Central Valley Landscape Conservation Project

Climate Change Vulnerability Assessment (January 2017 version)

Wintering Waterbirds & Shorebirds

Vulnerability Assessment Summary

Overall Vulnerability Score and Components:

Vulnerability Component	Score
Sensitivity	Low-moderate
Exposure	Moderate
Adaptive Capacity	Moderate-high
Vulnerability	**Low-moderate**

Overall vulnerability of the wintering waterbirds and shorebirds species group was rated as moderate-high. The rating is the result of low-moderate sensitivity, moderate future exposure, and moderate-high adaptive capacity ratings.

Air temperature is a key climate factor for wintering waterbirds and shorebirds, impacting migration timing, food availability, and energy requirements. Disease is the primary disturbance mechanism for this species group, with bird density influencing the rate of spread; it is likely that the distribution of diseases may shift as factors like temperature and precipitation change. Wintering waterbirds and shorebirds exhibit a moderate-high degree of specialization, as they are dependent on wetland habitat in their wintering range, and are sensitive to factors such as water depth that influence their ability to forage effectively.

There were no non-climate factors identified for this species group, but additional sensitivity may be driven by changes occurring on breeding grounds; climate impacts and/or non-climate stressors can degrade or destroy nesting areas, reducing species recruitment and contributing to associated decreases of wintering birds.

Wintering waterbirds and shorebirds have relatively stable populations, and the mobility of this species group allows dispersal between habitat patches. However, habitat availability is likely a limiting factor for wintering birds, and has been tied to many aspects of health, density, and species distribution. No landscape barriers were identified for this species group. Wintering birds exhibit high genetic diversity and phenotypic/behavioral plasticity, allowing shifts in complex aspects of their life history such as migration strategies.

The high degree of mobility and wide range of environmental conditions experienced by this species group is likely to contribute to the moderate-high adaptive capacity to climate stressors, and may allow them to adapt to future conditions.

Management potential for wintering waterbirds and shorebirds was scored as moderate, and is likely focused on protecting and restoring flooded habitat, including wetlands and flooded cropland; conservation-focused policies and incentive programs may help land managers continue to manage for wintering waterbirds and shorebirds as water availability declines in the future.

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Introduction

Description of Priority Natural Resource

Waterbirds and shorebirds wintering in the Central Valley are migratory species that often breed across the Arctic and sub-arctic regions of Alaska and Canada (Galbraith et al. 2014), as well as in the Prairie Pothole Region in North and South Dakota (Drum et al. 2015). Between 10 and 12 million waterfowl pass through the Central Valley annually, comprising 60% of waterfowl within the Pacific Flyway, and 20% of the entire continental population (Gilmer et al. 1982; Elphick 2000).

As part of the Central Valley Landscape Conservation Project, workshop participants identified wintering waterbirds and shorebirds as a Priority Natural Resource for the Central Valley Landscape Conservation Project in a process that involved two steps: 1) gathering information about the species group's management importance as indicated by its priority in existing conservation plans and lists and, 2) a workshop with stakeholders to identify the final list of Priority Natural Resources, which includes habitats, species groups, and species.

The rationale for choosing the wintering waterbirds and shorebirds species group as a Priority Natural Resource included the following: the species group has high management importance, and the species group's conservation needs are not entirely represented within a single priority habitat. Please see Appendix A: "Priority Natural Resource Selection Methodology" for more information.

Vulnerability Assessment Methodology

During a two-day workshop in October of 2015, 30 experts representing 16 Central Valley resource management organizations assessed the vulnerability of priority natural resources to changes in climate and non-climate factors, and identified the likely resulting pressures, stresses, and benefits (see Appendix B: "Glossary" for terms used in this report). The expert opinions provided by these participants are referenced throughout this document with an endnote indicating its source[1]. To the extent possible, scientific literature was sought out to support expert opinion garnered at the workshop. Literature searches were conducted for factors and resulting pressures that were rated as high or moderate-high, and all pressures, stresses, and benefits identified in the workshop are included in this report. For more information about the vulnerability assessment methodology, please see Appendix C: "Vulnerability Assessment Methods and Application." Projections of climate and non-climate change for the region were researched and are summarized in Appendix D: "Overview of Projected Future Changes in the California Central Valley".

Vulnerability Assessment Details

Climate Factors

Workshop participants scored the resource's sensitivity to climate factors and this score was used to calculate overall sensitivity. Future exposure to climate factors was scored and the overall exposure score used to calculate climate change vulnerability.

Climate Factor	Sensitivity	Future Exposure
Air temperature	Low-moderate	Moderate
Overall Scores	**Low-moderate**	**Moderate**

Climate variables will likely contribute to a shift in the location or size of the winter range of many bird species (Stralberg et al. 2009; National Audubon Society 2013; Galbraith et al. 2014). Species that are predicted to experience reductions in winter range include the hooded merganser (*Lophodytes cucullatus*; 65% loss of winter range), red-necked grebe (*Podiceps grisegena*; 57%), bufflehead (*Bucephala albeola*; 42%), common merganser (*Mergus merganser*; 39%), common goldeneye (*Bucephala clangula*; 35%), spotted sandpiper (*Actitis macularius*; 21%), and mallard (*Anas platyrhynchos*; 9%) (National Audubon Society 2013). For other species, like the sandhill crane (*Grus canadensis*), the Central Valley may no longer be within its wintering range despite a potential increase in winter range size nationwide. For the Western Sandpiper (*Calidris mauri*), the Central Valley will remain within their winter range through the end of the century (National Audubon Society 2013).

Across the state, 10-57% of the land area will contain novel species assemblages by 2070 as species shift their ranges independently of one another in response to a combination of climate variables, including temperature (Stralberg et al. 2009). The southern part of the Central Valley is one of the regions most likely to see the greatest changes in species composition, while the Delta is among the regions that will see the least change (Stralberg et al. 2009).

Air temperature

Sensitivity: *Low-moderate (moderate confidence)*
Future exposure: *Moderate (moderate confidence)*
Potential refugia: *North-south gradient*

Cold temperatures may affect wintering waterbirds and shorebirds by impacting the timing of migration (Beason 1978), food availability, and energy expenditure (Weathers & Sullivan 1993). Temperature may affect spring and fall migration differently, with spring migration showing a stronger overall correlation to meteorological factors, including changes in temperature and temperature at sunset and midnight, while fall migration is more strongly associated with seasonality (e.g., day of the year; Beason 1978). The number of birds migrating during both

periods is higher when the freezing level is at a higher altitude (Beason 1978). The influence of temperature on migration may be less significant for waterbirds and shorebirds than for passerines (Beason 1978).

Indirectly, temperature increases may reduce wintering habitat and forage availability by causing reductions in crop yield, crop conversion, or an increase in fields left fallow (Jackson et al. 2009; Lee et al. 2011), resulting in reduced availability of seed left on post-harvest fields. Late spring and early summer heat waves may have a particularly large impact on growth of commonly flooded crops, especially rice (Jackson et al. 2009).

Climatic changes that may benefit the species group:

- Warming temperatures would mean fewer cold periods, reducing energy demands

Non-Climate Factors

Workshop participants scored the resource's sensitivity and current exposure to non-climate factors, and these scores were then used to assess their impact on climate change sensitivity.

All the factors in the Permanent Wetland, Seasonal Wetland, and Flooded Cropland vulnerability assessments apply here, but no non-climate factors were identified that directly affect the species group[1]. Increasing goose populations could affect marsh vegetation/habitat, and potentially impact other wetland species such as secretive marsh birds[1].

Disturbance Regimes

Overall sensitivity to disturbance regimes: *Low (high confidence)*

Disease

The high concentration of migrating birds passing through the Central Valley can increase the transmission of diseases such as avian influenza, avian cholera, and botulism, which are spread more readily in low-quality crowded habitat (Gilmer et al. 1982; Hénaux et al. 2012). Warmer temperatures may alter the types of diseases that affect both wildlife and plants if diseases that are currently limited by cold temperatures expand into new areas and/or if disease organisms and vectors become more likely to overwinter (Jackson et al. 2009; Hénaux et al. 2012; Brown et al. 2013; Elias et al. 2015).

Wildfire

Wildfire may have a less impact on riparian birds than the previous disturbances[1].

Dependency on habitat and/or other species

Overall degree of specialization*: Moderate-high (high confidence)*
Dependency on one or more sensitive habitat types: *High (high confidence)*

Description of habitat: *Wetlands*

Dependency on specific prey or forage species: *Low-moderate (high confidence)*

Dependency on other critical factors that influence sensitivity: *Moderate-high (high confidence)*

Description of other dependencies: *Availability of agricultural forage/rice farms*

Breeding waterbirds and shorebirds have a generalized diet and are opportunistic nesters[1]. However, they are dependent on wetland habitat for foraging and roosting (Ackerman et al. 2006), and species are sensitive to water depth. For instance, dabbling ducks are found in deeper water, while wading birds and shorebirds are typically found in areas with shallow flooding that allows them to reach seeds (Elphick 2000; Strum et al. 2013; Sesser et al. 2016). Over 95% of the 4 million wetland acres historically present in the Central Valley have been lost since the mid-1800s (Frayer et al. 1989), but flooded croplands are able to fulfill many of the same ecosystem functions for wintering birds (Gilmer et al. 1982; Elphick 2000, 2004; Fleskes et al. 2005), and the area of flooded cropland has increased dramatically over the last 30 years (Fleskes et al. 2005). However, increased demand for water resources, which are expected to become more limited under changing climate conditions, makes it more difficult for farmers and land managers to maintain flooded habitat (Kiparsky & Gleick 2003; Ackerman et al. 2006; Medellín-Azuara et al. 2007). For example, a recent study found that drought led to a decline in wetland habitat (including both seasonal/permanent wetlands and flooded cropland; Reiter et al. 2015), and impacts can occur within a single season in the drier southern areas (Elphick 2004; Reiter et al. 2015).

Adaptive Capacity

Workshop participants scored the resource's adaptive capacity and the overall score was used to calculate climate change vulnerability.

Adaptive Capacity Component	Score
Extent, Status, and Dispersal Ability	High
Intraspecific Species Group Diversity	Moderate
Resistance & Recovery	Moderate-high
Overall Score	**Moderate-high**

Extent, status, and dispersal ability

Overall degree extent, integrity, connectivity, and dispersal ability: *High (high confidence)*

Geographic extent: *Transboundary (high confidence)*

Health and functional integrity: *Increasingly healthy (high confidence)*

Population connectivity: *Continuous (high confidence)*
Dispersal ability: *High (high confidence)*

Waterbirds and shorebirds are highly mobile, increasing population connectivity and the ability to travel between habitat patches (Newton 2010). However, more continuous habitat reduces energy requirements for foraging and travel (Elphick 2000; Ackerman et al. 2006). Habitat availability is likely a limiting factor for waterbird populations, especially during the dry months that coincide with fall migration (Central Valley Joint Venture 2006), and has been associated with health, body condition, daily flight distances, and shifts in density and regional distribution in waterbirds (Fleskes et al. 2005; Ackerman et al. 2006; Hénaux et al. 2012). Increased habitat availability has contributed to decreased range sizes and shorter distances traveled daily between roosting and foraging areas for wintering Pacific greater white-fronted geese (*Anser albifrons frontalis*), with larger shifts in goose distribution into basins with increased rice production (Ackerman et al. 2006).

Landscape permeability

Overall landscape permeability: *No landscape barriers were identified by workshop participants, and landscape permeability was not assessed.*

Resistance and recovery

Overall ability to resist and recover from stresses: *Moderate-high (moderate confidence)*
Resistance to stresses/maladaptive human responses: *Moderate (moderate confidence)*
Ability to recover from stresses/maladaptive human response impacts: *Moderate-high (moderate confidence)*

The high mobility of wintering waterbirds and shorebirds is closely tied to their resistance to climate stressors, potentially allowing them to shift their range and/or migration strategy (Dolman & Sutherland 1995) and reach foraging and breeding habitat patches across a fairly wide area (Ackerman et al. 2006). Jiguet et al. (2006) also found that avian species adapted to a wide range of temperatures are more resilient to heat waves and warming patterns.

Species group diversity

Overall species group diversity: *High (moderate confidence)*
Diversity of life history strategies: *Moderate-high (high confidence)*
Genetic diversity: *Moderate-high (high confidence)*
Behavioral plasticity: *High (moderate confidence)*
Phenotypic plasticity: *Workshop participants noted that this question is not applicable to this species group.*

Genetic and phenotypic diversity can prompt shifts in species' migration strategies, which is a vital part of species' adaptation to changing environmental conditions (including both climate changes and habitat loss; Dolman & Sutherland 1995). Although little research exists on the link between genetics and migration strategies for most species, there is some evidence that assortative mating (i.e., a tendency for individuals to mate with others that share their own traits) may contribute to shifts in migration strategies; for instance, individuals that pair off in their wintering grounds could be more likely to increase the frequency of genetic coding that is tied to wintering in that particular location (Dolman & Sutherland 1995). Migration strategies are less likely to have a genetic component when birds migrate in large family groups, where young birds are able to learn the route rather than depending entirely on internal cues (Dolman & Sutherland 1995; Newton 2010).

Some populations are entirely (or almost entirely) dependent on Central Valley wintering habitat, which can increase vulnerability to changing climate conditions and other stressors. These species include tule white-fronted geese (*Anser albifrons elgasi*), Aleutian Canada Geese (*Branta canadensis leucopareia*), and Ross' geese (*Anser rossii*) (Gilmer et al. 1982). The long-billed curlew (*Numenius americanus*) is a federal Bird Species of Conservation Concern that also utilizes the Central Valley for wintering habitat (Sesser et al. 2016).

Other Factors

Overall degree to which other factors affect adaptive capacity:

Localized impacts on breeding grounds: *Moderate (moderate confidence)*

Localized impacts on breeding grounds

Migratory birds are vulnerable to climate and non-climate stressors (e.g., habitat loss) because they are dependent on conditions in both their breeding and wintering habitats, as well as in stopover locations (Dolman & Sutherland 1995; Small-Lorenz et al. 2013; Galbraith et al. 2014). Wintering waterbirds and shorebirds in the Central Valley often breed in marine, coastal, and wetland habitats throughout Alaska and Canada. Habitat loss in these areas is occurring due to human activity, as well as sea level rise, peat decomposition, changes in precipitation/drought, and increasing temperatures combined with limited room for northward range expansion (Fox et al. 2005; Hinzman et al. 2005; Galbraith et al. 2014). Birds may also lose breeding territory to competitor species or altered predator/prey relationships. For example, two species of Arctic-breeding geese may be declining due to competition with Canada geese for nesting and molting habitats (Fox et al. 2005). Habitat loss in a migratory species' breeding range may lead to observed population declines in the wintering range, and vice versa (Dolman & Sutherland 1995).

Management potential

Workshop participants scored the resource's management potential.

Management Potential Component	Score
Species value	Moderate-high
Societal support	Moderate-high
Agriculture & rangeland practices	Moderate-high
Extreme events	Moderate
Converting retired land	Moderate
Managing climate change impacts	Low-moderate
Overall Score	**Moderate**

Value to people

Value to people: *Moderate-high (moderate confidence)*

Support for conservation

Degree of societal support for management and conservation: *Moderate-high (high confidence)*

Degree to which agriculture and/or rangelands can benefit/support/increase resilience: *Moderate-high (high confidence)*

Degree to which extreme events (e.g., flooding, drought) influence societal support for taking action:

Flooding: *Moderate-high (moderate confidence)*
Drought: *Low-moderate (low confidence)*

Description of events: *Frequent flooding may increase awareness of importance wetland ecosystem services (flood protection). Drought reduces support because water is needed for other uses.*

Likelihood of converting land to support species group

Likelihood of (or support for) converting retired agriculture land to maintain or enhance species group: *Moderate (moderate confidence)*
Description of likelihood: *Retired rice in Sacramento Valley.*

Likelihood of managing or alleviating climate change impacts: *Low-moderate (high confidence)*
Description of likelihood: *In the face of projected climate change impacts such as decreased snowpack, decreased seasonal run-off, and earlier seasonal runoff, decreased water availability (and therefore habitat quantity and quality) will lower the likelihood of managing or alleviating the impacts of climate change on this species group.*

Changing climate conditions are likely to impact water availability, commodity prices, and other factors that may discourage the management of fields as flooded cropland and/or influence agricultural practices (e.g., flooding, rice straw removal; Medellín-Azuara et al. 2007; Sesser et al. 2016). The creation of the North American Waterfowl Management Plan in 1986 and the Central Valley Joint Venture in 1988 has contributed to changes in management practices, shifting policies and incentive programs toward wetland restoration, habitat improvement, and enhanced value of agricultural lands (Ackerman et al. 2006; Central Valley Joint Venture 2006; North American Waterfowl Management Plan 2012).

Incentive programs pay farmers and landowners to provide habitat for waterbirds and shorebirds, either by using agricultural practices that are beneficial (e.g., flooding post-harvest rice fields), or by removing environmentally sensitive habitat from active agricultural use (Duffy & Kahara 2011; DiGaudio et al. 2015). Wetlands restored through these efforts have been successful at providing habitat for diverse bird species, including many special status species (DiGaudio et al. 2015). For instance, The Nature Conservancy's BirdReturns program (The Nature Conservancy 2014) are helping to create pop-up wetlands during critical periods for migrating and wintering birds, increasing habitat availability and quality. Nationally, the Conservation Reserve Program pays farmers to remove certain sensitive areas from agricultural use; this program also protects nesting habitat for waterfowl breeding in the Prairie Pothole regions of North and South Dakota and eastern Montana and has successfully increased species recruitment among migratory waterfowl (Drum et al. 2015).

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