



1

BREEDING SHOREBIRDS

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CHAPTER SUMMARY

The three species of shorebirds considered in this chapter breed broadly in the Central Valley: the American avocet, black-necked stilt, and killdeer. The relative size of the Valley's breeding population of the killdeer is unknown, but those of the avocet and stilt account for one-fourth and one-sixth, respectively, of the estimated totals for these species in the continental United States. The American avocet and killdeer are considered to be of conservation concern nationally.

This chapter describes the process for developing conservation objectives for permanent and semi-permanent wetlands needed to support genetically robust, self-sustaining, ecologically functional, and resilient populations of breeding shorebirds in the Central Valley. Habitat objectives are based on population and density objectives developed for the three focal species of shorebirds and account for use of habitats other than wetlands.

The Conservation Delivery chapter in Section I integrates these habitat objectives with the habitat objectives for other bird groups in the Implementation Plan to present total habitat needs in the Central Valley. The chapter then describes conservation actions for achieving these integrated habitat objectives.

SHORT-TERM HABITAT OBJECTIVE:

ADD 28,500 ACRES OF PERMANENT AND SEMI-PERMANENT WETLANDS

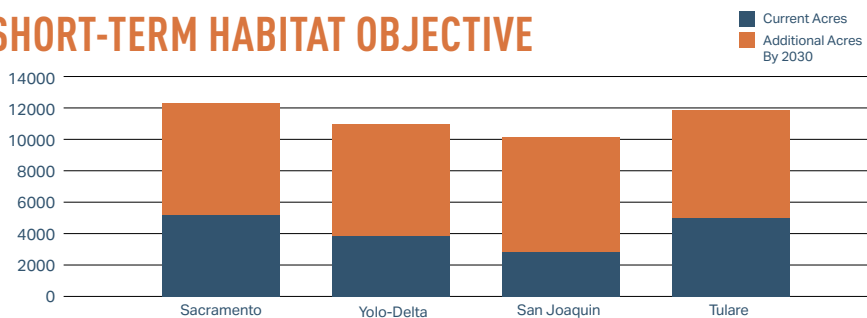
TOTAL BREEDING SHOREBIRD HABITAT IN 10 YEARS:

45,800 ACRES

HABITAT TYPE

Primary habitats used by the three focal species of shorebirds breeding in the Central Valley include permanent and semi-permanent wetlands and shallowly flooded rice fields, with water depths from zero (mudflats) to 8 inches. These focal shorebirds nest on small earthen mounds in flooded habitat or on sparsely vegetated ground, including islands, adjacent to or surrounded by suitable foraging habitat. These conditions are required throughout the breeding season, which peaks from mid-April through mid-July.

SHORT-TERM HABITAT OBJECTIVE

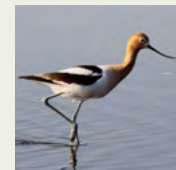


HABITAT SUCCESS STORIES

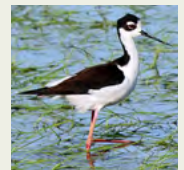
since the 2006 Implementation Plan

- Approximately 500 acres of permanent and semi-permanent wetland habitat was restored from 2009 to 2015.
- Nearly 54% of shorebirds breeding on private lands in the Tulare Basin were supported by private lands conservation programs such as the Agricultural Conservation Easement Program offered by the Natural Resources Conservation Service.
- Compensatory mitigation wetlands, designed to attract breeding shorebirds away from contaminated areas and to promote nesting success, have been highly successful in the Tulare Basin (Davis et al. 2008). This model could be considered as a complement to wetland restoration.

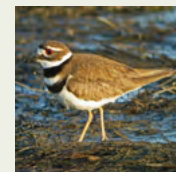
BIRD SPECIES INCLUDE:



American avocet*



Black-necked stilt***



Killdeer**

* Image: Audubon California ** Image: California Rice Commission
*** Image: Brian Gilmore

(1) Male and juvenile black-necked stilts - Tom Grey (2) Breeding shorebird habitat - Khara Strum (3) Adult American avocet with chick - Mike Peters

INTRODUCTION

Historically, the Central Valley flooded seasonally, creating an estimated 2.4 million acres of wetlands. This landscape was one of the largest areas of naturally-occurring freshwater habitat west of the Great Lakes (Garone 2011). Today, the Central Valley has lost over 90 percent of its former wetlands to agriculture, channelization and urban development (Frayer et al. 1989). Flooded habitat is now largely provided by irrigated agriculture and by managed wetlands that are controlled or influenced by natural resource managers in some way. Given the changes to the extent, spatial distribution, and types of available habitat, populations of migratory birds that now rely upon wetland and agricultural habitats are likely much smaller than they were historically (Banks and Springer 1994; Page and Gill 1994).

In addition to supporting large populations of wintering and migrating shorebirds, the Central Valley provides breeding habitat for seven species of shorebirds (Hickey et al. 2003). The most numerous and widespread are the American avocet, black-necked stilt, and killdeer. The region supports nearly 24 percent and 17 percent of the national populations of breeding avocets and stilts, respectively (Shuford et al. 2007; USSCPP 2015). The relative population size of killdeer is unknown.

Breeding shorebirds in the Central Valley face a variety of threats. The most recent compilation of population trends and status for shorebirds in the United States lists the American avocet as vulnerable to shifting climate conditions and the killdeer as a common species in decline (Table 10.1; USSCPP 2015). These trends emphasize the need to protect and restore flooded habitat in the Central Valley during the shorebird breeding season, which peaks from mid-April through mid-July.

The primary habitats used by breeding shorebirds in the Central Valley include permanent and semi-permanent wetlands (hereafter referred to as semi-permanent wetlands) and flooded rice fields (Shuford et al. 2007). Conserving, enhancing and restoring these habitats will also provide value for other wildlife, including various other species of water-dependent birds. Benefits will also extend to the giant garter snake (*Thamnophis gigas*), a federally and state threatened species that requires flooded habitat, especially from March through October (Halstead et al. 2010). Providing additional wildlife habitat also benefits local communities economically, through increased property values, increased visitation by people enjoying wildlife viewing and other recreational opportunities (Liu et al. 2013; USFWS 2014).

The CVJV established conservation objectives for semi-permanent wetlands, and for population sizes and densities of the three focal species of shorebirds that breed in the Central Valley. This chapter explains these conservation objectives and how they can be applied to reach the conservation goals. The CVJV's approach provides a transparent, repeatable process for defining science-based conservation objectives for breeding shorebirds and their habitats in the Central Valley, which can help unite stakeholders around common goals and motivate conservation actions.

CONSERVATION GOAL

The Central Valley Joint Venture's long-term goal is for the Central Valley to have sufficient high-quality breeding habitat, particularly in semi-permanent wetlands, to support genetically robust, self-sustaining, ecologically functional, and resilient populations of breeding shorebirds.



(1) Killdeer tail distraction display - Robert A. Hamilton (2) Killdeer - Dan Skalos

WHICH SPECIES ARE INCLUDED?

Of the seven species of shorebirds breeding in the region, the CVJV evaluated three: the American avocet (avocet), black-necked stilt (stilt), and killdeer. These focal species (Table 10.1) were chosen because they are sufficiently common and widespread in the Central Valley to be useful for evaluating the effects of management and enhancement of habitat for their benefit.

Four additional species of shorebirds breed regularly in the Central Valley: the snowy plover, spotted sandpiper, Wilson's snipe, and Wilson's phalarope (CVJV 2006). These species are beyond the scope of this analysis because they either have small, localized breeding populations or nest in specialized habitats other than the semi-permanent wetlands and other habitats addressed here.

SPECIES (SCIENTIFIC NAME)	CONSERVATION STATUS ^a	CENTRAL VALLEY IMPORTANCE ^b
Black-necked stilt (<i>Himantopus mexicanus</i>)	LC	Moderate
American avocet (<i>Recurvirostra americana</i>)	MCCV	--
Killdeer (<i>Charadrius vociferous</i>)	CSD	Primary

^a Conservation status designations: CSD, common shorebird in decline; MCCV, moderate climate change vulnerability; LC, least concern (Shorebirds of Conservation Concern in the United States, USSCPP 2015)

^b Southern Pacific Shorebird Conservation Plan (Hickey et al. 2003)

TABLE 10.1 Focal species of breeding shorebirds: National conservation status and importance of the Central Valley for nesting.



Killdeer - Brian Gilmore

WHICH GEOGRAPHIC AREAS ARE INCLUDED?

Conservation objectives were defined for breeding shorebirds in four of the five planning regions, excluding Suisun, in the Central Valley's Primary Focus Area (Figure 10.1). Suisun was excluded because there are no population estimates of stilts and avocets for this planning region.

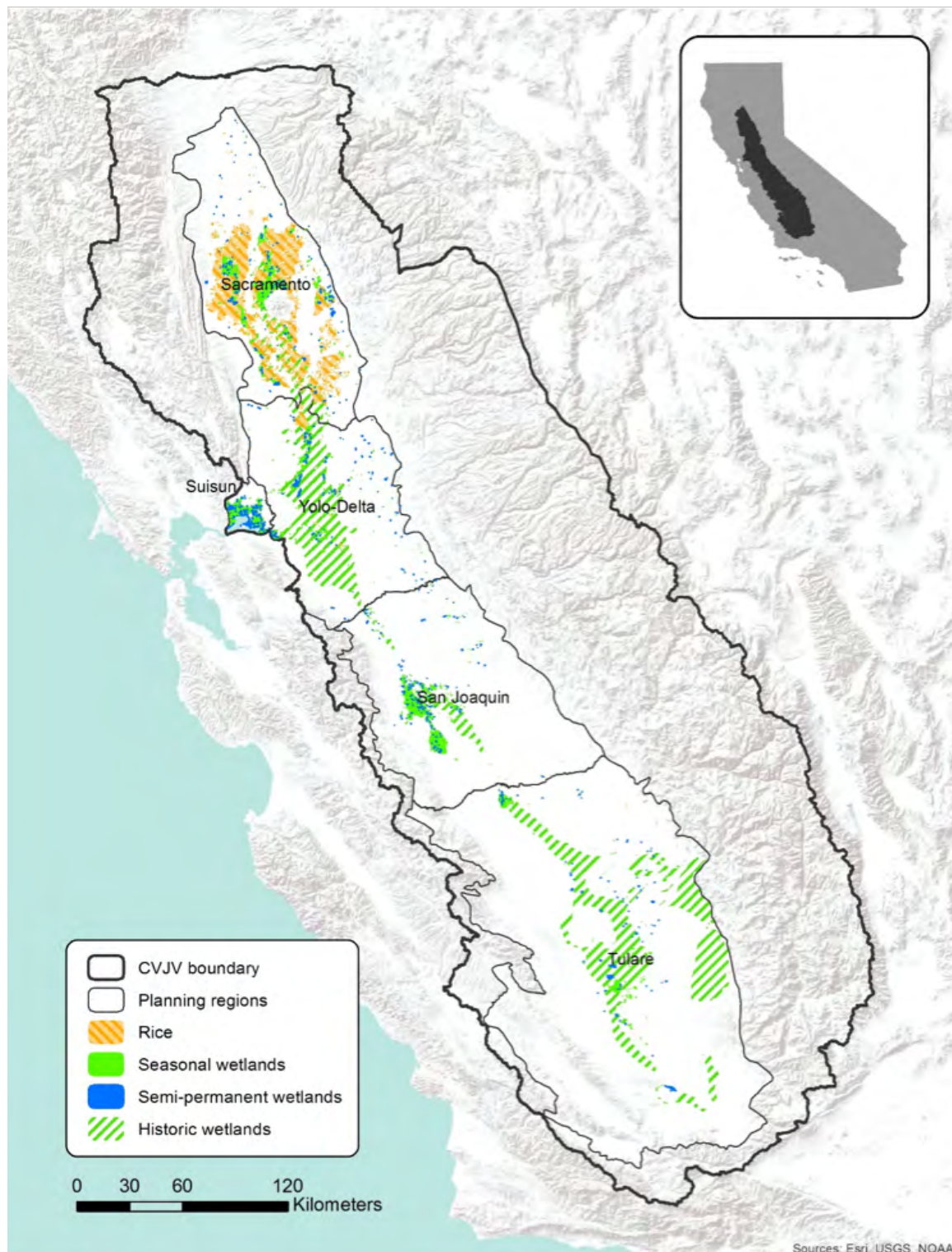


FIGURE 10.1 Central Valley Joint Venture perimeter and Primary Focus Area, showing estimated current extent of managed wetlands and rice agriculture and estimated historical (pre-1900) extent of wetlands.

CURRENT CONDITIONS

Current Population Sizes and Trends

To develop the long-term population objectives for each focal species in each planning region, the CVJV first developed a population status framework based on general principles of conservation and population biology (Dybala et al. 2017). The framework is structured as a hierarchy of four population size categories that mark milestones in becoming a genetically robust, self-sustaining, and ecologically functional population: very small (<1,000 individuals), small (<10,000 individuals), viable (>10,000 individuals), and large (>50,000 individuals). There are two additional modifiers, that describe steeply declining populations (>30 percent decline over 10 years), which are at high risk of extirpation regardless of population size, and resilient populations, which should be more capable of recovering from an environmental catastrophe in one part of the range if they have more than one self-sustaining sub-population.

Using this population-status framework, the CVJV characterized stilt populations as small (<10,000 individuals) or very small (<1,000 individuals) in three of the four planning regions, and avocet populations as small or very small in all four planning regions (Figure 10.2). Current population size estimates are based on surveys of the focal species in the Central Valley in 2003 (Shuford et al. 2007); there have been no comparable comprehensive surveys since. A local study of breeding shorebirds in the Glenn-Colusa Irrigation District of the Sacramento Valley in 2013 and 2014 provided the first estimates of breeding densities of killdeer in that region (Audubon California, unpublished data, 2016, see “Notes”); however, the current population size in the Central Valley is unknown. All three focal species show long-term (1968–2013) declining trends in the Coastal California Bird Conservation Region (BCR 32; Sauer et al. 2014). The population of killdeer shows a significant, steeply-declining trend of greater than 30 percent every 10 years, including during the most recent decade for which data were available (2004–2013; Figure 10.2; Strum et al. 2017).

Current Habitat

Breeding shorebirds use a variety of habitats in the Central Valley (Shuford et al. 2007). This Implementation Plan (hereafter, “the Plan”) focuses on semi-permanent managed wetlands, while accounting for breeding shorebird use of other habitats including rice fields, compensatory mitigation wetlands, sewage ponds, water storage facilities, evaporation ponds, and agricultural canals.

The CVJV estimated the total extent of current potential nesting habitat for breeding shorebirds in four planning regions of the Central Valley by evaluating the spatial extent



Black-necked stilt nest - Audubon California

of rice agriculture and semi-permanent wetlands (Figure 10.1). A Geographic Information Systems (GIS) data layer of Central Valley managed wetlands produced from 2009 satellite imagery (Petrik et al. 2014), supplemented by an estimate of the area of wetlands restored between 2009 and 2015 (D. Fehringer, personal communication, 2016, see “Notes”), was used to estimate a current (2015) total of 17,300 acres of semi-permanent wetlands. A current estimate of 541,400 acres of planted rice fields (averaged over 2007–2014) was derived from statewide survey statistics (NASS 2016) combined with a GIS layer representing the consistent spatial distribution of rice fields in California (The Nature Conservancy, unpublished data, 2015, see “Notes”).

Suitable nesting sites for the focal species generally include small islands or sparsely vegetated ground, adjacent to shallowly flooded foraging habitat (ranging from mudflat to 8 inches deep). These conditions need to persist for the duration of the nesting season for nesting to be successful. However, semi-permanent wetlands are generally managed as deep-water habitats, with areas of open water and patches of tall, dense vegetation (e.g., tules [*Schoenoplectus* spp.] and/or cattails [*Typha* spp.]) and with limited shallow areas, mainly along edges. Seasonal wetlands are typically drained in February and March, prior to or at the beginning of shorebird nesting. As a result, shallow-water habitat suitable for nesting is available only for a limited amount of time, if at all, during the shorebird breeding season (Iglecia and Kelsey 2012).

DEVELOPING THE CONSERVATION OBJECTIVES

Population Objectives

To meet the conservation goal, the overall long-term (100-year) population objectives for each focal species in the Central Valley Primary Focus Area was defined as large (>50,000 individuals), with viable (>10,000 individuals) sub-populations in each planning region.

Habitat and Density Objectives

Based on the estimated loss of over 90 percent of historical wetland habitat (Frayer et al. 1989) and the management strategies used on existing semi-permanent wetlands, populations of focal species are assumed to be currently limited by available habitat. Although surveys of breeding shorebirds in the Central Valley in 2003 found 80 percent of stilts and 66 percent of avocets in rice fields and managed wetlands combined (Shuford et al. 2007), habitat objectives were not set for rice fields because the extent of planted rice is strongly driven by changing economic and climatic conditions. Wetlands, by contrast, provide the greatest potential for increasing both long-term habitat availability and habitat quality through management actions.

After examining stilt and avocet breeding densities currently observed throughout the Central Valley, the CVJV estimated that a 50 percent increase in the overall average breeding density of each species in semi-permanent wetlands could be achieved through enhanced management of existing wetlands and restoration of wetlands with high-quality habitat. These estimates became the density and habitat objectives. It will be necessary to achieve both of these objectives in order to meet the population objectives, assuming no change to the numbers of individuals of each species breeding in rice fields or other habitat types.



Rice field suitable for nesting - Khara Strum

Current overall density estimates of breeding killdeer are lacking for the Central Valley. The species' density objective was estimated as the density of killdeer needed in semi-permanent wetlands to reach the population objective of more than 50,000 individuals, assuming no change to the number of killdeer breeding in rice fields (as extrapolated from the Glenn-Colusa Irrigation District) and assuming the habitat objective for stilts and avocets was met.

The objectives were distributed among the four planning regions to ensure each focal species reached a regional population threshold for a viable population (>10,000 individuals).

Additional details on the sources of data, methods, results, and references can be found in Strum et al. (2017).

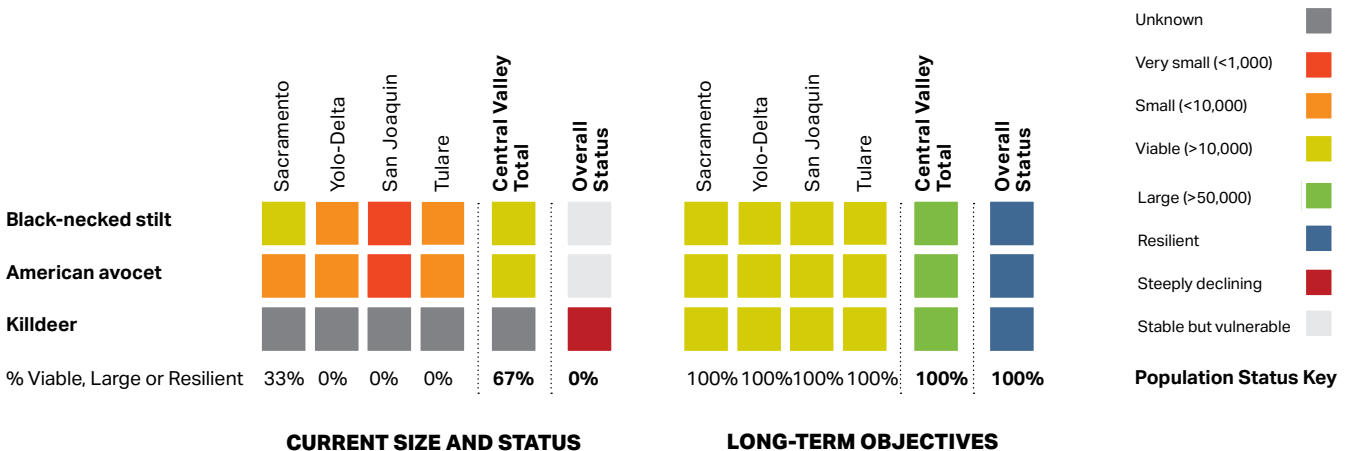


FIGURE 10.2 Population status and objectives for breeding shorebirds in the Central Valley.

CONSERVATION OBJECTIVES

Habitat Objectives

The Plan defines short-term (10-year) and long-term (100-year) habitat objectives for semi-permanent wetlands for each of the CVJV planning regions except Suisun (Table 10.2). These objectives reflect the estimated total extent of shorebird breeding habitat in semi-permanent wetlands required to achieve the long-term population objectives of all three focal species in each planning region.

Assuming no loss of existing semi-permanent wetland habitat, achieving long-term population objectives will require an estimated additional 285,000 acres of semi-permanent wetland habitat that is suitable for breeding shorebirds (meets the specific requirements for nesting and foraging) and is available during the peak breeding season (Table 10.2).

The corresponding short-term habitat objective for the Central Valley is an additional 28,500 acres of semi-permanent wetlands, distributed by planning region (Table 10.2). These objectives may also contribute to the habitat objectives for semi-permanent wetlands defined for other bird group such as breeding and non-breeding waterbirds and waterfowl (See the Conservation Delivery chapter for the integrated objectives).

Population Objectives

The long-term (100-year) population objective is to reach more than 50,000 individuals for each focal shorebird species within the CVJV's Primary Focus Area, with more than 10,000 individuals in each of four planning regions, during peak breeding season of mid-April through mid-July. These objectives represent the estimated population sizes needed to achieve genetically robust, self-sustaining, ecologically functional, and resilient populations.

Density Objectives

The density objectives represent the estimated average densities that could be reached with improvements in the quality of existing semi-permanent wetlands and in newly-restored semi-permanent wetlands in each planning region. Average densities needed to achieve long-term (100-year) population objectives for each CVJV planning region are 13.5 birds per 100 acres for avocets, 20.7 birds per 100 acres for stilts, and 14.0 birds per 100 acres for killdeer.

HABITAT TYPE PLANNING REGION	LONG-TERM HABITAT OBJECTIVE	CURRENT ESTIMATE	ADDITIONAL ACRES NEEDED (DIFFERENCE)	ACRES NEEDED BY 2030 (10%)
Semi-Permanent Managed Wetlands				
Sacramento	75,584	5,348	70,237	7,023
Yolo-Delta	75,584	4,011	71,574	7,159
San Joaquin	75,584	2,872	72,713	7,272
Tulare	75,584	5,034	70,551	7,055
Total	302,338	17,265	285,078	28,508

TABLE 10.2 Short-term (10-year) and long-term (100-year) habitat objectives for breeding shorebirds: semi-permanent managed wetlands. Shown in acres, with current estimates and the estimated additional acres needed to meet the habitat objectives by planning region. Habitat must be available during the peak breeding season, mid-April through mid-July. (Sums may not be exact, due to rounding in original data.)



Black-necked stilts - Dan Skalos

APPLYING THE CONSERVATION OBJECTIVES

Applying the Habitat Objectives

The long-term habitat objectives represent the estimated extent of semi-permanent wetlands required to be reliably flooded and managed annually to enable shorebird populations to meet the long-term population objectives, and therefore to reach the CVJV's conservation goal. Subtracting the estimated current extent of semi-permanent wetlands from the long-term habitat objective provides the estimated additional acres needed, assuming none of the current acreage is lost.

These additional acres can be gained by creating and flooding new semi-permanent wetlands, using 2015 as a starting point (the year of the most recent estimate of managed wetland acreage in the Central Valley). However, only the acreage of new wetlands that are flooded during peak shorebird nesting would count as contributing to the habitat objectives.

Although habitat objectives were defined only for semi-permanent wetlands, other types of wetlands could contribute to habitat objectives, such as reverse-cycle wetlands that are flooded in spring and summer and managed with relatively shallow water.

Progress toward achieving the habitat objectives for breeding shorebirds can be tracked through the CVJV's wetland restoration tracking database and by evaluating satellite imagery of surface water availability during mid-April through mid-July.

Enhancement of existing semi-permanent wetlands for breeding shorebirds may include adapting management practices to provide additional and higher-quality nesting and foraging habitat to support density objectives. The acreage of enhanced existing wetlands should not be counted toward the habitat objectives. Instead, habitat enhancement should be measured using the density objectives as described below.

Applying the Density Objectives

The density objectives can be used in several ways. At wetland restoration sites, density objectives can be used to measure whether the quality of the restored habitat is adequate to meet or exceed the density objectives for breeding shorebirds. Similarly, in existing habitat, density objectives can be used to demonstrate the effectiveness of habitat enhancement activities as densities of breeding shorebirds meet or exceed the density objectives. Finally, these objectives can be used as part of planning processes to project the potential number of individuals of each focal species that a restoration or enhancement project may be able to support. Progress toward the density objectives can be tracked through surveys of breeding shorebirds.

By increasing species densities, fewer acres of habitat are required to meet the population objectives, and in turn the CVJV's conservation goal. Therefore, improving conditions in existing wetland habitat should be a high priority. Habitat enhancement might include creating the specific nest-site characteristics needed by the three focal species (see Additional Conservation Considerations for details). Compensation wetlands in the Tulare Basin report numbers of birds that would exceed density objectives for each focal species (Davis et al. 2008) and could be considered as a complement to wetland restoration and enhancement after careful consideration of the benefits and drawbacks of this type of habitat. Short-term on-farm habitat programs implemented in rice agriculture (WHEP 2014) can also enhance breeding habitat and increase breeding densities in rice fields. Such enhancements likewise may reduce the area of semi-permanent wetlands needed to meet population objectives.



(1) American avocet nesting pair - Khara Strum (2) American avocet nest - Khara Strum

ADDITIONAL CONSERVATION CONSIDERATIONS

Consider foraging habitat for other water-dependent birds

In addition to providing habitat for breeding shorebirds, semi-permanent wetlands can also provide foraging habitat for other water-dependent birds, such as breeding and non-breeding waterbirds and waterfowl. For some of these birds, such as colonial nesting waterbirds, the amount of wetland habitat may not be as important as the location of the wetland within foraging distance of suitable nesting and roosting habitat, such as riparian forests. Wetland restorations that are strategically located near suitable riparian vegetation may contribute to the habitat objectives for both breeding shorebirds and other waterbirds. On the other hand, too close proximity to riparian or other vegetation may decrease overall use of wetlands by shorebirds if the vegetation hinders shorebirds' ability to detect aerial predators such as peregrine falcons.

Account for habitat needs of other wildlife

Enhancement of existing semi-permanent wetlands for breeding shorebirds may include changing management practices to provide more and higher-quality nesting habitat. These conditions need to persist for the duration of the breeding season for nesting to be successful. Other birds and wildlife may rely on semi-permanent wetlands as they are currently managed; assessing the potential trade-offs of changes in management strategies will be necessary.

Manage habitat for species-specific nesting requirements

In addition to a general strategy of restoring new and enhancing existing semi-permanent wetlands, habitat value can be added by providing the specific nest-site characteristics required by stilts, avocets, and killdeer. Stilts prefer to nest on small islands or on a mound above water (Robinson et al. 1999); avocets nest on dry, sparsely vegetated ground adjacent to shallow water (Ackerman et al. 2013); and killdeer nest on gravelly substrate near water or in upland habitats (Jackson and Jackson 2000). Slight differences in nest-site selection can have large effects on nest success and, therefore, on conservation measures needed for each species (Iglecia et al. 2014). Generally, suitable nesting sites for all focal species includes sparsely vegetated islands or high ground adjacent to shallowly flooded foraging habitat (ranging from mudflat to 8 inches deep). These conditions need to persist for the duration of the nesting season for nesting to be successful.



Island suitable for nesting, in a rice field - Monica Iglecia

Manage for landscape-level priorities

The distribution of habitat on the landscape may play an important role in meeting breeding shorebird population objectives. The Plan sets regional habitat objectives in order to meet regional population objectives (Table 10.2) for each focal species, allocating habitat evenly among the planning regions. Small adjustments can be made to where habitat is restored based on the feasibility of habitat restoration and/or the distribution of focal species most in need, as long as population objectives in each planning region are met. Despite the strong dispersal ability of shorebirds, the spatial distribution of habitat within each planning region may also affect habitat use (Reiter et al. 2015) and subsequent achievement of density and population objectives. The CVJV recommends creating and restoring habitat in areas that cluster habitat and maximize connectivity of semi-permanent wetlands and other shorebird breeding habitat.

(1) Black-necked stilt in flooded young rice field - California Rice Commission
(2) Female black-necked stilt and nest - Jim Dunn

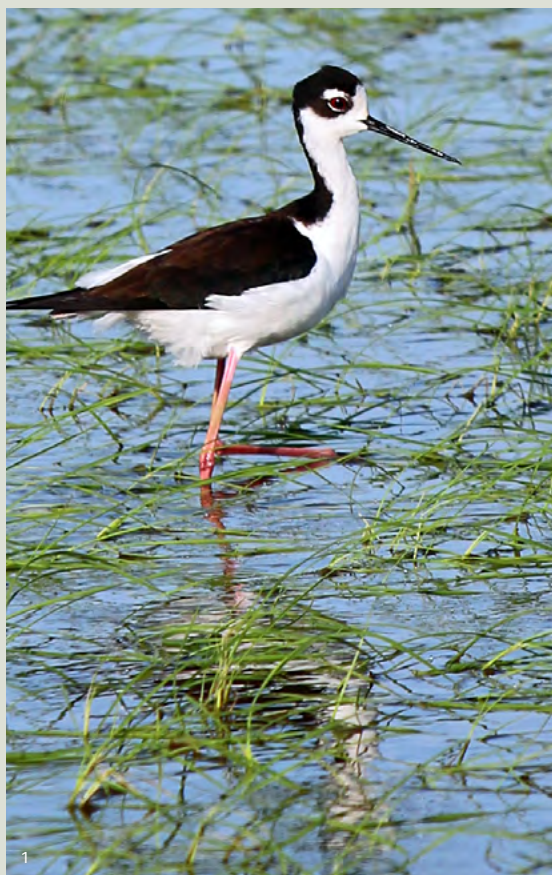
SUCCESS STORY

TULARE BASIN WETLANDS

In the Tulare Basin, nearly 1,100 acres of semi-permanent wetlands have been supported on private lands through the Natural Resources Conservation Service's Wetland Reserve Program (now the Agricultural Conservation Easement Program) or the California Landowner Incentive Program. These programs provide technical and financial assistance to help landowners restore and manage wetlands, riparian areas, and grasslands for improved environmental quality, including wildlife habitat.

A subset of these restored wetlands, surveyed during peak shorebird breeding season from 2005 to 2008, hosted an average density of nine American avocets and 51 black-necked stilts per 100 acres. In contrast, the majority of lands in this region that once were wetlands have been converted to uses that do not provide any breeding shorebird habitat. These densities demonstrate that private lands can be managed effectively for breeding shorebird habitat.

Nearly 54 percent of shorebirds breeding on private wetlands are supported by private land conservation programs. Understanding how these private wetlands are managed could provide insights, leading to enhanced management of other private and public wetlands to increase breeding shorebird densities.



LITERATURE CITED

- Ackerman JT, Hartman CA, Herzog MP, Takekawa JY, Robinson JA, Oring LW, Skorupa JP, Boettcher R. 2013. American avocet (*Recurvirostra americana*). In: Poole A, editor. *The Birds of North America Online*, No. 275. Ithaca (NY): Cornell Lab of Ornithology. doi: 10.2173/bna.275
- Banks RC, Springer PF. 1994. A century of population trends of waterfowl in western North America. *Stud Avian Biol.* 15:134–146. Available from: https://sora.unm.edu/sites/default/files/journals/sab/sab_015.pdf
- [CVJV] Central Valley Joint Venture. 2006. Central Valley Joint Venture implementation plan - conserving bird habitat. Sacramento (CA): US Fish and Wildlife Service. 286 p. Available from: http://www.centralvalleyjointventure.org/assets/pdf/CVJV_fnl.pdf
- Davis DE, Hanson CH, Hansen RB. 2008. Constructed wetland habitat for American avocet and black-necked stilt foraging and nesting. *J Wildl Manag.* 72:143–151. doi: 10.2193/2005-553
- Dybala KE, Clipperton N, Gardali T, Golet GH, Kelsey R, Lorenzato S, Melcer Jr R, Seavy NE, Silveira JG, Yarris GS. 2017. A general framework for setting quantitative population objectives for wildlife conservation. *San Franc Estuary Watershed Sci.* 15(1):8.
- Fraye WE, Peters DD, Pywell HR. 1989. Wetlands of the California Central Valley: Status and trends 1939 to mid-1980's. Portland (OR): US Fish and Wildlife Service. 36 p. doi: 10.3996/012014-JFWM-003.S10
- Garone P. 2011. The fall and rise of the wetlands of California's great Central Valley. Berkeley (CA): University of California Press. 448 p.
- Halstead BJ, Wylie GD, Casazza ML. 2010. Habitat suitability and conservation of the giant garter snake (*Thamnophis gigas*) in the Sacramento Valley of California. *Copeia* 4:591–599. doi: 10.1643/CE-09-199
- Hickey C, Shuford WD, Page GW, Warnock S. 2003. Southern Pacific shorebird conservation plan: A strategy for supporting California's Central Valley and coastal shorebird populations. Version 1.1. Stinson Beach (CA): PRBO Conservation Science. 137 p. Available from: http://www.prbo.org/cms/docs/wetlands/SPSCPlan_010904.pdf
- Iglecia MN, Kelsey R. 2012. Assessing the scope and scale of shorebird friendly management practices on managed wetlands in the Central Valley of California. Sacramento (CA): Audubon California.
- Iglecia MN, Velas KL, Kelsey TR, Dhundale JA, Shake CS, Hardy MA. 2014. Year 2 Summary of shorebird nesting habitat enhancement study. Sacramento (CA): Audubon California.
- Jackson BJ, Jackson JA. 2000. Killdeer (*Charadrius vociferus*). In: Poole A, editor. *The Birds of North America Online*, No 517. Ithaca (NY): Cornell Lab of Ornithology. doi: 10.2173/bna.517
- Liu X, Taylor LO, Hamilton TL, Grigelis PE. 2013. Amenity values of proximity to National Wildlife Refuges: An analysis of urban residential property values. *Ecol Econ.* 94:37–43. doi: 10.1016/j.ecolecon.2013.06.011
- [NASS] National Agricultural Statistics Service. 2016. Quick Stats 2.0. U.S. Department of Agriculture. Available from: <http://quickstats.nass.usda.gov/>
- Page GW, Gill RE Jr. 1994. Shorebirds in western North America: Late 1800s to late 1900s. *Stud Avian Biol.* 15:147–160. Available from: https://sora.unm.edu/sites/default/files/journals/sab/sab_015.pdf
- Petrik K, Fehring D, Weverko A. 2014. Mapping seasonal managed and semi-permanent wetlands in the Central Valley of California. Rancho Cordova (CA): Ducks Unlimited, Inc.
- Reiter ME, Wolder MA, Isola JE, Jongsomjit D, Hickey CM, Carpenter M, Silveira JG. 2015. Local and landscape habitat associations of shorebirds in wetlands of the Sacramento Valley of California. *J Fish Wildl Manag.* 6:29–43. doi: 10.3996/012014-JFWM-003
- Robinson JA, Reed JM, Skorupa JP, Oring LW. 1999. Black-necked stilt (*Himantopus mexicanus*) In: Poole A, editor. *The Birds of North America Online*, No 449. Ithaca (NY): Cornell Lab of Ornithology. doi: 10.2173/bna.449
- Sauer JR, Hines JE, Fallon JE, Pardieck KL, Ziolkowski DJ Jr, Link WA. 2014. The North American breeding bird survey, results and analysis 1966–2013. Version 01.30.2015. Laurel (MD): USGS Patuxent Wildlife Research Center. Available from: <http://www.mbr-pwrc.usgs.gov/bbs/bbs.html>
- Shuford WD, Humphrey JM, Hansen RB, Page GW, Stenzel LE, Hickey CM. 2007. Summer distribution, abundance and habitat use of black-necked stilts and American avocets in California's Central Valley. *West Birds.* 38:11–28. Available from: [https://www.westernfieldornithologists.org/archive/V38/38\(1\)%20p0011-p0028.pdf](https://www.westernfieldornithologists.org/archive/V38/38(1)%20p0011-p0028.pdf)
- Strum KM, Dybala, KE, Iglecia MN, Shuford WD. 2017. Population and habitat objectives for breeding shorebirds in California's Central Valley. *San Franc Estuary Watershed Sci.* 15(1):3.
- [USFWS] U.S. Fish and Wildlife Service, US Department of the Interior and US Department of Commerce, US Census Bureau. 2014. 2011 National survey of fishing, hunting, and wildlife associated recreation. Available from: <http://www.census.gov/prod/2012pubs/fhw11-nat.pdf>
- [USSCPP] US Shorebird Conservation Plan Partnership. 2015. US Shorebirds of Conservation Concern, 2015, U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Falls Church, Virginia. Available from <https://www.shorebirdplan.org/wp-content/uploads/2015/01/ShorebirdsConservationConcernJan2015.pdf>. 2016 update available from: <http://www.shorebirdplan.org/science/assessment-conservation-status-shorebirds>
- [WHEP] Waterbird Habitat Enhancement Program. 2014. Bird-friendly farming in California rice fields: A model of collaboration benefitting birds and people. 24p. Available from: http://calrice.org/pdf/waterbirdhabitatbro_web.pdf

NOTES

- Audubon California. 2016. Nesting study data. Excel (.xls) file. Located at 400 Capitol Mall, Suite 1535, Sacramento, CA 95814. Available from: kstrum@audubon.org.
- Fehring D. 2016. Email communication to K. Dybala regarding estimates of wetland acres restored between 2009 and 2015 in the Central Valley.
- The Nature Conservancy. 2015. Suitable agriculture GIS layer, developed from the remotely-sensed CropScape Cropland Data Layer provided by the U.S.D.A. National Agricultural Statistics Service and processed to include only pixels that were consistently classified into one of several major crop classes in the majority of the years 2007–2014. Available from: [Rodd Kelsey, rkelsey@trc.org](http://roddkelsey.com).