: reproduction strongly tied to water temperature. Water temperatures must be 48-86 degrees F before oviposition occurs. Eggs hatch 0.6-6 days	Low Sensitivity: short-distance breeding migrations occur	Medium Sensitivity: post-metamorphic dispersers may move to different breeding sites and may be sensitive to habitat fragmentation and isolation exacerbated by climate change. However,	Medium Sensitivity: rate of larval maturity related to food sources. Feed on a variety of insects, worms, and other	High Sensitivity: precipitation levels positively correlated with annual reproductive success. Forego reproduction in drought	Medium-High

Table 11-1
Evaluation and Ranking of Covered Species Sensitivity to Climate Change

Covered Species	Habitat Specialization/Habitat Changes	Physiological Tolerance	Migratory Status	Dispersal Ability	Changes in Food Availability	Changes in Extreme Weather	Overall Sensitivity Ranking
	water volume and hotter temperatures may reduce reproductive output. Longer persisting pools allow longer larval development, and larger juveniles with greater fat reserves at metamorphosis. Foraging – Blue oak savanna, blue oak woodland, valley grassland, vernal pool, swale, seasonal wetlands, open water, and streams/creeks. Aestivation – valley grasslands and blue oak woodland and savanna. Foraging and aestivation habitat less likely to be affected by climate change.	depending on water temperature. At water temperatures greater than 70 degrees F egg failure may occur. Larval develop in 3 to 11 weeks depending on food resources and water temperature, but must be complete before pools dry. High mortality rates in prematurely drying pools (e.g., pools lasting less than 5 weeks).	between breeding sites and adjacent upland areas. These short-distance migrations are unlikely to be affected by climate change.	dispersal movements between breeding sites unknown. Species has broad geographic range in California, suggesting some capacity to disperse over relatively long distances.	invertebrates. Large juveniles have greater fat reserves, greater survival and greater reproductive fitness.	years and remain dormant in burrows.	
Western pond turtle	Medium Sensitivity: Breeding and foraging – Streams/creeks, open water, and freshwater marshes that contain slow-moving, deep water habitat and emergent woody debris, rocks, or other similar features used for basking. Perennial water sources at breeding and foraging sites are probably less prone to fluctuations related to climate change than ephemeral wetlands. However, sites with fluctuating water levels are less suitable and turtles may abandon sites that dry out. Nesting and aestivation – Blue oak woodland and savanna, valley grassland, mine tailing riparian woodland, valley oak riparian woodland, mixed riparian woodland, and mixed riparian scrub. Nesting and aestivation habitat less likely to be affected by climate change.	High Sensitivity: reproduction related to climate conditions. Have temperature-related sex determination, with males produced at lower incubation temperatures and females at high temperatures; temperature threshold is about 86 degrees F. Although eggs are laid in dry soils, may have greater risk of desiccation with hotter and drier conditions. Hatchlings may not leave the eggs when temperature exceeds 81 degrees F to avoid dehydration. Occupied aquatic habitats have water temperature range of about 34-102 degrees F, but appear to be more active in waters at least 60 degrees F. Bask to regulate body temperature between 75-90 degrees F.	Low Sensitivity: short-distance migrations occur between aquatic sites and adjacent upland nesting/aestivation areas; usually upland nesting/aestivation sites are within several hundred feet of aquatic sites, but females may move along streams more than 1 mile to find suitable nesting sites. These short-distance migrations are unlikely to be affected by climate change.	Medium Sensitivity: capable of long distance within-stream and overland movements (at least 8 miles). Climate change, however, may increase isolation and fragmentation of suitable aquatic sites.	Low Sensitivity: opportunistic predators and scavengers, feeding on crustaceans, arthropods, and sometimes carrion. Also feed on submergent vegetation mats, as well as willow, alder, and other plant types. Young feed on mosquito larvae and other aquatic invertebrates, and nekton (aggregates of actively swimming organisms.). Food sources are unlikely to be limited by climate change.	Medium Sensitivity: inhabit perennial aquatic sites, but may abandon sites that have fluctuating water levels or that dry out, suggesting sensitivity to prolonged drought or high seasonal variability in water levels.	Medium
Giant gartersnake	Medium Sensitivity: Breeding – Seasonal wetlands, freshwater marsh, open water, and streams/creeks. Foraging – Breeding habitats and croplands (restricted to rice fields). Hotter and drier climate may adversely affect breeding and foraging habitat because adequate water during the active season (early spring through mid-fall) is important. Nesting and aestivation – Mixed riparian scrub and valley grassland less likely to be affected by climate change.	Medium Sensitivity: early winter foraging and other activities are temperature dependent, but unclear that climate change would substantially affect these activities. May be active on surface in winter when temperature is and least 59 degrees F but timing of spring emergence is variable. Use burrows to escape summer heat and become less active. Bask to bring body temperature up to activity levels. May shift daily activity patterns in response to temperature (e.g., more nocturnal in hotter months).	Low Sensitivity: short-distance migrations between wetlands and adjacent upland areas up to several hundred feet from wetlands. These short-distance migrations are unlikely to be affected by	Medium Sensitivity: capable of long distance movements over short time periods (up to 5 miles in 2 days), suggesting ability to respond to climate-related changes in habitat availability. However, due to its restricted and fragmented geographic range and distribution, it's unlikely it could make substantial latitudinal or elevational shifts in its range in response to climate change.	Medium Sensitivity: prey on aquatic species including small fish and amphibians. Reduction in perennial water sources related to climate change could affect prey availability.	High Sensitivity: inhabit perennial aquatic sites, but capable of relocating to more suitable sites if a site is temporarily degraded by extreme weather events, including drought or floods. Main requirement is that suitable alternative habitat is available. However, water management during drought periods (e.g., less water for rice fields) may reduce suitable	Medium

Table 11-1
Evaluation and Ranking of Covered Species Sensitivity to Climate Change

Covered Species	Habitat Specialization/Habitat Changes	Physiological Tolerance	Migratory Status	Dispersal Ability	Changes in Food Availability	Changes in Extreme Weather	Overall Sensitivity Ranking
			climate change.			alternative wetlands. Also excessive flood events could be adverse due to loss of upland refuge habitat combined with inherently small, fragmented populations, thus increasing chances of extirpations.	
Cooper's hawk	Medium Sensitivity: Nesting – Blue oak woodland, mine tailing riparian woodlands, valley oak riparian woodlands, mixed riparian woodland, and mixed riparian scrub; dense canopy structure for nesting; nest sites usually in trees groves (often highest tree), but also in solitary trees. Foraging – Blue oak woodland, blue oak savanna, mine tailing riparian woodlands, valley oak riparian woodlands, mixed riparian woodland, mixed riparian scrub, and valley grasslands. Climate change, including increased fire frequency and intensity, could reduce or degrade suitable nesting and foraging habitat.	Low Sensitivity: eggs and nestlings could be adversely affected by increased temperatures, but thermoregulation likely more under behavioral control of adults than ambient conditions. Species also nests in a wide variety of climatic conditions in North America from southern Canada to northern Mexico so local temperature changes likely would have small effect.	Low Sensitivity: most Cooper's hawks in California are non-migratory breeding residents, but seasonal movements by montane individuals to lower elevations may occur. No substantial adverse effects on seasonal movements by climate change are expected.	Medium Sensitivity: strong adult fidelity to nesting areas, so loss or degradation of nesting site could reduce reproductive success. Juveniles are capable of long distance dispersal from natal nest sites (at least several miles). Dispersal limited by available nest sites/territories, which could be affected by climate change.	Low Sensitivity: prey on a variety of avian and mammal prey that are available year round in a broad range of climatic conditions, including ubiquitous mourning doves, pigeons, crows, starlings, house sparrows, ground squirrels, and deer mice. Climate change is unlikely to substantially affect food availability.	Low Sensitivity: as relatively long-lived species (9 years for breeding birds) unlikely to be substantially affected by extreme weather events (e.g., disruption of a breeding season) as long as nesting habitat integrity is maintained.	Low-Medium
Tricolored blackbird	Medium Sensitivity: Nesting – Cropland, valley grassland, seasonal wetlands, and freshwater marsh, typically supporting tules and cattails, but also more recently in Himalayan blackberries, thistle, silage and grain fields. Nesting habitat typically supporting tules and cattails may be altered as a result of climate change. Available breeding habitat may be reduced and result in fewer and smaller nesting colonies, exacerbating the current declining population trend. Foraging – Cropland, irrigated pasture-grassland, valley grassland, vernal pool, swale, seasonal wetlands, freshwater marsh, and open water; most foraging is within 3 miles of their colony sites, but may commute up to 8 miles. Climate change could affect suitability of foraging sites, forcing birds to commute farther distances to productive foraging sites.	Low Sensitivity: eggs and nestlings could be adversely affected by increased temperatures, but thermoregulation likely more under behavioral control of adults than ambient conditions. Species also nests in a wide variety of climatic conditions in California, including the Mojave Desert.	Low Sensitivity: not migratory, but nomadic, with an unpredictable, but apparently flexible pattern. No substantial adverse effects on nomadic movements by climate change are expected.	Medium Sensitivity: due to its restricted range, it is unlikely that it could significantly shift its range in response to climate change, and it is possible that its range could contract with the loss of suitable nesting habitat.	Medium Sensitivity: rely on concentrations of insects and seeds within commuting distance (typically less than 3 miles) from nesting colonies. Could be adversely affected if climate change resulting in reduced food availability in areas near nesting colonies.	Medium Sensitivity: breeding sites may be affected by extreme weather conditions, including drought and flooding.	Low-Medium

Table 11-1
Evaluation and Ranking of Covered Species Sensitivity to Climate Change

Covered Species	Habitat Specialization/Habitat Changes	Physiological Tolerance	Migratory Status	Dispersal Ability	Changes in Food Availability	Changes in Extreme Weather	Overall Sensitivity Ranking
Western burrowing owl	Low Sensitivity: Wintering – Blue oak savanna, cropland, irrigated pasture-grassland, valley grassland, vernal pool, seasonal wetlands, swale, streams/creeks. Nesting – Cropland, irrigated pasture-grassland, stream/creeks; nest substrates include excavated burrows (primarily ground squirrel) or similar cavities, such as pipes, culverts, rubble piles, and other debris. These habitats unlikely to be substantially affected by climate change and may actually be increased by hotter and drier conditions and associated increases in fire frequency and intensity.	Low Sensitivity: broods are raised in underground burrows where microclimate conditions are affected by site-specific physical factors such as soil type, entrance aspect, slope, burrow depth, and convection. Nests in a broad range of climate regions (including Imperial Valley in California), suggesting that surface temperatures and other climate factors are not particularly critical limits on nesting activities.	Low Sensitivity: California supports both year-round resident burrowing owls (especially in central and Southern California) and over-wintering migrants. Climate change in California should not affect migratory and other seasonal movement patterns because there would be relatively little impact on suitable habitat and prey.	Low Sensitivity: climate change itself unlikely to affect habitat availability so dispersal ability not directly related to climate change; e.g., the need to shift range in response to climate change.	Low Sensitivity: prey includes insects, small mammals, reptiles, birds, and carrion. Any climate-related changes to a prey type (e.g., altered timing of insect blooms) could be compensated for by switching to alternate prey.	Low Sensitivity: as relatively long-lived species (at least 8 years) unlikely to be substantially affected by extreme weather events (e.g., disruption of a breeding season) as long as long-term habitat values are maintained.	Low
Ferruginous hawk	Low Sensitivity: Foraging (winter) – valley grassland, vernal pool, swale, seasonal wetland, and irrigated-pasture where rodents such as ground squirrels, gophers, and rabbits are abundant. Habitat quality, as defined by openness and prey availability likely has little sensitivity to climate change.	Low Sensitivity: as related to wintering activities, there are no evident consequences of climate change. It can be assumed that individuals would use behavioral responses to respond to climate effects.	Medium Sensitivity: Spring migration and initiation and support of breeding activity may be affected by climate change if predator-prey relations at nesting sites are altered (e.g., timing and or abundance of prey).	NA	Low Sensitivity: opportunistic selection of available prey, including ground squirrels, gophers, and rabbits that are unlikely to be substantially affected by climate change, although short-term temporal losses of prey may occur in some areas due to intense fires.	Low Sensitivity: no apparent substantial effects of extreme weather on prey or wintering habitat. Prey are available year round in the Plan Area regardless of weather conditions, although abundance may vary from year to year in relation to local weather conditions.	Low
Swainson's hawk	Medium Sensitivity: Nesting – Blue oak savanna, blue oak woodland, mine tailing riparian woodland, valley oak riparian woodland, mixed riparian woodland, and mixed riparian scrub. May nest in isolated trees and nest site selection may relate more to territory quality than tree characteristic. Foraging (year-round) – Blue oak savanna, cropland, irrigated pasture-grassland, valley grassland, vernal pool, swale, and seasonal wetlands. High quality	Low Sensitivity: eggs and nestlings could be adversely affected by increased temperatures, but thermoregulation likely more under behavioral control of adults than ambient conditions. Species nest in hot climates in California, including the western Mojave Desert.	Medium Sensitivity: arrival and departure times for migration could be disrupted by climate change, especially if timing of predator-prey relations are altered, including insect prey. Birds	Low Sensitivity: species is highly mobile and no impacts of climate change related to dispersal ability are anticipated.	Medium Sensitivity: depend on abundant food sources near nest sites. Forages for both insects and vertebrates (e.g., during breeding season) and may be sensitive to disruptions of predator-prey timing related to climate change.	Low Sensitivity: as a long-lived species (more than 20 years) unlikely to be substantially affected by extreme weather events (e.g., disruption of a breeding season) as long as long-term habitat values are maintained.	Low-Medium

Table 11-1
Evaluation and Ranking of Covered Species Sensitivity to Climate Change

Covered Species	Habitat Specialization/Habitat Changes	Physiological Tolerance	Migratory Status	Dispersal Ability	Changes in Food Availability	Changes in Extreme Weather	Overall Sensitivity Ranking
	foraging habitats support vertebrate prey (e.g., California voles, ground squirrels, gophers) during breeding season. Voles tend to occur in areas of high grass cover and wet meadows. Drier and hotter conditions and/or water management during drought reducing irrigation in agriculture could adversely affect foraging habitat quality and therefore reduce territory quality.		may fast during migration, reaching destinations undernourished and therefore adequate prey at destination important.				
Northern harrier	Medium Sensitivity: Nesting – Cropland, irrigated pasture-grassland, and valley grassland; Nesting habitat at ground level at the margin of wetlands, but also grassland and agriculture in dense, tall vegetation. Foraging - Cropland, irrigated pasture-grassland, valley grassland, vernal pool, swale, seasonal wetlands, and freshwater marsh. High quality foraging habitat for males supports high California vole densities which occur in areas with high grass cover and wet meadows. Drier and hotter conditions and/or water management during drought could reduce nesting and foraging habitat availability and quality.	Low Sensitivity: eggs and nestlings could be adversely affected by increased temperatures, but thermoregulation likely more under behavioral control of adults than ambient conditions	Low Sensitivity: most breeders in California are non-migratory, but rather nomadic in response to prey availability. Nomadic behavior unlikely to be substantially affected by climate change.	Low Sensitivity: species is highly mobile with low fidelity to nest sites. No anticipated impact of climate change related to dispersal ability are anticipated because individuals should be able to respond to changing habitat conditions.	Medium Sensitivity: California voles are a primary prey that occur in dense grasses and wet meadows. Vole habitat quality could be affected directly by climate change and/or water management during drought. Also, voles exhibit population cycles that may be affected by climate change. However, harriers can switch prey in relation to availability. Foraging also tied to small passerine nesting periods, which could be altered by climate change.	Low Sensitivity: as a long-lived species (more than 16 years) unlikely to be substantially affected by extreme weather events (e.g., disruption of a breeding season) as long as long-term habitat values are maintained.	Low-Medium
White-tailed kite	Medium Sensitivity: Nesting – Blue oak woodland, mine tailing riparian woodland, valley oak riparian woodland, mixed riparian woodland, and mixed riparian scrub that may be sensitive to extended drought conditions and lack of regeneration/recruitment, as well as more frequent and intense wildfires. Foraging – Blue oak savanna, mixed riparian scrub, cropland, irrigated pasture-grassland, valley grassland, vernal pool, swale, and seasonal wetlands; foraging habitat includes grasslands, lightly grazed pasture, wet meadows, and agricultural areas. Most foraging during breeding season is within about 0.5 mile of nest site. Drier and hotter conditions and/or water management during drought could reduce foraging habitat availability and quality.	Low Sensitivity: eggs and nestlings could be adversely affected by increased temperatures, but thermoregulation likely more under behavioral control of adults than ambient conditions. Nest failures related to weather conditions have been observed, but capable of two broods when prey are abundant.	Low Sensitivity: most breeders in California are non-migratory, but exhibit rather nomadic behavior in response to prey availability. Nomadic behavior not expected to be substantially affected by climate change.	Low Sensitivity: species is highly mobile with apparent low fidelity to nest sites. No anticipated impact of climate change related to dispersal ability because individuals should be able to respond to changing habitat conditions.	High Sensitivity: reproduction highly related to prey availability. As a small mammal specialist, sensitive to fluctuations in prey density (e.g., voles). Several years of poor prey availability (potentially exceeding its life span of less than 6 years) could substantially affect this species' productivity and recruitment. Also most foraging during breeding season is within 0.5 mile of nest, so sensitive to distribution of prey in relation to suitable nesting habitat that could be affected by climate change.	High Sensitivity: a relatively short-lived raptor (less than 6 years) and mortality has been attributed to inclement weather. Also sensitive to prey fluctuations that could be affected by weather extremes.	Medium-High
Greater sandhill crane	High Sensitivity: Roosting (winter only) – Vernal pool, seasonal wetlands, and freshwater marsh; use rocky uplands and dirt and gravel roads to obtain "grit," which	Unknown. Does not nest in Plan Area so local climate change should not directly affect reproductive success.	Medium Sensitivity: individuals likely would be sensitive	Medium Sensitivity: species is highly mobile but extremely philopatric to its roosting and foraging habitat. Climate change would not affect their dispersal ability, but they may not be able to	Low Sensitivity: omnivorous, feeding on cultivated grains, berries, small mammals, insects, snails, reptiles,	Low Sensitivity: as a long-lived species (more than 20 years) with high annual survival rates, unlikely to be substantially	High

Table 11-1
Evaluation and Ranking of Covered Species Sensitivity to Climate Change

Covered Species	Habitat Specialization/Habitat Changes	Physiological Tolerance	Migratory Status	Dispersal Ability	Changes in Food Availability	Changes in Extreme Weather	Overall Sensitivity Ranking
	is important when diet is seeds. Foraging (winter only) - Cropland, irrigated pasture-grassland, valley grassland, freshwater marsh, and seasonal wetlands. Drier and hotter conditions and/or water management September-March could reduce both roosting and foraging habitat availability and quality. Reduced availability of suitable roosting areas could also increase distances between roosting and foraging sites, resulting in greater energy expenditure and greater chance of collisions with structures. Limited roost areas also may increase bird densities and increase susceptibility to epizootic events such as cholera, avian botulism, aspergillosis, salmonella, and avian tuberculosis.		to roosting and foraging habitat conditions upon arrival on winter grounds in the fall, which may be adversely affected by hotter and drier climate and water management.	locate suitable alternative habitat to which they can disperse.	amphibians, nestling birds, and seeds. Foraging for invertebrates in grassland and pastures occurs at onset of winter rains by probing soils in and overturning cattle dung. Altered precipitation may affect access to this food source. Has become accustomed to abundant waste grains from agriculture, which could become more limited with loss of agricultural lands from sea-level rise.	affected by extreme weather events (e.g., disruption of a breeding season) as long as long as long-term habitat values are maintained. However, collisions with transmission lines are increased during windy and foggy conditions.	
Loggerhead shrike	Low Sensitivity: Nesting – Mine tailing riparian woodlands, mixed riparian scrub, and valley grassland. habitat generally include grasslands, pastures with fence rows, agricultural fields, woodland savannas, scrub, and riparian. Foraging – Cropland, irrigated pasture-grassland, valley grassland, vernal pool, seasonal wetlands, and swale; important habitat features include short, sparse vegetation, scattered or isolated low trees or large shrubs for nest sites, available hunting perches with an open view. Except for riparian, these habitats likely are not highly sensitive to climate change.	Low Sensitivity: eggs and nestlings could be adversely affected by increased temperatures, but thermoregulation likely more under behavioral control of adults than ambient conditions.	Low Sensitivity: while some northern populations of shrikes are migratory, it is assumed that shrikes in the Plan Area are breeding residents and non-migratory.	Low Sensitivity: species is mobile and widely distributed in arid portions of the western North America. Juveniles capable of long dispersal movements (typically several miles and documented as far 43 miles). Should be capable of any necessary dispersal and range shift in response to climate change.	Low Sensitivity: forage primarily on large ground-dwelling insects that require little to no water. Also opportunistic predator on birds, amphibians, reptiles, and small mammals. Also eat road kill and carrion. Climate change unlikely to substantially availability of food sources.	Low Sensitivity: There is no information for shrike suggesting that it might be sensitive to changes in extreme weather.	Low
Western red bat	Medium Sensitivity: Roosting – Blue oak woodland, blue oak savanna, mine tailing riparian woodlands, valley oak riparian woodlands, mixed riparian woodland, and orchards; roosting habitat is primarily low and middle elevation broadleaf tree communities, including cottonwood, sycamore and orchards (often walnut); generally roosts solitarily in the foliage of trees or shrubs, but reproductive females may roost together in small groups; roosts commonly in edge habitats adjacent to streams or open fields, in orchards, and sometimes in urban areas with mature trees; generally forages in same areas as roosts. Roosting habitat could be degraded	High Sensitivity: has high energy requirements and enters torpor during the day to conserve energy during colder, inactive periods. Increased temperatures, along with habitat effects, could disrupt thermoregulation and energy budgets. Become active at temperatures of about 68 degrees F, but have been observed flying at temperatures as low as 45 degrees F. Reduced free water available for lactating females could affect reproductive success.	High Sensitivity: makes seasonal north-south migrations which could be disrupted by phenological changes from climate change, including disruptions in predator-prey relationships.	Low Sensitivity: species is highly mobile and roosts in suitable tree habitats; therefore should have the ability to disperse and respond to climate change through range shifts if necessary.	Medium Sensitivity: has high energetic demands. Sensitive to a potential disruption in predator-prey relations by climate change, especially during reproductive season. However, takes a variety of prey, including moths, cicadas, leaf hoppers, beetles, wasps, flies, crickets, and grasshoppers so a particular type of available prey probably not critical.	Medium Sensitivity: as a tree rooster, this species is more exposed to ambient weather conditions than crevice/cave roosting bats. However, red bat has adaptations to cold weather, including thicker fur and rounder ears to prevent heat loss. Longevity in the wild is unknown and may be sensitive to extreme weather events that reduce reproductive success and recruitment.	Medium-High

Table 11-1
Evaluation and Ranking of Covered Species Sensitivity to Climate Change

Covered Species	Habitat Specialization/Habitat Changes	Physiological Tolerance	Migratory Status	Dispersal Ability	Changes in Food Availability	Changes in Extreme Weather	Overall Sensitivity Ranking
	by hotter and drier conditions, as well as increased frequency and intensity of wildfires that affect habitat structure. Foraging – Blue oak woodland, blue oak savanna, mine tailing riparian woodlands, valley oak riparian woodlands, mixed riparian woodland, mixed riparian scrub, orchards, valley grassland, vernal pool, swale, seasonal wetlands, freshwater marsh, open water, and streams/creeks. Climate change may affect predator-prey relations by altering the abundance or distribution of insect prey.						
American badger	Low Sensitivity: Open habitats, including blue oak savanna, valley grassland, vernal pool, swale, and seasonal wetlands; habitat with friable soils and available of prey such as ground squirrel. Generally found in arid, open habitats that likely are not highly sensitive to climate change. These kinds of habitats may increase in California with a hotter drier climate.	Low Sensitivity: badgers are adapted to a broad range of climate conditions in North America and likely responds to local climate conditions behaviorally and physiologically. Can reduce activity and metabolism in response to severe cold and reduced food availability characteristic of northern latitudes within its range. Could be some effect of climate change on patterns of torpor and reproductive activity, but unlikely to be substantial.	NA	Low Sensitivity: capable of making long dispersal movements (females more than 30 miles and males more than 60 miles) and its range includes a broad range of habitat conditions. Should be able to shift range both latitudinally and in elevation in response to climate change if necessary.	Low Sensitivity: opportunistic predator and adapted to conditions with seasonally low prey availability.	Low Sensitivity: its range includes regions subject to extreme weather events. Can respond both behaviorally (denning and reduced activity) and physiologically (reduced metabolism). Also long-lived (up to 15 years) and able to withstand years with poor conditions for reproduction.	Low

INTENTIONALLY LEFT BLANK

The climate change sensitivities identified in Table 11-1 were used to refine the SSHCP Covered Species list (Chapter 3), Biological Goals and Measurable Objectives (Chapter 7), Preserve System design (Chapter 7), Preserve System Monitoring and Management Program framework (Chapter 8), and Changed Circumstances (Section 11.4).

Implementing the Conservation Strategy will protect and enhance a range of Plan Area natural communities, species habitat types, and water sources; and conserving environmental gradients (e.g., altitude, aspect, slope) that will be important to species as climate change affects timing and availability of resources and habitat types in the Plan Area. This will allow many Covered Species to emigrate and disperse to the portions of the Plan Area that continue to provide suitable habitat. The SSHCP Preserve System will provide habitat connectivity for northward and upslope movement of Covered Species, by conserving and restoring habitat linkages (Section 7.5), and reducing habitat fragmentation. The Conservation Strategy also requires redundant habitat linkages to ensure effective connectivity (Section 7.5). As a result of this habitat preservation and connectivity, the distribution of Covered Species and natural land cover types in the Plan Area will be able to shift response to climate change and maintain or expand their distributions as required under Biological Goal 5. As described in Chapter 7, habitat re-establishment and establishment are included in the SSHCP Conservation Strategy to increase the resilience of Covered Species by improving quality and quantity of modeled habitat.

At the species level, the Plan Permittees developed biological goals, measurable objectives, Conservation Actions, and monitoring to ensure the life history needs of Covered Species are provided for in the SSHCP Preserve System. These species-specific measurable objectives and Conservation Actions will ensure shifts of species range, distribution, and abundance driven by climate change do not affect the species' persistence in the Plan Area, by protecting and enhancing individuals, populations, and groups of populations. The SSHCP Covered Species list includes all species with a possibility of being listed during the Permit Term, using the best information available at the time of Plan preparation. This information included the climate change sensitivities in Table 11-1, which emphasizes coverage of unlisted species with restricted distributions, small population sizes, habitat specialization, and those that depend on habitat most likely to be affected by climate change.

The climate change sensitivities of Covered Species identified in Table 11-1 were considered when developing the Conservation Strategy, including the Biological Goals and Measurable Objectives. Examples of ways in which the Conservation Strategy ensures that the species-level goal can be achieved, even with projected climate change, include the following:

- Measurable Objective GS-6 preserves upland forage areas for greater sandhill crane that can be used during flood events.

- Measurable Objective GGS1 and GGS2 for giant gartersnake targets Preserve lands in the Badger Creek watershed, which based on its elevation and position within the watershed, the Permittees assume is not vulnerable to sea level rise-related flooding. Therefore, the Permittees assume that suitable upland habitat will remain available to support overwintering giant gartersnakes in these Preserves, even during flood events.
- The SSHCP provides several dry crossings (AMM ROAD-2) where roadways cross a SSHCP Preserve or directly abut a SSHCP Preserve. These dry crossings will be sized to accommodate a minimum of medium-sized mammals (e.g., coyote) and will provide overland connectivity between Preserve lands during flooding events.
- Vernal pool species also have a limited potential to shift upslope in response to climate change because the vernal pool habitat is restricted to particular soil types that are only present in valley floors and limited portions of foothills. Therefore, the Preserve System will protect more than 23,000 acres of the Vernal Pool Ecosystem across a range of soil types, hydrologies, and locations within the Plan Area. This will provide the best feasible scenario for persistence of the vernal pool species with the effects of climate change.

The relative potential sensitivities of the Covered Species to climate change presented in Table 11-1 will help the Permittees to develop the SSHCP Preserve Monitoring and Management Program. Examples of how the SSHCP Preserve System Management and Monitoring Program framework accounts for future climate change include the following:

- The vernal pool Covered Species are considered to have a medium to medium-high sensitivity to climate change and therefore climate change effects will be closely tracked for the vernal pool Covered Species (see Section 8.3.4.4).
- During drought periods, the Implementing Entity will use adaptive management of Preserves to reduce biomass of annual grasses in the Vernal Pool Ecosystem, to help extend vernal pool ponding by reducing water uptake (Chapter 8). The Implementing Entity will also increase monitoring and management of invasive plant species that may have competitive advantages in drought.
- The effects of wildfire on Covered Species and the Preserve System will be minimized through adaptive management. Changed circumstances for wildfire (Section 11.4.6) will be addressed through the SSHCP Preserve System Monitoring and Management Program.
- The Implementing Entity will provide supplemental water at re-establishment/ establishment sites if needed.
- Preserve monitoring will track the status of Covered Species and allow for early identification of Preserve System occupancy trends, which will serve as an early warning

for the possible effects of climate change and will allow for adaptive management within the Preserve System to ensure species persistence in the Plan Area.

Collectively, these and other monitoring and management efforts will allow the Implementing Entity to detect and respond to the effects of climate change on Covered Species to ensure effective implementation of the SSHCP Conservation Strategy.

11.4 SSHCP Changed and Unforeseen Circumstances

The Plan Permittees have identified nine changed circumstances likely in this Plan Area during the Permit Term that can reasonably be anticipated by the Permittees and the USFWS, and that can be planned for. Specific remedial measures or procedures within the SSHCP to address nine changed circumstances are described. In addition, the Plan Permittees identify at what level or extent each of the nine circumstances would be addressed as unforeseen circumstances under the No Surprises Rule.

11.4.1 Listing of Covered Species

Changed Circumstances: The 28 SSHCP Covered Species (Table 1-2) include 21 plants and animal species that are not currently listed as threatened or endangered under the federal ESA:

- Mid-valley fairy shrimp
- Ricksecker's water scavenger beetle
- Western spadefoot
- Western pond turtle
- Cooper's hawk
- Tricolored blackbird
- Western burrowing owl
- Ferruginous hawk
- Swainson's hawk
- Northern harrier
- White-tailed kite
- Greater sandhill crane
- Loggerhead shrike
- Western red bat
- American badger
- Dwarf downingia
- Boggs Lake hedge-hyssop
- Ahart's dwarf rush
- Legenere
- Pincushion navarretia
- Sanford's arrowhead

However, non-listed SSHCP Covered Species are addressed in the SSHCP impact analysis and the SSHCP Conservation Strategy as if they are listed species. All SSHCP Covered Species, including the plant species and federally unlisted species, will receive No Surprises assurances under USFWS' No Surprises Rule (USFWS and NOAA 1998).

Therefore, if any of the non-listed Covered Species become listed during the 50-year SSHCP Permit Term, the federal ITP will immediately become effective for that species, once the USFWS' Conference Opinion for that species is converted to a Biological Opinion. The Permittees will not be required to change SSHCP Conservation Strategy, the Implementing Agreement, or the terms and conditions of the permit.

Unforeseen Circumstances: There are no unforeseen circumstances associated with the listing of Covered Species.

11.4.2 Listing of New Species

As described in Chapter 1, the SSHCP Covered Species list includes all species with a possibility of being listed during the Permit Term, using the best information available at the time of Plan preparation. However, the possibility remains that a new species could be listed in the Plan Area during the Permit Term and this possibility can be planned for.

Changed Circumstances: If a species not covered by the SSHCP becomes listed, or is proposed for listing as endangered or threatened under the federal ESA or California Endangered Species Act (CESA) during the Permit Term, and Plan implementation could adversely affect the newly listed species, a changed circumstance will have occurred. The USFWS and California Department of Fish and Wildlife (CDFW) will notify the Implementing Entity of any findings that a species is warranted for listing under the ESA or is a candidate for listing under the CESA. This notification will ensure that the Permittees can begin planning changes to the Plan or Plan implementation to conserve the species, and to ensure that the operating Conservation Strategy does not foreclose opportunities for species conservation. As a first step after notification, the Implementing Entity will map and quantify species suitable habitat present in the Plan Area to determine conservation needs of the newly listed species.

If the new species does become listed and the SSHCP has not been amended to address the newly listed species, the Plan Permittees will implement the following remedial measures:

- Plan Permittees will work with the Wildlife Agencies to develop measures to avoid take during implementation of Covered Activities. Permittees and Third-Party Project Proponents will implement the avoidance measures.
- Any parts of a Covered Activity that cannot fully avoid effects to the newly listed species or its habitat shall not proceed until the species is added to the SSHCP ITPs.
- The Implementing Entity will use SSHCP impact methodology to quantify Covered Activity impacts to the species modeled habitat.

- The Plan Permittees will work with the Wildlife Agencies to address the newly listed species in an SSHCP amendment. The Plan Permittees will submit application packages to amend the existing ITPs to add the newly listed species as a Covered Species (see Chapter 9 for Plan amendment process).
- Alternatively, the Plan Permittees or Third-Party Project Proponents could apply for individual take coverage under the ESA and CESA for the project and activities.

Unforeseen Circumstances: There are no unforeseen circumstances associated with the listing of new species.

11.4.3 Climate Change

Changed Circumstance: As discussed in Section 11.3.1**,** several physical climate change effects are currently occurring in California, including shifts in precipitation patterns (changes in the timing, location, amount, and variability of precipitation), reduction of average annual snowpack and changes in the timing of snowmelt and runoff patterns, and increased average temperature and seasonal shifts that lengthen the growing season. Potential physical and biological effects of those changes include increased number and intensity of winter floods; increased number and length of droughts; more frequent and intense wildfires; changes to natural community composition; more invasive species; and increases in wildlife disease.

Although climate change is reasonably foreseeable over the SSHCP 50-year Permit Term, it is not within the scope of the Plan to respond directly to air temperature increases or changes in regional precipitation patterns. Additionally, it will not be possible to determine when a Plan Area change over the 50-year Permit Term is the result of climate change or other non-climate factors. Because of the high level of uncertainty of how natural communities and species will respond to changes in temperature, precipitation patterns, or other climate factors, SSHCP remedial actions to address future climate change would be implemented primarily through the SSHCP Preserve Monitoring and Management Program, as described and provided for in SSHCP Chapter 8.

The SSHCP response to climate change, and therefore the delineation of Changed Circumstances for climate change, is most appropriately gauged by the character and magnitude of the physical and biological changes that may occur within the Plan Area and can reasonably be anticipated and planned for, including floods, wildfires, drought, invasive species, and disease.

Unforeseen Circumstances: The following sections for flood, wildfire, drought, invasive plant species, invasive animal species, and disease address unforeseen circumstances related to climate change.

11.4.3.1 Floods

Changed Circumstances: A flood event occurs when a waterway's capacity to hold water is exceeded by high-water flows and results in water overtopping the stream bank and entering the floodplain. The term *flood* can also apply to localized flooding events caused by levee breaks, pipeline breaks, dam breaks, drainage blockages, and equipment failure.

Flooding is common in some portions of the Plan Area. The primary reason for this history of flooding is the Plan Area's natural topographic position in the Central Valley, including flatness in the valley and high tributary mountain watersheds (Lund 2012). Within the Sacramento Valley, major flooding has occurred from rainstorms or snowmelt that quickly inundate slow-draining populated and agricultural areas (Lund 2012). Low-lying parts of the Plan Area, including the portion in the Sacramento-San Joaquin Delta are flood-prone because they are below sea level and protected only by relatively weak levees (Lund 2012).

Some SSHCP land cover types support plant and animal species with adaptations to periodic flood disturbances, and those land covers and species (e.g., vernal pool invertebrates) may actually benefit from flooding. Generally, flooding can deposit soils rich in nutrients and biological materials, which can enhance habitat, temporarily expand an aquatic species' range, and even increase stream and riparian biological functions over time. Most flood events that occur in the Plan Area) (i.e., excluding major or catastrophic events) are expected to have minimal negative impacts, and in many cases positive effects, on Covered Species or their habitats. For example, flooding increases use by waterbirds such as greater sandhill cranes that forage and roost in shallow flooded habitat (Silveira 1998). Moderate seasonal flooding in broad, shallow flood basins provides expansive areas of giant gartersnake habitat (Hinds 1952). Flooding will not adversely affect the Vernal Pool Ecosystem (Vernal Pool, Swale, Stream/Creek (VPIH) and hydrologically connected valley grassland). Flooding that temporarily connects normally isolated vernal pools can facilitate dispersal by vernal pool invertebrates.

However, extreme or extended flooding could impact Preserves and destroy newly established habitat re-establishment and/or establishment sites by depositing debris or sedimentation, downing trees, and scouring vegetation from stream banks. Plant and animal communities, which may benefit by moderate flooding, may also shift or be eliminated in response to extended flooding, including fairy shrimp (Silveira 1998). According to the USFWS (1993), most or all giant gartersnake populations are vulnerable to adverse effects from extensive flooding, and a 100-year flood event has the potential of extirpating all remaining populations of giant gartersnake due to loss of winter refugia over the species' range. The severity of impacts caused by flooding will vary depending on several factors, including flood duration, intensity, the type of habitat that is affected, and the amount of upland habitat available in the vicinity.

Based on flood flow forecast models, Willis et al. (2011) identified some main effects of future temperature increase scenarios as a result of climate change on river hydrologic regimes and flood control operations in the Sacramento Basin. In particular, flows will change even with small temperature increases causing more rainfall runoff. Willis et al. (2011) found that with either increased or reduced precipitation intensities, temperature increases are expected to increase runoff volumes and flood risks in the Sacramento Basin. In contrast, the U.S. Bureau of Reclamation (2014) found that projected increases in early season runoff will contribute to flood control releases earlier in the year, providing more flood storage capacity. For example, they estimate that storage volumes at Folsom Lake will decrease by up to 12% by the year 2070. However, that study did not consider the effects of peak flows that could contribute to a higher risk of flooding due to climate change.

The SSHCP assumes that climate change will result in sea level rise and lands in the Plan Area located below sea level have a reasonable chance of being inundated. The SSHCP Conservation Strategy accounts for projected sea level rise in its acquisition of Preserve lands to meet the measurable objectives for greater sandhill crane by excluding lands from modeled habitat that are located below sea level. If sea level rise and flooding exceeds SSHCP projections such that preserved lands acquired for benefit of greater sandhill crane can no longer provide suitable roosting habitat for greater sandhill cranes, that sea-level rise or flooding would constitute an unforeseen circumstance. The SSHCP accounts for this changed circumstance by providing suitable refuge foraging habitat for greater sandhill cranes outside the Cosumnes floodplain for use when flooding precludes use of typical foraging habitat.

The Conservation Strategy for giant gartersnake targets Preserve lands in the Badger Creek watershed, which based on its elevation and position within the watershed, the Permittees assume is not vulnerable to sea level rise-related flooding. Therefore, the Permittees assume that suitable upland habitat will remain available to support overwintering giant gartersnakes in these Preserves, even during flood events. However, if a massive flood event occurs in the Badger Creek watershed that results in the drowning of a large proportion of the overwintering giant gartersnake population, that would be an unforeseen circumstance.

For other Covered Species, the SSHCP provides several dry crossings (AMM ROAD-2) where roadways cross a SSHCP Preserve or directly abut a SSHCP Preserve. These dry crossings will be sized to accommodate a minimum of medium-sized mammals (e.g., coyote) and will provide overland connectivity between Preserve lands during flooding events.

Should flooding occur that potentially damages or destroys SSHCP Preserves, re-establishment/establishment sites, or enhancement sites, the following actions shall be taken by the Implementing Entity to deal with the changed circumstance:

- Within 48 hours of determining that a flood event has caused damage, the Preserve Manager will begin inspections of the Preserve to determine if adverse effects occurred

to Covered Species or their habitats within the Preserve. The Preserve Manager will conduct site reconnaissance, sampling, or surveying, as deemed appropriate, and prepare a brief disturbance assessment report that will be provided to the Implementing Entity. Specific issues to be considered in the disturbance assessment report will include, but not be limited to:

  - Damage to Preserve irrigation, pumping, or security equipment;
  - Direct mortality of species;
  - Damage to re-established/established riparian sites, including loss of plantings, damage to irrigation equipment, and erosion of graded banks;
  - Long-term flooding of land cover types that result in conversion of the land cover type to open water or freshwater marsh;
  - Erosive forces and materials deposition including sand, gravel, or invasive species (especially floating-type seeds or plants); and
  - Non-organic debris (e.g., shopping carts, clothing, vehicles, building materials, etc.).

- The Preserve Manager will initiate protective measures where appropriate and repair structures necessary to secure and maintain the affected site, such as fences and irrigation facilities.
- If necessary, the Implementing Entity will convene the TAC to develop measures that address immediate recovery of the affected site(s). Actions that could be recommended by the TAC include additional remediation measures (e.g., erosion control) or reseeding the area to prevent the establishment of invasive species.
- Within 1 year after the changed circumstance occurs, the Preserve Manager will prepare a disturbance assessment report to determine if natural processes at the affected site(s) are acting to resolve the problem. If not, the Preserve Manager will develop appropriate response measures to remediate the disturbance.
- After reviewing the disturbance assessment report, the Implementing Entity will determine whether habitat re-establishment is necessary. A re-establishment plan and a reasonable timeframe shall be established in coordination with the TAC (Chapter 9).
- The Implementing Entity will set up proper monitoring protocols for the affected site(s) in accordance with the SSHCP Preserve System Monitoring and Management Program described in Chapter 8, if re-establishment is necessary.

Unforeseen Circumstances: Flooding will be considered a changed circumstance until such time as two 100-year flood events occur within a 5-year period. According to the Federal Emergency Management Agency (FEMA), a "100-year flood" is the flood elevation that has a 1% chance of being equaled or exceeded each year. Two 100-year floods within a 5-year period

are not expected based in the historical data of five 100-year floods over 46 years and would be considered an unforeseen event.

11.4.3.2 Wildfire

Wildfire was a common historical occurrence within the Plan Area. Native vegetation communities that evolved in a setting with periodic natural fires typically are well adapted to such fire events. Fire presence and absence at varying cycles or regimes affects vegetation community composition and succession, or the natural sequential replacement of vegetation types over time. For California's valley grasslands, which dominate the Plan Area, native species are tolerant of fire within its natural regime of frequency and season (Brooks et al. 2004) and occasional fires have little permanent effect (Bartolome et al. 2007). However, altered fire regimes, in combination with naturalized non-native grasses and livestock grazing, have complex effects on grassland structure and composition (D'Antonio et al 2000) and have contributed significantly to the conversion of native valley grasslands to non-native annual grasslands (Brooks et al. 2004). Since the introduction of non-native Mediterranean grasses and other exotic weeds by European settlers, wildfire has helped control the buildup of non-native grass thatch (Brooks et al. 2004; Bartolome et al. 2007).

Wildfires, especially grassland fires, occur frequently in the Plan Area. Fires in the Plan Area since 2000 generally were nearer urban areas or along other highly traveled roadways (which facilitated quick reporting and response), were constrained by barriers to fire spread (e.g., roads, irrigated agricultural land), or burned early in the year when fuel moisture levels typically are higher. However, fire suppression can allow thatch and woody materials to build up over time, thereby increasing fuel loads. Because the fuel loads in the Plan Area are limited mostly to grasses, the Permittees assume that these large fires will not burn at the temperatures that would cause irreversible effects to grassland or woodland ecosystems in the Plan Area. Fire frequency will also be limited by re-growth of grasses, as several years will have to pass before grassland fuel loads recover from a fire.

A total of 32 fires were recorded in the Plan Area between 1950 and 2011 with sizes ranging from 10.9 to 14,125.6 acres (FRAP 2012). Of these, 27 burned at least 100 acres, 16 burned at least 500 acres, and 6 burned at least 1,000 acres. Only two fires (the 1981 Meiss Fire and the 1996 Scott Fire) burned in excess of 5,000 acres, considered Class G Fires (NWCG 2014). As presented in Table 11-2, the trend over the past decade (2000–2009) is a higher number of smaller fires, although the capacity of Plan Area vegetation to fuel large (Class G 5,000 acre) fires does exist. Over a 60-year period from 1950 through 2009 the average number of fires in the Plan Area per year is 0.516 and the average fire size is 1,255 acres. Increased average temperatures related to climate change will increase fire frequency and fire size, and are forecast to have a greater influence on fire frequency and fire size than any increased population or urbanization in the Plan Area (Baltar et al. 2014; Hurteau et al. 2014).

Table 11-2
Plan Area Wildfire Burn Acreage and Fire Quantity, by Decade

Decade	Total Acreage Burned	Number of Fires by Decade
1950–1959	1,217	2
1960–1969	4,532	3
1970–1979	2,016	4
1980–1989	18,982	10
1990–1999	10,006	2
2000–2009	3,415	11

Wildfire will damage SSHCP Preserve System infrastructure such as fences, buildings, and water supply pipelines. Damage to any SSHCP Preserve System infrastructure will be covered by insurance and will be repaired by the Implementing Entity. Any fires in the SSHCP Preserve System substantially affecting enhancement, re-establishment or establishment sites, regardless of the number of burned acres, will be remediated by the Implementing Entity as a changed circumstance. Prescribed fires were not included in the definition of changed circumstances, unless the prescribed fire accidentally escapes the planned perimeter. Based on historical fire data and weather patterns for the Plan Area and the expected climate change discussed in Section 11.3, wildfire occurrence is most likely during the warm, dry summer months (June through September). However, given the high ignition potential for grasslands and the proximity of potential ignition sources (roadways), wildfires may occur outside of this period under appropriate weather conditions.

Individual Preserve Management Plans will identify fire prevention and habitat protection actions consistent with the California Board of Forestry and Fire Protection 1994 Joint Policy on Pre, During, and Post Fire Activities and Wildlife Habitat.[4] Such actions may include identification and installation/maintenance of fuel breaks, prescribed fire, pre-incident planning, and public education campaigns. Prescribed burning to control buildup of thatch and woody debris, plus control invasive species, is an important tool for ecosystem management, including reducing the chances of fires, and will be considered in the individual management plans. In addition, preventive measures such as fuel breaks will be included as best management practices (BMPs).

Preventative actions include, but are not limited to:

- Each Preserve Manager will create or redesign fuel breaks as appropriate to limit fire spread.
- As allowed and consistent with the Preserve Management Plan, the Preserve Manager will use low-intensity prescribed fires to encourage growth of fire-adapted native plants and discourage growth of non-fire-adapted invasive plants.

[4] http://www.bof.fire.ca.gov/board_joint_policies/joint_policies/pre.pdf

- The Implementing Entity will develop Memoranda of Understanding with all applicable fire agencies to be included with each Preserve Management Plan that identifies appropriate response and fire suppression techniques, including access points, priority locations for fire camps, firebreak construction, water uptake, use of chemical retardants, heavy equipment operation, and post-fire cleanup.
- The Implementing Entity will incorporate public-awareness programs into Preserve Management Plans. This includes public outreach to neighboring lands to minimize fire risk.

Should a wildfire occur in a SSHCP Preserve, the following remedial actions shall be undertaken:

- Each Preserve Manager will work closely with responding fire agencies to ensure fire response and suppression is consistent with the Memorandum of Understanding described above to minimize impacts to sensitive ecological areas;
- Within 48 hours of learning of a Preserve wildfire, the Preserve Manager will begin inspections of the Preserve to determine adverse effects occurred to Covered Species or their habitats within the Preserve. The Preserve Manager will conduct site reconnaissance, sampling, or surveying, as deemed appropriate, and prepare a brief disturbance assessment report that will be provided to the Implementing Entity. Specific issues to be considered in the disturbance assessment report will include, but not be limited to:
    - GPS mapping of boundaries and calculation of acreages of SSHCP land covers burned or disturbed;
    - Qualitative description of ground disturbances specifically created during fire-fighting effort (e.g., access points, fire lines);
    - Damage to irrigation, pumping, fencing or other Preserve facilities;
    - Direct mortality of species;
    - Responses to control erosion, invasive plants, and identify needs for repair or replacement of Preserve facilities; and
    - Analysis of effectiveness of AMMs and consistency with the fire agencies MOU listed in the Preserve Management Plan.
- If necessary, Preserve Staff will initiate erosion control measures where appropriate consistent with Section 5.4, and repair structures necessary to secure and maintain the Preserve such as fences and irrigation facilities.
- The Implementing Entity will set up proper post-fire monitoring protocols for the site in accordance with the SSHCP Monitoring Program and Preserve System Management Program approach described Chapter 8.

- After reviewing the disturbance assessment report, the Implementing Entity will determine whether habitat re-establishment is necessary. A re-establishment plan and a reasonable timeframe shall be established in coordination with the TAC (Chapter 9).

Unforeseen Circumstances: The Permittees assume that wildfire will not cause permanent conversion of land cover types within the Preserve System. If wildfire in the Preserve System is sufficiently intense to fully remove a land cover type and damage soils so that they no longer support the pre-existing land cover type that represents an unforeseen circumstance. Further, if a wildfire occurs in the Preserve System of such a size or intensity that aerial application of chemical fire retardants is used, that is also an unforeseen circumstance.

11.4.3.3 Drought

Changed Circumstances: Drought is a natural, cyclical weather phenomenon that generally occurs over a period of several years. There is no universal definition of when a drought begins or ends. A drought is declared by a statewide drought emergency proclamation. Droughts lasting more than 3 years are relatively rare in Northern California (DWR 2015). Over the past century there have been eight multi-year drought events, five of which lasted 3 to 5 years and two of which lasted 6 years (DWR 2015).

Given that drought is a naturally recurring environmental condition in California, many plants and animals are adapted to natural drought cycles. However, the negative effects of natural drought cycles have been exacerbated by anthropogenic factors, including climate change, that have disturbed the native California landscape, including increased competition from invasive plant and animal species, habitat conversion, intensive water uses for agriculture and urban development, air and water pollution, and climate change. The natural adaptations and resiliency to drought by the Covered Species and their habitats in the Plan Area may not be adequate to respond to drought in the future.

If adverse effects related to drought are observed but vernal pools still support vernal pool species, the following actions shall be taken:

- The Implementing Entity will use adaptive management of Preserves to reduce biomass of annual grasses in the Vernal Pool Ecosystem, to help extend vernal pool ponding by reducing water uptake.
- The Implementing Entity will increase monitoring and management of invasive plant species that may have competitive advantages in drought.
- The Implementing Entity will provide supplemental water at re-establishment/ establishment sites if needed.

- The Implementing Entity will implement other measures through the Monitoring Program and Preserve System Management Program (Chapter 8) in ways consistent with permit obligations and with the consent of the Implementing Entity.

Unforeseen Circumstances: If drought occurs in the Plan Area over enough years that the wetted area of vernal pools no longer support vernal pool species and converts to a terrestrial land cover type, that will be an unforeseen circumstance. In that circumstance, the USFWS will extend the No Surprises assurances to the Plan Permittees for all SSHCP aquatic Covered Species. If drought occurs in the Plan Area over enough years that farmers on SSHCP conservation easements have no irrigation water sources, the USFWS will extend the No Surprises assurances to the Plan Permittees for all SSHCP Covered Species that require Cropland, Irrigated-Pasture Grassland, Orchard, or Vineyard.

11.4.3.4 Invasive Plant Species

Changed Circumstances: A number of plant invasive species are already present and common within the Plan Area (see Section 6.6.1), and it is unlikely that many of these species can be wholly eradicated in the future. As several invasive plant species are likely to be present in SSHCP Preserves now or in the future, the SSHCP requires an invasive species management component for each Preserve Management Plan. The SSHCP Conservation Strategy also includes roadside monitoring and removal of invasive plants in the Plan Area (Measurable Objective HAB 4). New invasive plant species or expanded invasive plant species distributions are considered a changed circumstance from baseline conditions. Invasive plant species baseline conditions in the SSHCP Preserve System will be established for each SSHCP Preserve parcel as it is acquired for the Preserve System.

In the event that a new invasive plant species becomes established or an existing invasive species exhibits substantial or unexpected expansion in the SSHCP Preserve System, the following actions shall be taken:

- Within 30 days of discovery or notification of a new invasive species or substantial or unexpected expansion of an existing invasive species, the Implementing Entity will meet with the TAC to determine appropriate eradication efforts consistent with the PMP and Measurable Objective HAB4.
- The Implementing Entity will conduct expedited monitoring for invasive plant species according to the SSHCP Preserve System Monitoring and Management Program on all SSHCP Preserves. If the invasive plant species is found on additional SSHCP Preserves, eradication efforts will be implemented consistent with each PMP to control or eliminate the invasive plant species threat.

- If eradication efforts result in a need to re-establish habitat in a Preserve, the re-establishment will be completed within 2 years of the eradication.
- The Implementing Entity will set up proper long-term monitoring protocols for the site in accordance with the SSHCP Preserve System Monitoring and Management Program described in Chapter 8 if restoration is necessary.

Unforeseen Circumstances: There is no unforeseen circumstance for invasive plant species; the Plan Permittees will treat any invasive plant species establishment or expansion with adaptive management.

11.4.3.5 Invasive Animal Species

Changed Circumstances: A number of animal invasive species are already present and common within the Plan Area (see Section 6.6.1), and it is unlikely that many of these species can be wholly eradicated in the future. As several invasive animal species are likely to be present in SSHCP Preserves now or in the future, the SSHCP requires an invasive species management component for each Preserve Management Plan. New invasive species or expanded invasive species distributions are considered a changed circumstance from baseline conditions. Invasive species baseline conditions in the SSHCP Preserve System will be established for each SSHCP Preserve parcel as it is acquired.

Examples of invasive animal species that are harmful to Covered Species and could become established or expand their range in the Plan Area include bullfrogs, which could invade California tiger salamander breeding ponds and prey on tadpoles; and hybrid California tiger salamander, which interbreed with native California tiger salamander and dilute the genetic diversity of the native species.

General

In the event that a new invasive species becomes established or an existing invasive species exhibits substantial or unexpected expansion in the SSHCP Preserve System, the following actions shall be taken:

- Within 30 days of discovery or notification of a new invasive animal species or substantial or unexpected expansion of an existing invasive animal species, the Implementing Entity will meet with the TAC to determine appropriate eradication efforts consistent with the PMP.
- Monitoring protocols for the invasive animal species will be implemented on all SSHCP Preserves. If the invasive animal species is found on additional preserves, eradication efforts will be implemented consistent with each PMP to control or eliminate the invasive species threat.

Hybrid California Tiger Salamander

In the event that hybrid California tiger salamanders are found in SSHCP Preserves, the following actions will be taken:

- The Implementing Entity will contract with species experts to help identify potential remediation measures for the hybrid California tiger salamander. The Implementing Entity will meet with Wildlife Agencies, the TAC, and the contracted species experts to develop a plan for selection and implementation of the remediation measures in the Preserve System.
- The Implementing Entity will work with the Wildlife Agencies to develop a plan to eradicate hybrid California tiger salamander, or take other actions, up to the limits described under the No Surprises Rule.

Unforeseen Circumstance: If hybrid California tiger salamanders eliminate the native California tiger salamanders in the Plan Area that will constitute an unforeseen circumstance.

11.4.3.6 Disease

Changed Circumstances

Under historical circumstances, Covered Species populations in the Plan Area probably either occurred in equilibrium with disease (i.e., the population was maintained by balance of births and deaths of immigration and emigration) and/or had the resiliency to recover from severe outbreaks. Even if some populations historically experienced local, and occasionally severe, disease-related reductions in numbers or local extirpations, over the long term these impacts probably were not substantial enough to result in extinctions due to adequate suitable habitat and movement corridors to allow repopulations. However, given the current level of habitat fragmentation due to agricultural and urban development in the region (i.e., including the Central Valley), and environmental stressors related to climate change in the Plan Area, unusual outbreaks or introductions of new diseases could adversely, and potentially irreversibly, affect the populations of some Covered Species.

Should a disease or vector organism adversely impact a Covered Species, the following actions shall be taken:

- The Implementing Entity will contract with species experts to help identify potential remediation measures for the Covered Species disease infestation. The Implementing Entity will meet with Wildlife Agencies, the TAC, and the contracted species experts to

develop a plan for selection and implementation of the remediation measures in the Preserve System.

- The Implementing Entity will set up proper disease monitoring protocols in the Preserve System, and potentially outside the Preserve System, in accordance with the SSHCP Monitoring Program and Preserve System Management Program described in Chapter 8.

Unforeseen Circumstances: If a disease results in the extirpation of a Covered Species from the Plan Area, that will constitute an unforeseen circumstance. In that event, the Implementing Entity may work with the Wildlife Agencies to develop a translocation plan to repopulate the Preserve System with the affected Covered Species, or take other actions, up to the limits described under the No Surprises Rule.

11.5 References Cited

Baltar, M.J.E. Keeley, F.P. Schoenberg. 2014. "County-level analysis of the impact of temperature and population increases on California wildfire data." *Environmetrics* 25: 6 pages 397–405.

Bartolome, J. W., W.J. Barry, T. Griggs, and P. Hopkinson.2007. "Valley grassland." *Terrestrial Vegetation of California*, third edition. M. G. Barbour, T. Keeler-Wolf, and A. Schoenherr. Berkeley, California: University of California Press.

Bernazzani, P, B.A. Bradley, and J.J. Opperman. 2012. "Integrating Climate Change into Habitat Conservation Plans Under the U.S. Endangered Species Act." *Environmental Management*. DOI 10.1007/s00267-012-9853-2.

Brooks, M.L., C.M. D'Antonio, D.M. Richardson, J.B. Grace, J.E. Keeley, J.M. DiTomaso, R.J. Hobbs, M. Pellant, D. Pyke. 2004. Effects of invasive alien plants on fire regimes. *Bioscience 54:677-688*.

California Energy Commission and California Natural Resources Agency. 2012. *Our Changing Climate: Vulnerability and Adaptation to the Increasing Risks rom Climate Change in California*. A Summary Report on the Third Assessment from the California Climate Change Center. Accessed January 2016. http://www.energy.ca.gov/2012publications/CEC-500-2012-007/CEC-500-2012-007.pdf.

California Natural Resources Agency. 2009. *California Climate Adaptation Strategy: A Report to the Governor of the State of California in Response to Executive Order S-13-2008*. http://resources.ca.gov/docs/climate/Statewide_Adaptation_Strategy.pdf.

California Natural Resources Agency. 2014. *Safeguarding California: Reducing Climate Risk.* An Update to the 2009 California Climate Adaptation Strategy. July. http://resources.ca.gov/docs/climate/Final_Safeguarding_CA_Plan_July_31_2014.pdf.

Capital Region Climate Readiness Collaborative. 2014. *Climate Change Risks and Solutions for the Capital Region*. November 2014. http://www.climatereadiness.info/wp-content/uploads/2014/04/Sacramento-Climate-Change-Risks-Nov-2014.pdf.

D'Antonio, C, S. Bainbridge, C. Kennedy, J. Bartolome, S. Reynolds. 2000. *Ecology and Restoration of California Grasslands With Special Emphasis on the Influence of Fire and Grazing on Native Grassland Species*. Dept. of Integrative Biology; Dept. of Environmental Science, Policy, and Management, UC Berkeley. http://globalrestorationnetwork.org/uploads/files/LiteratureAttachments/120_ecology-and-restoration-of-california-grasslands-with-special-emphasis-on-the-influence-of-fire-and-grazing-on-native-grassland-species.pdf.

DWR (Department of Water Resources). 2015. *California's Most Significant Droughts: Comparing Historical and Recent Conditions*. February 2015.

Hinds, N.E.A. 1952. "Evolution of the California Landscape." *California Division of Mines* Bulletin No. 158. 240 pp.

FRAP. 2014. GIS Data analysis based on Fire Perimeters Version 13_2. http://frap.cdf.ca.gov/data/frapgisdata-sw-fireperimeters_download.php.

Gardali, T., N.E. Seavey, R. T. Digaudio, and L.A. Comrack. 2012. A climate change vulnerability assessment of California's at-risk birds. PLoS One Volume 7, Issue 3. March 2012. http://www.plosone.org/article/fetchObject.action?uri=info:doi/10.1371/journal.pone.0029507&representation=PDF.

Hurteau, M.D., A.L. Westerling, C. Wiedinmyer, and B.P. Bryant. 2014. Projected Effects of Climate and Development on California Wildfire Emissions through 2100. Environmental Science and Technology 48:2298−2304. dx.doi.org/10.1021/es4050133.

Lund, J.R. 2012. "Flood Management in California." *Water* 4:157–169.

NWCG (National Wildfire Coordinating Group) 2014. Glossary of Wildland Fire Technology. October 2014. http://www.nwcg.gov/pms/pubs/glossary/pms205.pdf.

Phurisamban. 2014. *Addressing Climate Change Adaptation in Water Resource Management: A Case Study of the Sacramento Region*. October 2014. Sacramento, California: Capital Region Climate Readiness Collaborative.

Silveira, J.G. 1998. Avian uses of vernal pools and implications for conservation practices. Pages 92-106 in: C.W. Witham, E.T. Bauder, D. Belk, W.R. Ferren Jr., and R. Ornduff (Editors). *Ecology, Conservation, and Management of Vernal Pool Ecosystems* – Proceedings from a 1996 Conference. Sacramento, California: California Native Plant Society. 1998.

U.S. Bureau of Reclamation. 2014. *West-Wide Climate Risk Assessment. Sacramento and San Joaquin Basins Climate Impact Assessment*. September 2014.

USFWS (United States Fish and Wildlife Service). 1993. Endangered and threatened wildlife and plants; determination of threatened status for the GGS. Federal Register 58: 54053-54066.

USFWS (United States Fish and Wildlife Service) and NOAA (National Oceanic and Atmospheric Administration). 1998. Final rule: "Habitat Conservation Plan Assurances ("No Surprises") Rule." February 23, 1998. Federal register, Volume 53, pages 8859–8873.

Willis, A.D., J.R. Lund, E.S. Townsley, and B.A. Faber. 2011. Climate change and flood operations in the Sacramento Basin, California. San Francisco Estuary & Watershed Science. 9:1–18.