CENTRAL VALLEY
JOINT VENTURE
CONSERVING BIRD HABITAT

# 2020 IMPLEMENTATION PLAN

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Cover photo: Waterfowl in the Sacramento Valley – Mike Peters

# Central Valley Joint Venture
# 2020 Implementation Plan


# EXECUTIVE SUMMARY



**The Central Valley Joint Venture 2020 Implementation Plan uses the best available science to establish habitat and population objectives for the major groups of birds in the Central Valley of California. The Plan is intended to be useful to policy makers, regulators, agencies, conservation organizations and landowners working to further bird habitat conservation efforts in the Central Valley. The Plan represents the combined expertise of a wide range of professionals from conservation organizations, state and federal agencies and the private sector.**

This 2020 Plan updates and expands the Central Valley Joint Venture (CVJV) 2006 Implementation Plan to incorporate new science, new bird groups and the practical constraints of water availability, conservation opportunities, current and predicted shifts in climate and the impacts and needs of human communities in the region.

The CVJV is a self-directed coalition consisting of 19 public and private organizations. For more than 30 years, the partnership has directed its efforts toward the common goal of meeting the habitat needs of migrating and resident birds in California's Central Valley. This Implementation Plan identifies specific goals and objectives for bird conservation that will drive the CVJV's efforts until the next plan update.

Protecting, restoring and managing habitat to benefit bird species also provides many benefits for other native Central Valley animals and plants. These species and habitats, in turn, collectively benefit the people and communities of this region through improved water quality, more effective flood control, increased recreational opportunities and improved quality of life from connection to natural spaces, among other benefits.

*(1) San Luis National Wildlife Refuge, Kesterson Unit - Daniel Nylen/American Rivers (2) California black rail - Philip Robertson (3) American avocet in the non-breeding season - Tom Grey (4) American kestrel - Tom Grey*

## CENTRAL VALLEY BIRDS AND HABITAT

The Central Valley provides some of the most important bird habitat in North America. The Valley hosts one of the largest concentrations of migratory birds in the world during the fall and winter, in their non-breeding seasons, and also provides critical breeding habitat for a wide variety of bird species. Altogether, approximately 400 species of birds use the Central Valley during all or part of their lifecycles.

Once a vast mosaic of wetlands, riparian forests, grasslands, oak woodlands and saltbush scrub, the Central Valley has transformed dramatically over the last century. The loss of a large proportion of native habitat by conversion to agriculture, river channelization and urban development caused dramatic declines in wildlife. Many once-abundant bird species are now reduced to relatively small populations or are entirely gone from the region.

Despite this significant alteration of the Valley's natural landscape, land managers, landowners, conservation organizations and others work together to maintain valuable habitat and create new habitat in support of migratory bird populations. Since the 2006 plan, the CVJV and its partners have made clear and measurable improvements to critical bird habitat in the region.

## CONSERVATION OBJECTIVES AND STRATEGIES

The Plan establishes short-term habitat and population objectives to guide conservation efforts over the next ten years. It also sets long-term (100-year) objectives that represent the ultimate conditions necessary to sustain bird populations.

In this Plan, the CVJV establishes conservation objectives for the following bird groups:

- non-breeding waterfowl
- breeding waterfowl
- non-breeding shorebirds
- breeding shorebirds
- breeding and non-breeding waterbirds
- breeding riparian landbirds
- breeding grassland-oak savannah landbirds
- at-risk bird species

The objectives cover habitat protection, enhancement and/or restoration; population levels; and in some cases, breeding density. Experts on each bird group used existing data from the Central Valley region, employed established methods and developed new methods when necessary to develop the objectives. Most of the chapters focusing on specific bird groups were developed from peer-reviewed scientific publications that are publicly available for readers seeking more in-depth information. The Plan also presents a framework for setting conservation objectives for all Central Valley bird species that are at particularly high risk of population decline ("at-risk bird species").

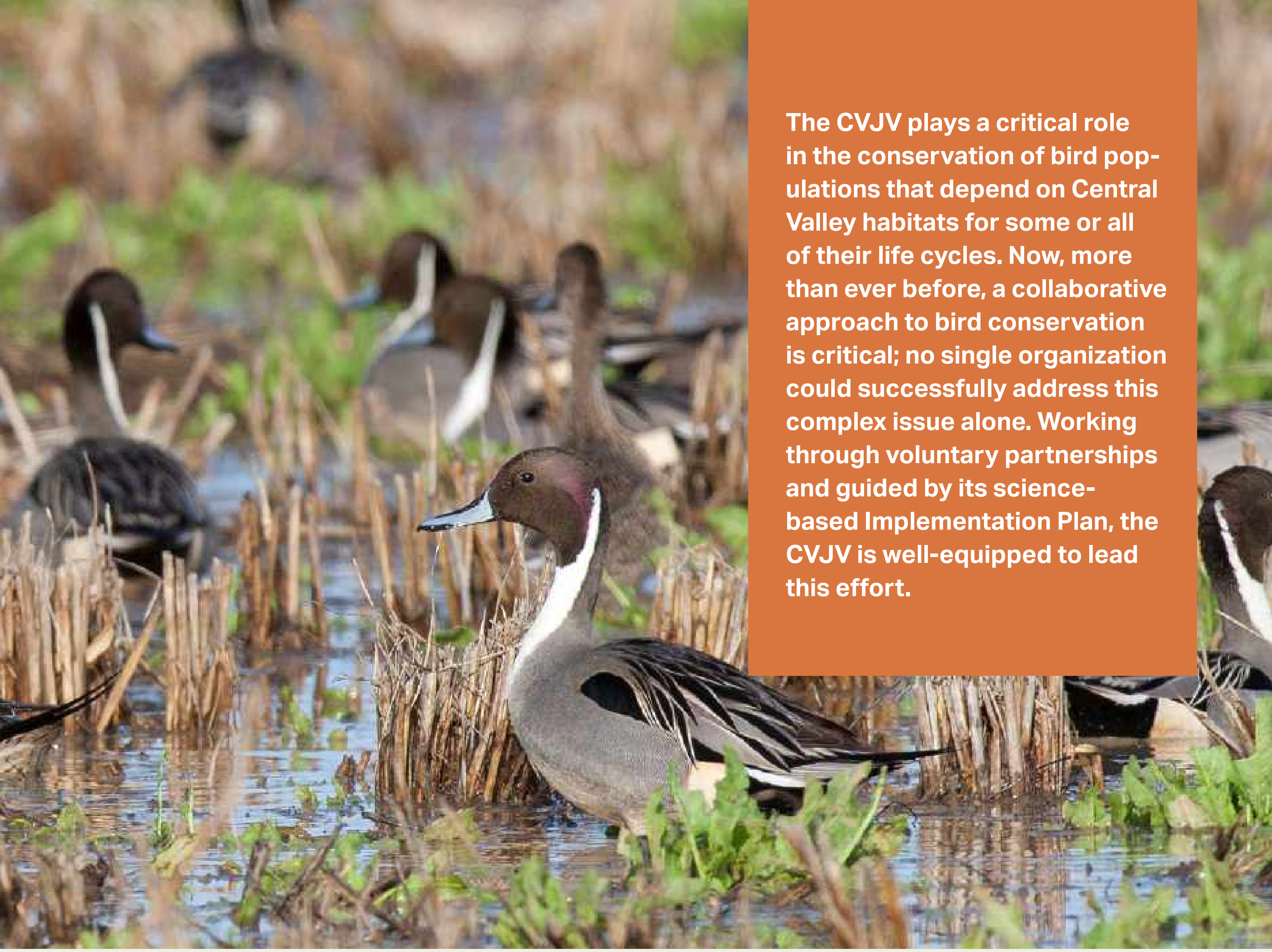
The habitat objectives developed for each bird group, shown in Table ES. 1, are generally organized by the CVJV's five planning regions, collectively the CVJV's Primary Focus Area. The higher-elevation region surrounding the planning regions is the CVJV's Secondary Focus Area; this area is covered by the grassland bird habitat objectives.

Strategies to achieve the conservation objectives fall within four focal categories: land management and conservation, water management, funding and budgets and the human dimensions of conservation. Given the necessity of planning for uncertainty, the Plan includes an examination of the most likely scenarios under which priority conservation actions should take place. The two key drivers of these scenarios are conservation opportunities and water availability.

## OTHER IMPORTANT CONSIDERATIONS

- **Water supplies:** Adequate water supplies are critical for wetland-dependent bird habitat, which includes both managed wetlands (such as refuges) and flooded agricultural lands.
- **Policy:** Public policy decisions play a significant role in bird conservation efforts.
- **Multiple benefits:** Bird conservation actions that also provide direct benefits to human communities, such as groundwater recharge, improved water quality and enhanced access to recreation, build increased support for the CVJV's efforts.
- **Climate considerations:** Major shifts in climate patterns in the Central Valley, occurring now and projected to occur over the next century, will have profound effects on bird populations.
- **Role of human communities:** It is critical to explicitly integrate human interests and motivations into conservation policies and programs.

**The CVJV plays a critical role in the conservation of bird populations that depend on Central Valley habitats for some or all of their life cycles. Now, more than ever before, a collaborative approach to bird conservation is critical; no single organization could successfully address this complex issue alone. Working through voluntary partnerships and guided by its science-based Implementation Plan, the CVJV is well-equipped to lead this effort.**



*Pintails using a postharvest-flooded rice field during their non-breeding season – Mike Peters*

| | PLANNING REGION | | | | | |
|---|---|---|---|---|---|---|
| **HABITAT TYPE** | **SACRAMENTO** | **YOLO-DELTA** | **SUISUN** | **SAN JOAQUIN** | **TULARE** | **VALLEY-WIDE** |
| **Managed Semi-Permanent Wetlands** | 9,420 | 7,160 | 1,355 | 9,378 | 7,055 | **34,368** |
| **Managed Seasonal Wetlands** | 6,875 | 4,500 | | 5,837 | 2,792 | **20,004** |
| **Managed Seasonal Wetland Enhancement** | 6,256 | 2,196 | 2,386 | 5,330 | 1,795 | **17,963** annually |
| **Riparian Habitat** | 8,377 | 5,906 | 1,408 | 8,368 | 9,273 | **33,332** |
| **Winter-Flooded Rice** | 324,847 | 15,823 | | | | **340,670** annually |
| **Agricultural Easements** | 54,000 | | | | | **54,000** |
| **Grassland** (Secondary Focus Area) | | | | | | **10,337** |
| **Oak Savannah** (throughout Primary Focus Area) | | | | | | **8,483** |

**TABLE ES. 1 Habitat conservation objectives (acres), integrated across all bird groups, by planning region and for the Central Valley as a whole. (See the Conservation Delivery chapter for more details.)**

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**Mike Dunphy**
CVJV Coordinator 2014-2018

**Ruth Ostroff**
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CENTRAL VALLEY JOINT VENTURE

CONSERVING BIRD HABITAT

## Partnering to conserve Central Valley birds and their habitats for current and future generations.

Loafing ducks, perched peregrine falcon, Sacramento NWR - Mike Wolder

# ACRONYMS

| TERM | DEFINITION |
|---|---|
| **ACEP** | Agricultural Conservation Easement Program |
| **AHM** | Adaptive harvest management |
| **AJVMB** | Association of Joint Venture Management Boards |
| **BBC** | Breeding Bird Census |
| **BCR** | Bird Conservation Region |
| **BLM** | Bureau of Land Management, U.S. Department of the Interior |
| **BMPs** | Best management practices |
| **CBPAR** | Community-based participatory action research |
| **CDFW** | California Department of Fish and Wildlife |
| **CPIF** | California Partners in Flight |
| **CRHCP** | California Riparian Habitat Conservation Program |
| **CVBC** | Central Valley Bird Club |
| **CVHJV** | Central Valley Habitat Joint Venture |
| **CVJV** | Central Valley Joint Venture |
| **CVLCP** | Central Valley Landscape Conservation Project |
| **CVP** | Central Valley Project |
| **CVPIA** | Central Valley Project Improvement Act |
| **CWA** | California Waterfowl Association or Clean Water Act |
| **DGP-GIC** | Department of Geography and Planning and Geographical Information Center, California State University, Chico |
| **DU** | Ducks Unlimited |
| **DWR** | California Department of Water Resources |
| **EJO** | Environmental justice organization |
| **ER** | Ecological reserve |
| **EREP** | Environmental restoration and enhancement projects |
| **ESA: CESA** | California Endangered Species Act |
| **ESA: FESA** | Federal Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) |
| **GEA** | Grasslands Ecological Area |
| **GIC** | Geographical Information Center. See also DGP-GIC. |
| **GIS** | Geographic Information System |
| **GRCD** | Grassland Resource Conservation District |
| **GSAs** | Groundwater Sustainability Agencies |
| **GSPs** | Groundwater Sustainability Plans |
| **GWD** | Grassland Water District |
| **ICP** | Interagency Coordinated Program |
| **ILRP** | Irrigated Lands Regulatory Program |
| **IPCC** | Intergovernmental Panel on Climate Change |

| TERM | DEFINITION |
| --- | --- |
| **IRWMT** | Interagency Refuge Water Management Team |
| **IWCP** | Inland Wetlands Conservation Program |
| **JV** | Joint Venture |
| **LIP** | Landowner Incentive Program |
| **LTA** | Long-term average |
| **L4** | Refuge water supplies, Full Level 4 |
| **NABCI** | North American Bird Conservation Initiative |
| **NAWCA** | North American Wetlands Conservation Act |
| **NAWMP** | North American Waterfowl Management Plan |
| **NGO** | Non-governmental organization |
| **NRCS** | Natural Resources Conservation Service, U.S. Department of Agriculture |
| **NWR** | National Wildlife Refuge |
| **PRBO** | Point Reyes Bird Observatory |
| **RCD** | Resource Conservation District |
| **RCPP** | Regional Conservation Partnership Program |
| **RD** | Reclamation District |
| **RWSP** | Refuge Water Supply Program |
| **SGMA** | Sustainable Groundwater Management Act of 2014 |
| **SHARE** | Shared Habitat Alliance for Recreational Enhancement Program |
| **SHC** | Strategic Habitat Conservation (the term the U.S. Fish and Wildlife Service uses for landscape-scale conservation of habitats) |
| **SMART** | Specific, measurable, achievable, relevant, and time-bound (as applied to goal-setting) |
| **SSC** | Species of special concern (a designation by the California Department of Fish and Wildlife) |
| **SWP** | State Water Project |
| **SWRCB** | State Water Resources Control Board |
| **TC** | Technical committee |
| **USBR** | U.S. Bureau of Reclamation (also called “Reclamation”), U.S. Department of the Interior |
| **USDA** | U.S. Department of Agriculture |
| **USFWS** | U.S. Fish and Wildlife Service, U.S. Department of the Interior |
| **USGS** | U.S. Geological Survey, U.S. Department of the Interior |
| **WA** | Wildlife Area |
| **WCB** | Wildlife Conservation Board |
| **WHEP** | Waterbird Habitat Enhancement Program |
| **WMA** | Wildlife Management Area (a unit of the National Wildlife Refuge System) |
| **WRE** | Wetland Reserve Easement |

# CONTENTS

# SECTION I

# THE BIG PICTURE

# 1 INTRODUCTION TO THE 2020 CVJV IMPLEMENTATION PLAN

**Many bird populations and habitats throughout North America have continued to suffer steep declines (NABCI 2016) over the past ten years. The Central Valley Joint Venture (CVJV) plays a critical role in the conservation of bird populations that depend on Central Valley habitats for some or all of their life cycles. Now, more than ever before, a collaborative approach to bird conservation is critical; no single organization could successfully address this complex issue alone. The CVJV, working through voluntary, non-regulatory partnerships and guided by its science-based Implementation Plan, is well-equipped to play a leadership role in this effort. Taken together, the previous two CVJV Implementation Plans tell the story of how CVJV bird conservation efforts have expanded over time. This Implementation Plan builds on and expands upon that earlier work.**

## THE CENTRAL VALLEY JOINT VENTURE

The CVJV is one of 21 habitat-based Migratory Bird Joint Ventures in North America, all of which work to protect and restore bird habitat. The U.S. Fish and Wildlife Service (USFWS) provides guidance for the establishment and organization of Joint Ventures. The USFWS defines Joint Ventures as self-directed partnerships of agencies, organizations, corporations, tribes and individuals that have formally accepted the responsibility of implementing national or international bird conservation plans within a specific geographic area or for a specific taxonomic group and have received general acceptance in the bird conservation community for such responsibility (USFWS 2005).

The Joint Ventures were established after the adoption of the 1986 North American Waterfowl Management Plan (NAWMP), an international plan focused on strategies to recover waterfowl populations. The NAWMP identified the CVJV, originally called the Central Valley Habitat Joint Venture, as one of the original six priority areas on the continent to focus on waterfowl conservation. It was renamed the Central Valley Joint Venture in 2004.

The CVJV is currently administered through a coordination office within the USFWS and is guided by a management board that receives input and recommendations from four standing committees and a variety of working groups and ad hoc committees. Its management board is composed of representatives from 19 partner organizations, including non-governmental organizations, state and federal agencies, and one regulated utility. The board members work cooperatively to address the habitat needs of migratory and resident bird species in California's Central Valley. Originally focused exclusively on waterfowl, the CVJV's mission has expanded over time to also encompass the conservation needs of shorebirds, waterbirds, landbirds, and at-risk bird species.

*(1) Butte Sink Wildlife Management Area - Mike Peters (2) Least bittern - Tom Grey (3) Sandhill cranes at Cosumnes River Preserve, Sacramento County - BLM*

**The Central Valley Joint Venture works collaboratively through diverse partnerships to protect, restore, and enhance wetlands and associated bird habitats in accordance with conservation strategies identified in the CVJV's Implementation Plan.**

## THE IMPLEMENTATION PLAN

In 1990, the CVJV published the Central Valley Habitat Joint Venture Implementation Plan (CVHJV 1990), its first strategic plan, to help guide delivery of partnership-based conservation of waterfowl habitat. The 1990 Plan was updated in 2006 and retained a waterfowl focus while incorporating new information and objectives for shorebirds, waterbirds and riparian songbirds.

The 2020 Central Valley Joint Venture Implementation Plan builds on the previous plans and is organized into three sections:

I. The Big Picture provides an introduction to the CVJV partnership, describes the conservation planning approach, presents the overarching conservation objectives for the CVJV geographic area and identifies conservation delivery strategies.

II. Setting the Stage provides an overview of the geographic area covered by the Plan and the social and political landscape within which the CVJV operates, and examines the human dimensions of wildlife conservation.

III. Conservation Objectives by Bird Group identifies biologically-based conservation objectives for the eight bird groups on which the CVJV focuses its efforts.

Gray Lodge Wildlife Area - Brian Gilmore

## NEW APPROACHES

Several new approaches guided the development of this Plan.

1. **Role of human communities: The Plan describes and identifies priority topics related to the human dimensions of bird conservation. This is the CVJV's first effort to explicitly integrate human interests and motivations into policies and programs.**

2. **Conservation delivery: The Plan identifies potential future scenarios that allow for adaptability in identifying and implementing priority conservation strategies and actions.**

3. **Multiple benefits: The Plan promotes land use projects designed to meet societal needs, enhance ecological function and improve habitat quality for fish and wildlife that also provide additional benefits such as groundwater recharge, improved water quality and enhanced access to recreation. Bird conservation actions that incorporate these types of benefits encourage increased support for achieving CVJV objectives.**

4. **Climate considerations: The Plan considers major shifts in climate patterns projected to occur over the next century in the Central Valley and summarizes the vulnerability of the region's bird populations to a shifting climate.**

5. **Planning regions: A number of the chapters in Section III use planning regions rather than basins as the core unit for management actions. Some of the planning regions incorporate multiple basins to reflect the current scientific knowledge and conservation needs of the different bird communities.**

6. **Expanded focus: The 2020 Plan incorporates additional habitat types and bird communities not considered in previous Implementation Plans (i.e., at-risk bird species and grassland and oak savannah birds and their habitats).**

7. **Technical documentation: Chapters focusing on specific bird groups were developed from peer-reviewed publications (UC Davis 2017). These papers are publicly available for readers seeking more in-depth information.**

Through the strong partnerships fostered by the CVJV, diverse interests are brought together to create what would otherwise be unlikely conservation outcomes. Despite the significant alteration of California's landscape in modern times, wildlife managers, landowners, conservation organizations, and others have achieved considerable conservation successes. As in previous versions, the current Plan provides habitat and population objectives for the next ten years. The Plan is intended to be useful to policy makers, regulators, conservation organizations, and landowners in furthering bird habitat conservation efforts in the Central Valley.

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# 2 PLANNING FOR BIRD CONSERVATION SUCCESS

Privately-owned wetland, San Joaquin Basin - Ryan DiGaudio

**The Central Valley Joint Venture uses a variety of methods to ensure success in its bird conservation work. This chapter looks at the three methods the CVJV uses to guide conservation planning: Strategic Habitat Conservation, scenario planning, and Joint Venture planning at the national level. It highlights successful delivery of conservation actions since the adoption of CVJV's first Implementation Plan in 1990, the Central Valley Habitat Joint Venture Implementation Plan (CVHJV 1990).**

**Finally, the chapter shares research and monitoring activities undertaken by CVJV partners to evaluate and improve conservation planning.**

## FRAMEWORK

### Strategic Habitat Conservation

The CVJV has adopted a strategic, science-based philosophy toward bird habitat conservation and uses a framework called Strategic Habitat Conservation (SHC) to maximize benefits to bird populations while minimizing costs of conservation investments.

Strategic Habitat Conservation (Figure 2.1) is a specific form of adaptive resource management (Walters 1986; Walters and Holling 1990; Williams 2003) that uses an iterative process to evaluate the effectiveness of habitat management actions. It encompasses four broad elements: biological planning, conservation design, delivery of conservation actions, and monitoring and research. Strategic Habitat Conservation moves wildlife conservation beyond the opportunistic and into the strategic realm, using an adaptive framework to ensure that learning and enhancements to conservation strategy occur.

### Scenario Planning

Natural resource managers today face unprecedented challenges arising from changes in factors such as land use, drought, climate patterns and invasive species. These challenges introduce numerous uncertainties that can complicate decision-making. Scenario planning is a structured way of developing a narrative about potential futures based on key uncertainties.

The 2006 Implementation Plan assumed that environmental conditions and conservation opportunities that had characterized the previous decade would continue, but that was not the case. In just ten years, wetland restoration opportunities declined due to such things as unanticipated high commodity and land prices and changes to regulatory requirements. Further, multiple years of severe drought resulted in curtailed water supplies to existing wetland and agricultural habitats. This shift in conditions illustrates the importance of identifying strategies that are robust across a variety of potential future conditions (Cook et al. 2014). Scenario planning is one tool that can be used to develop such strategies (Peterson et al. 2003).

The CVJV used scenario planning as a tool to develop this Implementation Plan, with the goal of identifying actions that would achieve the CVJV bird population and habitat objectives under a range of possible futures. The CVJV developed future scenarios by hosting four workshops that engaged a variety of CVJV partners. Each workshop encouraged team building and creative, solution-oriented thinking and followed a process of (1) identifying key drivers of the system (those critical elements that can contribute to conservation success or failure);

(2) exploring drivers with the greatest uncertainty over a 10-year time horizon; and (3) integrating the uncertainty in these drivers into narratives that define four scenarios of future conditions. The workshops included identifying conservation strategies to use in a particular scenario or in multiple scenarios. The Conservation Delivery chapter discusses the strategies that were identified as being robust under multiple scenarios.

The two key drivers of the system, identified during the scenario planning exercise, are water availability and conservation opportunity. Wetland water supplies are clearly a critical driver of the amount and quality of flooded habitat in the Central Valley. The workshop groups expressed the uncertainty in water supply over the next 10 years as a gradient from high water supply to low water supply.

The groups quantified this gradient from High to Low as:

1) Full Level 4 Central Valley Project Improvement Act (CVPIA) refuge water supplies, sufficient surface water supplies for existing and future restored wetlands, sufficient water supplies for rice producers wanting to winter-flood.
2) Recent water supplies in an average water year (i.e., typical water supplies).
3) 25% reduction in average water supplies.
4) 50% reduction in average water supplies.
5) 75% reduction in average water supplies.

In defining conservation opportunity, the workshop groups identified three main aspects:

1. The cost of purchasing land for conservation. Commodity prices, patterns of urban development, and other factors will all drive the cost of land. When land prices are low, there are more numerous traditional conservation opportunities than when land prices are high (e.g., there is little interest in converting rice fields to wetlands when commodity prices are high).

2. Public support and funding for conservation. When public policies support conservation, funding is readily available and there are more conservation opportunities than when support is low.

3. Hunter numbers. If hunter numbers go up, there will be more conservation opportunities. If hunter numbers decline, it could erode support for waterfowl conservation in general (e.g., annual public land expenditures that benefit waterfowl), and reduce current and future investments in waterfowl hunting clubs and leases.

Together, these variables describe a conservation opportunity axis that varies from high (available funds and low land prices) to low (little funding and high land prices).

These drivers are both important, and they span a continuum of environmental and social conditions with inherent uncertainty. To capture the uncertainty, the workshop groups defined four scenarios based on the continuum of identified drivers (Figure 2.2): Build Resilience (high water availability and high conservation opportunity), High and Dry (high conservation opportunity but low water availability), Catch Your Breath (high water availability but low conservation opportunity), and Crisis Management (low water availability and low conservation opportunity). The groups then created qualitative narratives that described the situations under each of these scenarios.

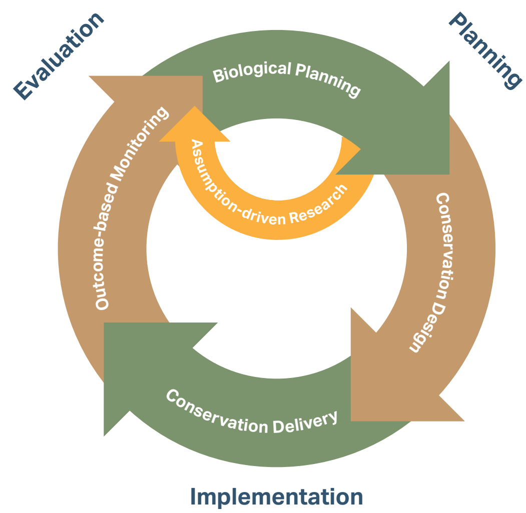


**FIGURE 2.1** The elements of Strategic Habitat Conservation.

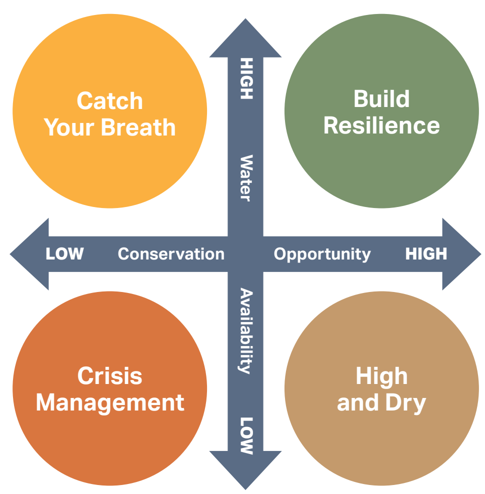


**FIGURE 2.2** Conservation opportunity and water availability interact to drive scenario planning.

### Joint Venture Planning at the National Level

At a national level, the Migratory Bird Joint Venture Program defines technical expectations for Joint Ventures in the broad categories of biological planning; conservation design; habitat delivery; monitoring; research; and communication, education and outreach. As one of the original Joint Ventures, the CVJV continues to be successful in meeting many of these expectations as they relate to the ability to deliver waterfowl conservation, and, to a slightly lesser degree, shorebird conservation. The CVJV is also making progress in the area of landbird conservation, including riparian birds and, more recently, grassland and oak savannah birds. However, there is considerable work to be done to enhance the CVJV's ability to coordinate, implement, and evaluate the progress of bird habitat conservation. This updated Implementation Plan addresses these deficiencies.

## DELIVERY OF CONSERVATION ACTIONS

The CVJV's efforts to protect, restore, and enhance migratory bird habitats, first guided by the 1990 Central Valley Habitat Joint Venture Implementation Plan (CVHJV 1990) and later by the 2006 CVJV Implementation Plan, significantly increased migratory bird habitat in the Central Valley, benefitting a variety of birds and other wildlife. People also continue to benefit through improved water quality, more effective flood control, and increased recreational opportunities. Using a collaborative, voluntary approach and guided by this updated Plan, CVJV partners will work to ensure that the benefits of habitat conservation continue to expand for both wildlife and people.

The CVJV gauges conservation success by gains in habitat quality and quantity, accomplished through habitat protection, restoration, and enhancement projects aligned to achieve bird conservation objectives. Strong partnerships within the CVJV have generated considerable conservation successes by utilizing federal, state, and non-governmental conservation programs and funding.

Since the 2006 plan, the CVJV and its partners have delivered numerous bird habitat conservation achievements (see "Bird Habitat Conservation Successes" sidebar). These are just a few of the programs in the CVJV "toolbox" that have proven successful in achieving CVJV habitat objectives over the last decade. By broadening bird habitat conservation goals with this 2020 Plan, CVJV partners will make additional contributions toward the long-term goal of ensuring vital populations of birds into the future.

### BIRD HABITAT CONSERVATION SUCCESSES

**Since the 2006 Implementation Plan…**

- **Through the North American Wetlands Conservation Act grant program, from 2006 to 2018, CVJV partners leveraged almost $50 million in grant funding with more than two and a half times this amount in other funding. This effort has resulted in protection of more than 26,000 acres of habitat, restoration of more than 42,000 acres, and enhancement of 250,000 acres.**
- **Working with private landowners, the USFWS Partners for Fish and Wildlife Program has provided $4.8 million dollars in federal funds and leveraged an additional $19 million in matching funds to restore and/or enhance 24,300 acres of wetlands, 7,000 acres of associated uplands, and 104 miles of stream/shoreline within the Central Valley.**
- **The Inland Wetlands Conservation Program of the California Wildlife Conservation Board was created in 1990 specifically to assist the CVJV in its mission. Using a wide range of options to accomplish wetland conservation, the program restored and enhanced more than 65,000 acres of wetland habitat in the Central Valley between 2006 and 2018.**
- **The USDA Natural Resources Conservation Service (NRCS) has protected and restored 32,825 acres of wetlands and associated uplands in California's Central Valley under the Wetland Reserve Program and has enrolled 20 percent of rice-growing acres in habitat-enhancing practices under the Waterbird Habitat Enhancement Program.**

## EVALUATING CONSERVATION SUCCESS

CVJV partners continue to make considerable investments in the priorities outlined in the CVJV Monitoring and Evaluation Plan (CVJV 2010), which refined the ecological and biological assumptions used for this Plan.

These investments are critical to strengthen the science-based foundations of CVJV planning. For example, our understanding of the abundance and distribution of wetlands in the Central Valley improved since 1990 as the accuracy and precision of remote sensing tools improved. The 1990 Plan estimated that there were roughly 300,000 acres of managed wetlands remaining at that time, but later satellite imagery showed that the number was closer to 150,000 acres. Thus, the CVJV modified habitat objectives in the 2006 Plan. Due to improved technology and to conservation successes, the CVJV estimate was further refined for this Plan to show that there are now more than 220,000 acres of managed wetlands in the Central Valley.

Examples of how CVJV investments in research have paid off since publication of the 2006 Plan include:

- CVJV partners can now quantify in "near-real time" the amount of open surface water on the landscape, and that information is publicly available to land managers and decision-makers.
- A non-breeding shorebird survey is up and running to assess changes in numbers and distribution. Already scientists are using this survey's dataset to assess shorebird response to the most recent drought. Results from this study will also allow scientists to assess long-term trends in shorebird populations and habitat use.
- A riparian landbird survey on the Sacramento and San Joaquin Rivers and in the Delta provides baseline data that can assess long-term changes in populations. This survey helped inform the development of the latest riparian bird population objectives.
- All known waterbird colonies are catalogued. This baseline dataset will soon be archived online and available to the scientific community to assess changes in the future distribution of colonies, as well as for local or regional planning purposes such as the state's high-speed rail project.
- Data from nearly 30,000 dabbling duck nest records in California were archived into a computer database for secure long-term storage and retrieval. This archive of historical nesting information allows scientists to study long-term trends in habitat use and reproductive success, and it provides guidance to improve programs for locally nesting ducks.
- Comparative studies demonstrate a clear link between improved winter habitat conditions and increased waterfowl body condition and survival in the Central Valley. Results from these long-term studies support the original CVJV premise that restoring and enhancing habitat (including flooded agriculture) is an essential activity for restoring waterfowl populations.
- CVJV organizations are leading studies that identify where and when instream flows or reservoir releases can benefit both fish and birds.

The development and release of the Monitoring and Evaluation Plan followed the release of the 2006 Implementation Plan. In the spirit of innovation and adaptive management, the CVJV has now elected to develop a more comprehensive science and monitoring needs assessment. During the assessment, which will begin in 2020, the CVJV will develop methods to evaluate progress toward the biological objectives and to test whether the conservation strategies and actions yield the intended ecological and social outcomes. The iterative process of testing biological assumptions to improve conservation planning and delivery is germane to the Strategic Habitat Conservation process, and it bridges the gap between managers and researchers.

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# 3 CONSERVATION DELIVERY


2

## INTRODUCTION

**The Central Valley Joint Venture 2020 Implementation Plan ("the Plan") establishes integrated conservation objectives for major groups of birds: non-breeding waterfowl, breeding waterfowl, non-breeding shorebirds, breeding shorebirds, breeding and non-breeding waterbirds, breeding riparian landbirds and breeding grassland-oak savannah landbirds. The Plan also presents a framework for setting conservation objectives for all Central Valley bird species that are at particularly high risk of population decline (at-risk bird species).**

The Central Valley's nine drainage basins served as planning regions in the 1990 and 2006 Implementation Plans. This 2020 Plan combines some of these basins for a total of five planning regions, which together comprise the Plan's Primary Focus Area. The American, Butte, Colusa and Sutter Basins now comprise the Sacramento planning region, while the Yolo and Delta Basins comprise the Yolo-Delta planning region. The Suisun Marsh, San Joaquin and Tulare Basins are maintained as separate planning regions (Figure 3.1). This Plan also includes a Secondary Focus Area that encompasses the foothills surrounding the Valley floor and generally extends to the crests of surrounding watersheds.

The first part of this chapter presents the Central Valley Joint Venture (CVJV) integrated 10-year habitat objectives across bird groups, for the Central Valley as a whole and for each planning region. The second part of the chapter summarizes the habitat objectives for each bird group. The chapter concludes with the results of a scenario planning exercise and examines how scenario planning will be used to maximize the CVJV's progress toward meeting its objectives under different future scenarios.

*(1) Snow geese - Jeff McCreary (2) Recently-fledged yellow warbler in riparian habitat - Tom Grey*

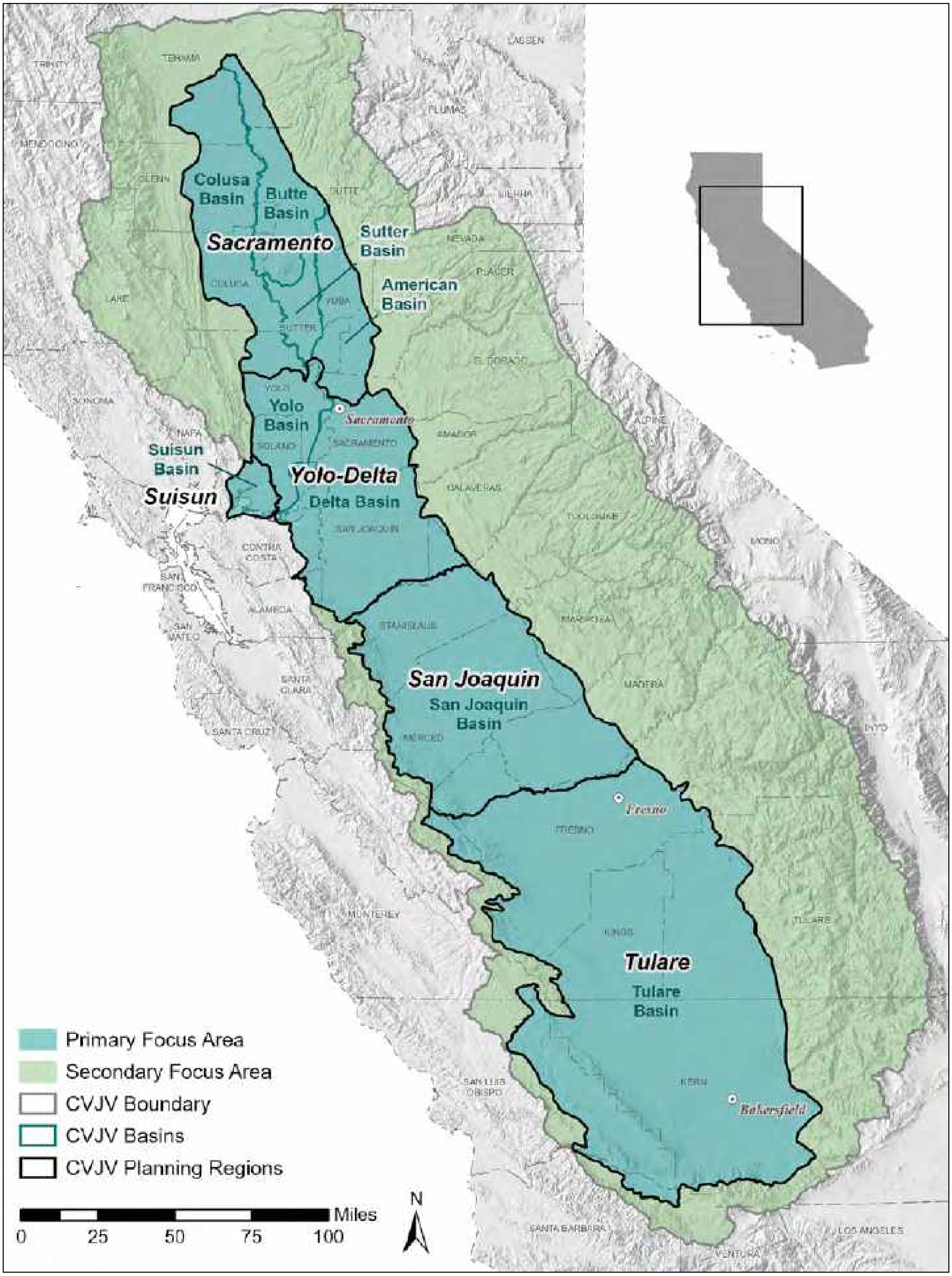


**FIGURE 3.1** CVJV planning regions, basins, Primary and Secondary Focus Areas, and counties.

## INTEGRATED BIRD HABITAT OBJECTIVES

Habitat objectives for each bird group were developed independently as part of the Plan revision process, yet the habitat needs of different bird groups frequently overlap. Meeting habitat objectives for one bird group may partially or wholly meet the needs of other bird groups. Identifying these areas of overlap increases the efficiency of all bird habitat conservation, and it points to the benefits of an integrated set of habitat objectives. The CVJV identified four conservation approaches that were associated with two or more bird groups and thus, were integrated when establishing habitat objectives: restoration of managed semi-permanent wetlands, restoration of managed seasonal wetlands, restoration of riparian habitat, and maintenance of existing winter-flooded rice and grain corn. Habitat objectives associated with wetland enhancement and with agricultural easements in the grassland and oak savannah habitats were not subject to the process of integration, as they were only associated with a single bird group. Nevertheless, these latter objectives are included when summarizing the integrated habitat objectives for each planning unit and for the Central Valley as a whole.

One complicating factor that the CVJV is trying to reconcile is the importance of grassland or other upland habitat, such as beneficial agriculture, associated with managed semi-permanent wetlands. Many waterfowl build nests in upland habitat. Therefore, semi-permanent wetlands without associated uplands will likely not contribute to achieving breeding waterfowl objectives and may possibly complicate recovery of breeding duck numbers. The relationship of life cycle requirements and different habitats can be complex for some species. This complication demonstrates not only the importance of key habitat types, but also the importance of proximity of different habitat types to each other for life stages such as nesting (upland) and brood-rearing (wetland).

The CVJV used the following process to integrate bird needs for each of the four conservation approaches. First, all bird groups associated with a given habitat objective were identified. For example, objectives for managed semi-permanent wetlands were established for breeding waterfowl, breeding shorebirds, non-breeding shorebirds and breeding waterbirds. Second, the bird group with the largest acre objective served as the integrated objective. For example, the objective for semi-permanent wetlands in the Sacramento planning region ranges from a high of 9,420 acres for breeding waterfowl, to just 228 acres for breeding waterbirds (see Tables 3.9 and 3.12). Thus, the managed semi-permanent wetland objective associated with breeding waterfowl was adopted as the integrated objective for this planning region, since meeting this objective would presumably satisfy the need of all bird groups. Integrated habitat objectives for the Central Valley as a whole and for each planning region are presented in Tables 3.1 through 3.6.

**CENTRAL VALLEY-WIDE HABITAT OBJECTIVES BY HABITAT TYPE**

| HABITAT | OBJECTIVE (ACRES) |
|---|---|
| Managed Semi-Permanent Wetlands | 34,368 |
| Managed Seasonal Wetlands | 20,004 |
| Riparian Habitat | 33,332 |
| Winter-Flooded Rice[a] | 340,670 |
| Grassland[b] | 10,337 |
| Oak Savannah | 8,483 |
| Wetland Enhancement[c] | 17,963 |
| Agricultural Easements | 54,000 |

*[a] Annual objective reflects the CVJV's desire to maintain the existing amount of winter-flooded rice (see Non-Breeding Waterfowl chapter).*
*[b] Acre objective is for the Secondary Focus Area. Objective for Primary Focus Area is to maintain existing grassland habitat (see Breeding Grassland-Oak Savannah Landbirds chapter).*
*[c] Annual wetland enhancement objective when wetland restoration objectives are met. This objective assumes that the infrastructure of managed seasonal wetlands requires some form of maintenance, on average, every 12 years.*

**TABLE 3.1** Integrated habitat objectives for the Central Valley as a whole.

| HABITAT OBJECTIVE | ACRES |
|---|---|
| Managed Semi-Permanent Wetlands | 9,420 |
| Managed Seasonal Wetlands | 6,875 |
| Riparian Habitat | 8,377 |
| Winter-Flooded Rice[a] | 324,847 |
| Wetland Enhancement[b] | 6,256 |
| Agricultural Easements (Rice) | 54,000 |

*[a] Annual objective reflects the CVJV's desire to maintain the existing amount of winter-flooded rice (see Non-Breeding Waterfowl chapter).*
*[b] Annual wetland enhancement objective when wetland restoration objectives are met. This objective assumes that the infrastructure of managed seasonal wetlands requires some form of maintenance, on average, every 12 years.*

**TABLE 3.2** Integrated habitat objectives for the Sacramento planning region.

| HABITAT OBJECTIVE | ACRES |
|---|---|
| **Managed Semi-Permanent Wetlands** | 7,160 |
| **Managed Seasonal Wetlands** | 4,500 |
| **Riparian Habitat** | 5,906 |
| **Winter-Flooded Rice**[a] | 15,823 |
| **Wetland Enhancement**[b] | 2,196 |

*[a] Annual objective reflects the CVJV's desire to maintain the existing amount of winter-flooded rice (see Non-Breeding Waterfowl chapter).*
*[b] Annual wetland enhancement objective when wetland restoration objectives are met. This objective assumes that the infrastructure of managed seasonal wetlands requires some form of maintenance, on average, every 12 years.*

**TABLE 3.3 Integrated habitat objectives for the Yolo-Delta planning region.**

| HABITAT OBJECTIVE | ACRES |
|---|---|
| **Managed Semi-Permanent Wetlands** | 9,378 |
| **Managed Seasonal Wetlands** | 5,837 |
| **Riparian Habitat** | 8,368 |
| **Wetland Enhancement**[a] | 5,330 |

*[a] Annual wetland enhancement objective when wetland restoration objectives are met. This objective assumes that the infrastructure of managed seasonal wetlands requires some form of maintenance, on average, every 12 years.*

**TABLE 3.5 Integrated habitat objectives for the San Joaquin planning region.**

| HABITAT OBJECTIVE | ACRES |
|---|---|
| **Managed Semi-Permanent Wetlands** | 1,355 |
| **Riparian Habitat** | 1,408 |
| **Wetland Enhancement**[a] | 2,386 |

*[a] Annual wetland enhancement objective when wetland restoration objectives are met. This objective assumes that the infrastructure of managed seasonal wetlands requires some form of maintenance, on average, every 12 years.*

**TABLE 3.4 Integrated habitat objectives for the Suisun planning region.**

| HABITAT OBJECTIVE | ACRES |
|---|---|
| **Managed Semi-Permanent Wetlands** | 7,055 |
| **Managed Seasonal Wetlands** | 2,792 |
| **Riparian Habitat** | 9,273 |
| **Wetland Enhancement**[a] | 1,795 |

*[a] Annual wetland enhancement objective when wetland restoration objectives are met. This objective assumes that the infrastructure of managed seasonal wetlands requires some form of maintenance, on average, every 12 years.*

**TABLE 3.6 Integrated habitat objectives for the Tulare planning**

*Protected waterfowl habitat in Suisun Marsh – Robert Eddings*

# HABITAT OBJECTIVES BY BIRD GROUP

The integrated habitat objectives were derived from habitat objectives established for each bird group. These habitat objectives were established by planning region (Table 3.7) with the exception of non-breeding shorebirds and breeding grassland-oak savannah landbirds, for which objectives are established for the Central Valley as a whole. The Plan establishes long-term objectives for a 100-year period for all non-waterfowl bird groups, representing the ultimate conditions necessary to sustain bird populations. Short-term objectives that correspond to the 10-year life of the Plan are also established. These short-term objectives correspond to 10 percent of the 100-year objective. Unless otherwise stated, objectives associated with each habitat type reflect a desired increase in the amount of this habitat.

<table>
<tr><th>FOCUS AREA</th><th>PLANNING REGION</th><th>BASIN</th><th>NON-BREEDING WATER-FOWL</th><th>BREEDING WATER-FOWL</th><th>NON-BREEDING SHORE-BIRDS</th><th>BREEDING SHORE-BIRDS</th><th>NON-BREEDING WATER-BIRDS</th><th>BREEDING WATER-BIRDS</th><th>RIPARIAN LAND-BIRDS</th><th>AT-RISK SPECIES</th><th>GRASSLAND-OAK SAVANNAH LANDBIRDS</th></tr>
<tr><td rowspan="9">Primary Focus Area</td><td rowspan="4">Sacramento</td><td>American</td><td rowspan="4">•</td><td rowspan="4">•</td><td rowspan="6">•</td><td rowspan="4">•</td><td rowspan="4">•</td><td rowspan="4">•</td><td rowspan="4">•</td><td rowspan="4">•</td><td rowspan="9">•</td></tr>
<tr><td>Butte</td></tr>
<tr><td>Colusa</td></tr>
<tr><td>Sutter</td></tr>
<tr><td rowspan="2">Yolo-Delta</td><td>Yolo</td><td rowspan="2">•</td><td rowspan="2">•</td><td rowspan="2">•</td><td rowspan="2">•</td><td rowspan="2">•</td><td rowspan="2">•</td><td rowspan="2">•</td></tr>
<tr><td>Delta</td></tr>
<tr><td>Suisun</td><td>Suisun</td><td>•</td><td>•</td><td>N/O</td><td>N/O</td><td>•</td><td>•</td><td>N/O</td><td>•</td></tr>
<tr><td>San Joaquin</td><td>San Joaquin</td><td>•</td><td>•</td><td rowspan="2">•</td><td>•</td><td>•</td><td>•</td><td>•</td><td>•</td></tr>
<tr><td>Tulare</td><td>Tulare</td><td>•</td><td>•</td><td>•</td><td>•</td><td>•</td><td>•</td><td>•</td></tr>
<tr><td>Secondary Focus Area</td><td></td><td></td><td>N/O</td><td>N/O</td><td>N/O</td><td>N/O</td><td>N/O</td><td>N/O</td><td>N/O</td><td>N/O</td><td>•</td></tr>
</table>

*N/O: No objectives*

**TABLE 3.7** Scale at which habitat objectives are established for each bird

## Non-Breeding Waterfowl

The non-breeding waterfowl bird group includes migrating and wintering ducks and geese that rely on Central Valley habitats between August and March. The habitat objectives for this bird group reflect the landscape conditions necessary to support duck populations at North American Waterfowl Management Plan (NAWMP) goals. The habitat objectives listed for non-breeding waterfowl in this summary chapter correspond to 25 percent of the wetland objectives established in the Non-Breeding Waterfowl chapter. Twenty-five percent was deemed a reasonable number to be achieved over the 10-year life of the Plan.

Restoration objectives for seasonal wetlands over the life of the 2020 Plan total 17,292 acres and vary widely among planning regions (Table 3.8). In addition to restoration, which creates new acres of wetlands, enhancement of existing wetlands is also needed. Proper water management is critical to producing large amounts of food in seasonal wetlands. Water control structures, such as the levees and ditch networks that are used to manage water levels, must be periodically repaired or enhanced to maintain or improve food production. The CVJV assumes that managed seasonal wetlands need some form of intense habitat and infrastructure enhancement, on average, every twelve years to maintain the level of productivity assumed in the CVJV model. As a result, wetland enhancement objectives are expressed perpetually as one-twelfth of the total wetland acres. Note that, as more acres of wetland are restored, that creates more acres requiring periodic enhancement. Annual (perpetual) wetland enhancement objectives for the Central Valley total 17,738 acres once the 10-year wetland restoration objectives have been met.

The agricultural enhancement objective for non-breeding waterfowl is divided into two sub-objectives: the amount of winter-flooded rice and grain corn that is available annually, and the permanent protection of agricultural habitats. The CVJV's objective is to maintain the 340,670 acres of winter-flooded rice and 34,408 acres of non-deep plowed grain corn that is now available to waterfowl, and in addition, to permanently protect 54,000 acres of riceland through conservation easements. These riceland easements reflect a desire to permanently protect 10 percent of the planted rice base over the life of the 2020 Plan.

| CONSERVATION APPROACH | | | | |
|---|---|---|---|---|
| PLANNING REGION | MANAGED SEASONAL WETLAND RESTORATION | MANAGED SEASONAL WETLAND ENHANCEMENT | AGRICULTURAL HABITAT [a] | AGRICULTURAL HABITAT PROTECTION |
| **Sacramento** | 6,875 | 6,256 | 324,847 WFR<br>7,406 GC | 54,000<br>(Rice) |
| **Yolo-Delta** | 4,500 | 2,196 | 15,823 WFR<br>27,002 GC | 0 |
| **Suisun** | NA | 2,386 | NA | NA |
| **San Joaquin** | 3,125 | 5,105 | NA | NA |
| **Tulare** | 2,792 | 1,795 | NA | NA |
| **Central Valley Total** | **17,292** | **17,738** | **340,670 WFR<br>34,408 GC** | **54,000<br>(Rice)** |

*[a] Annual objectives that reflect the CVJV's desire to maintain the amount of winter-flooded rice and harvested grain corn currently available to non-breeding waterfowl.*
*WFR: Winter-Flooded Rice*
*GC: Grain Corn*
*NA: Not Applicable*

**TABLE 3.8** CVJV Primary Focus Area habitat objectives (acres) for non-breeding waterfowl over the intended life of this Plan.

## Breeding Waterfowl

Habitat objectives for breeding waterfowl are focused primarily on increasing the acreage of managed semi-permanent wetlands (Table 3.3). The objective is to increase the acres of managed semi-permanent wetlands by an amount that is equal to 20 percent of all existing managed wetlands in the Central Valley (that is, 20 percent of the combined total of existing managed seasonal and semi-permanent wetlands). It should be noted that the Breeding Waterfowl chapter of this Plan also includes objectives for associated uplands (for nesting), but these upland acres are not shown in Table 3.9.

| PLANNING REGION | |
|---|---|
| | MANAGED SEMI-PERMANENT WETLANDS |
| **Sacramento** | 9,420 |
| **Yolo-Delta** | 1,183 |
| **Suisun** | 1,355 |
| **San Joaquin** | 9,378 |
| **Tulare** | 0 |
| **Total** | **21,336** |

**TABLE 3.9** Managed semi-permanent wetland objectives (acres) for breeding waterfowl in each planning region and for the Central Valley as a whole.

## Non-Breeding Shorebirds

The non-breeding shorebirds group includes migrating and wintering birds that reside in the Central Valley between July and May. Habitat objectives for non-breeding shorebirds are specific to managed wetlands, regardless of whether these wetlands are managed as seasonal or semi-permanent habitats (that is, both habitat types can meet the needs of this bird group). These objectives have been further defined as managed wetlands that provide areas of open water four inches or less in depth. Part of the challenge of meeting the habitat needs of non-breeding shorebirds is that large numbers of birds are present during periods of time when, due to traditional land management practices, few wetlands or other habitat types are available. For example, peak populations of non-breeding shorebirds in the Central Valley occur in late April, when most seasonally managed wetlands are dry. Habitat objectives for this bird group reflect the time periods when habitats are in short supply (Table 3.10).

| NON-BREEDING SHOREBIRDS | | |
|---|---|---|
| | MID-MARCH THROUGH APRIL | LATE JULY THROUGH SEPTEMBER |
| **CVJV Primary Focus Area** | 11,594 | 5,337 |

**TABLE 3.10** Managed seasonal and semi-permanent wetland objectives (acres) for non-breeding shorebirds.

## Breeding Shorebirds

Habitat objectives for breeding shorebirds are focused exclusively on increasing the amount of managed semi-permanent wetlands (Table 3.11). Other types of wetlands could contribute to breeding shorebird habitat objectives, such as reverse-cycle wetlands that are flooded in spring and summer and managed with relatively shallow water.

| PLANNING REGION | BREEDING SHOREBIRDS |
|---|---|
| | Managed Semi-Permanent Wetlands |
| **Sacramento** | 7,023 |
| **Yolo-Delta** | 7,159 |
| **Suisun** | 0 |
| **San Joaquin** | 7,272 |
| **Tulare** | 7,055 |
| **Total** | **28,508** |

**TABLE 3.11** Managed semi-permanent wetland objectives (acres) for breeding shorebirds in each planning region and for the Central Valley as a whole.

## Breeding Waterbirds

Waterbirds in the Central Valley are represented in the Plan by a suite of 10 focal species that reflect the diversity of waterbird species that use the region for nesting, foraging and roosting. Habitat objectives for breeding waterbirds are presented in Table 3.12.

| PLANNING REGION | BREEDING WATERBIRDS | |
|---|---|---|
| | Managed Semi-Permanent Wetlands | Riparian Habitat |
| **Sacramento** | 228 | 213 |
| **Yolo-Delta** | 228 | 213 |
| **Suisun** | 228 | 141 |
| **San Joaquin** | 796 | 425 |
| **Tulare** | 796 | 425 |
| **Total** | **2,276** | **1,417** |

**TABLE 3.12** Habitat objectives (acres) for breeding waterbirds in each planning region and for the Central Valley as a whole.

## Non-Breeding Waterbirds

Habitat objectives for non-breeding waterbirds are presented in Table 3.13.

**NON-BREEDING WATERBIRDS**

| | Managed Seasonal Wetlands | Winter-Flooded Rice | Postharvest-Flooded Corn |
|---|---|---|---|
| **Sacramento** | 6,849 | 391,395 | 0 |
| **Yolo-Delta** | 2,195 | 20,690 | 5,280 |
| **Suisun** | 2,876 | NA | NA |
| **San Joaquin** | 5,837 | NA | NA |
| **Tulare** | 1,884 | NA | NA |
| **Total** | **19,641** | **412,085** | **5,280** |

*NA: Not Applicable*

**TABLE 3.13** Habitat objectives (acres) for non-breeding waterbirds in each planning region and for the Central Valley as a whole.

## Breeding Riparian Landbirds

Riparian landbirds are represented in the Plan by 12 focal species that reflect the suite of species and habitat types used by the full complement of riparian landbirds found in the Central Valley. Habitat objectives for breeding riparian landbirds are focused exclusively on increasing the amount of riparian habitat (Table 3.14).

| PLANNING REGION | RIPARIAN HABITAT |
|---|---|
| **Sacramento** | 8,377 |
| **Yolo-Delta** | 5,906 |
| **San Joaquin** | 8,368 |
| **Tulare** | 9,273 |
| **Total** | **31,924** |

**TABLE 3.14** Riparian habitat objectives (acres) for breeding riparian landbirds in each planning region and for the Central Valley as a whole.

*Riparian habitat restoration – Massimilano Sonego, Point Blue Conservation Science*

## Breeding Grassland-Oak Savannah Landbirds

The habitat objectives for breeding grassland-oak savannah landbirds focus on 12 bird species that breed in grassland and oak savannah ecosystems and that represent a broad range of life histories and a continuum of specific habitat needs. Habitat objectives for breeding grassland-oak savannah landbirds are presented in Table 3.15. These objectives can be met anywhere in the Central Valley (except the Suisun Marsh, which does not naturally contain these habitats).

| FOCUS AREA | GRASSLAND (<10% canopy) | OAK SAVANNAH (10-40% canopy) |
|---|---|---|
| **Primary Focus Area** | 0[a] | 8,483 |
| **Secondary Focus Area** | 10,337 | 0[b] |
| **Total** | **10,337** | **8,483** |

*[a] The long-term habitat objective for grasslands in the Primary Focus Area is to maintain the current extent, with no net loss (see Breeding Grassland-Oak Savannah Landbird chapter).*
*[b] The long-term habitat objective for oak savannah in the Secondary Focus Area is to maintain the current extent, with no net loss.*

**TABLE 3.15 Habitat objectives (acres) for breeding grassland-oak savannah landbirds in each focus area and for the Central Valley as a whole.**

*Waterfowl hunters - California Waterfowl Association*

*Grassland habitat near the South Fork American River - photo by American Rivers*

## SCENARIO PLANNING

The habitat objectives presented in this chapter reflect the best available science. Yet, this science does not fully inform the broad strategic choices the CVJV will face in pursuit of these habitat objectives. The 16 years that elapsed between the 1990 and 2006 plans were highly favorable for bird habitat conservation in the Central Valley. Many landowners took advantage of new public programs that funded wetland restoration on private lands and more than 65,000 acres of additional managed wetlands were protected during this period. During the same time period, winter flooding of harvested rice fields increased from an estimated 60,000-80,000 acres in the 1980s to more than 350,000 acres by 2006 (CVJV 2006). The 2006 CVJV Implementation Plan assumed that the conservation opportunities that had characterized the 1990s and early 2000s would continue. However, rising commodity prices and increasing land values have reduced wetland restoration opportunities on private lands since 2006. The recent California drought severely limited surface water supplies for managed wetlands and winter-flooded rice and revealed the vulnerability of these habitats to future water shortages (Petrie et al. 2016). This combination of declining wetland restoration opportunities and less water made it more difficult to achieve net gains in bird habitat acreage in recent years.

This 2020 Plan identifies the landscape characteristics (habitat of sufficient quality, quantity and distribution) needed to support bird populations at desired levels, and it establishes integrated habitat objectives aimed at creating these desired landscape conditions. While this approach provides a vision of what the Central Valley would look like from a bird and conservation perspective, future progress toward this desired landscape may be uncertain given the lessons of the past decade. Opportunities for conservation will likely change over the life of this Plan, so planning efforts must anticipate this uncertainty. The challenge is to identify what factors influence conservation opportunities in the Central Valley, recognize when these factors change for better or worse, and adjust or prioritize actions accordingly.

Scenario planning is an excellent tool for acknowledging uncertainty rather than trying to reduce or eliminate it. It can help resource managers generate creative approaches, thinking outside the historical and most obvious trends to incorporate uncertainty as a factor in prioritizing management actions. Scenario planning can help managers identify the most uncertain and most worrisome drivers of change, then enable them to plan around these drivers by putting them into a context of more known (or knowable) drivers (Moore et al. 2013).

CVJV partners participated in scenario planning workshops as part of the development of this Plan. The overarching goal of the workshops was to identify the conservation actions that allow the CVJV to maximize progress toward its integrated bird habitat objectives, regardless of the challenges that are likely to arise over the life of the Plan. Participants identified conservation opportunities and water availability as the two factors most likely to determine the CVJV's progress toward its integrated bird habitat objectives.

Conservation opportunities in the Central Valley are generally a function of three factors: public support of and funding for conservation, the cost of protecting land and implementing conservation actions, and the number of waterfowl hunters. Workshop participants assumed that the cost of protecting land is largely dependent on commodity prices and patterns of urban development, while public support for conservation can be indexed by the public financial resources available for habitat restoration and enhancement. The number of waterfowl hunters is an important component of conservation opportunity because land owned by private duck clubs accounts for two thirds of all managed wetlands in the Central Valley. Without this constituency, the opportunity to increase the quality of managed wetlands or add to the base of existing managed wetlands would be greatly reduced.

Water availability is driven by the annual variation in the water supply available for wetland-dependent bird habitat. Water supply is largely a function of annual precipitation, Sierra Nevada snowpack, existing reservoir storage and the needs of endangered fish species, agricultural producers and urban water users.

After identifying these two key drivers, workshop participants defined four possible scenarios that represent different combinations of conservation opportunity and water availability (Figure 3.2). Each of these scenarios occupy a quadrant on the figure. They are named and described in detail below.


**FIGURE 2.** Four scenarios representing combinations of conservation opportunity and water availability.

*Flooded wetlands - USFWS*

# IDENTIFYING PRIORITY CONSERVATION ACTIONS FOR EACH SCENARIO

The last task of the scenario planning process was to identify conservation strategies and actions the CVJV can consider under each potential future scenario. Through stakeholder interviews, workshops and facilitated CVJV Management Board discussions, the CVJV identified a suite of high-priority conservation strategies that it will pursue to achieve the Plan's habitat objectives (Table 3.16). The CVJV identified four categories – water management, land management and conservation, funding and budgets, and the human dimension of conservation – and identified key strategies within each category that could be applied, depending on which scenario is in effect. The CVJV also created an extensive list of conservation actions. Through an annual work planning process, the Management Board will determine which scenario the Valley or specific planning regions are in, then working groups will develop a specific set of prioritized conservation actions for partners to undertake.

Below each scenario are simple examples of means to implement the strategies under each scenario. The strategies and actions fall into one of two broad categories: maximizing progress in meeting the CVJV's habitat objectives when the opportunity to do so exists and minimizing the impact on bird populations when the conservation opportunities and general condition of Central Valley habitats are unfavorable. These are broad, high-level actions that help demonstrate how scenario planning could be used by the CVJV; they are far from complete. More specific actions that are tailored to each scenario will need to be developed, including actions that implementers would have no regrets taking in any scenario.

## Scenario A: "Building Resilience"

### High Conservation Opportunity & High Water Availability

Under this scenario, surface water supplies are sufficient to properly manage all the habitat required by wetland-dependent birds in the Central Valley. All Central Valley Project Improvement Act (CVPIA) refuges have full access to Level 4 CVPIA water supplies (see Water subchapter for an explanation of CVPIA water supplies), while publicly- and privately-managed wetlands also have access to sufficient and affordable surface water supplies, including for summer irrigation treatments. Water supplies do not limit the amount of rice that is traditionally planted, and the cost of water makes winter flooding the most economical means of decomposing rice straw.

Because of the large number of willing agricultural land sellers, the opportunity to acquire land for habitat restoration is high. Moreover, there are adequate public and private financial resources available to fully capitalize on these opportunities. Funding is also available to purchase permanent water rights, and to improve water use efficiency though improvements to water conveyance infrastructure. Government agency conservation budgets are robust, and habitat management staff is available to optimally manage most public lands. Similarly, managers of private wetlands (e.g., waterfowl clubs) are highly motivated to improve their properties, and the supportive funding needed for these improvements is generally available.

### Prioritized Strategy

Pursue habitat objectives that relate to restoration and agricultural easements, given the abundance of willing sellers. Enhancing existing bird habitats is a secondary priority in this scenario.

Priority would be placed on purchasing permanent water rights, especially in parts of the Central Valley that are disproportionately affected during periods of drought.

## Scenario B: "High and Dry"

### High Conservation Opportunity & Low Water Availability

Under this scenario, surface water supplies are insufficient to flood and properly manage all the habitat required by wetland-dependent birds in the Central Valley. Water storage reservoirs are well below average levels and competition among water users is severe. The CVPIA refuges, which include publicly-managed wetlands as well as the private wetlands in the Grassland Resource Conservation District (GRCD), have access to water supplies well below Level 2 CVPIA water supplies (50 percent reduction or more in average water supplies). Private wetlands outside the GRCD face similar water shortages. In general, water supplies are insufficient to flood all wetland units and little or no summer irrigation occurs. Limited water supplies reduce the amount of planted rice below traditional levels. The high cost and low availability of surface water greatly reduces the amount of winter flooding of harvested rice fields.

Despite water shortages, there are substantial public and private funds available for land acquisition and habitat restoration. In addition, there is growing interest by landowners in retiring agricultural lands because of drought-related financial hardships. Because public conservation programs are generally well funded, there is interest in improving the water and habitat management infrastructure and subsequent quality of managed wetlands to help offset the effects of water shortages.

### Prioritized Strategy

Focus on habitat objectives that relate to restoration and agricultural easements, given the abundance of willing sellers. Enhancing existing bird habitats should be a secondary priority at this time.

Invest in short-term management actions that would help offset the effects of reduced water supplies for wetland-dependent birds. For example, invest in programs that help increase food production on those public and private wetland habitats that are likely to receive some water during this period of low water availability.

*Levee construction for wetland habitat restoration, Gray Lodge Wildlife Area - Ducks Unlimited, Inc.*

## Scenario C: "Catch Your Breath"

### Low Conservation Opportunity & High Water Availability

Under this scenario, surface water supplies are sufficient to flood and properly manage all the habitat required by wetland-dependent birds in the Central Valley. CVPIA refuges have full access to Level 4 CVPIA water supplies, while privately managed wetlands outside the GRCD have access to affordable surface water supplies, including surface water supplies for summer irrigation treatments. Water supplies do not limit the amount of rice that is traditionally planted, and the low cost of water makes winter flooding the most economical means of decomposing rice straw.

Public and private funds available for conservation are reduced. Moreover, there is little interest by landowners in retiring marginal lands because of strong commodity prices. Government agency budgets are weak, and staff and funding are insufficient to improve public lands. Similarly, there is little funding available to improve the wetland and water management infrastructure, or other enhancement cost-sharing actions to offset the annual costs of producing food for waterfowl on these properties.

### Prioritized Strategy

Focus limited resources on the enhancement of existing bird habitats, since there is little opportunity to add to the existing habitat base during this scenario.

Work to increase the level of funding for public programs that are important to meeting the CVJV's habitat objectives.

## Scenario D: "Crisis Management"

### Low Conservation Opportunity & Low Water Availability

Under this scenario, surface water supplies are insufficient to flood and properly manage much of the habitat required by wetland-dependent birds in the Central Valley. Storage reservoirs are well below average levels and competition among water users is severe. CVPIA refuges have access to water supplies well below Level 2 CVPIA water supplies (greater than a 50 percent reduction in average water supplies), while private wetlands outside the GRCD face similar water shortages. In general, water supplies are insufficient to flood all wetland units and little or no summer irrigation occurs. Water supplies reduce the amount of planted rice below traditional levels, and the high cost and low availability of surface water greatly reduces the amount of winter-flooding of harvested rice fields.

Although there may be increased interest by landowners in retiring agricultural lands because of drought-related hardships, there is little public or private funding available to capitalize on these opportunities. Because government agency conservation budgets are weak, staff and funding are unavailable to make improvements on public lands or manage public lands in ways that might help offset the effects of less water. Similarly, there is little funding available to improve the management infrastructure on duck clubs or to offset the annual costs of producing food for waterfowl on these properties.

### Prioritized Strategy

Work to increase the level of funding for those public programs that are important to meeting the CVJV's habitat objectives.

Invest in short-term management actions to help offset the effects of reduced water supplies for wetland-dependent birds. For example, invest in programs that help increase food production on those public and private wetland habitats that are likely to receive some water during this period of low water availability.

Focus limited resources on the enhancement of existing bird habitats, since there is little opportunity to add to the existing habitat base during these times.

# OPERATIONALIZING SCENARIO PLANNING

Scenario planning can allow CVJV partners to rapidly incorporate new or emerging information, keeping the Plan fresh, relevant and in active use. On a regular basis, the Management Board will assess which scenario the CVJV is in. This assessment will be done for the Central Valley as a whole as well as for individual planning regions if necessary. If the Board finds a shift from one scenario to another has occurred, the Board or working groups will identify and prioritize conservation actions most relevant to the new scenario. These actions are likely to be highly specific, consistent with and expanding upon the broader actions described above.

The prioritized conservation actions will be in alignment with the priority strategies shown in Table 16. The Board will also review existing tools and programs, evaluating their suitability and effectiveness to support the priority actions. If no existing tool or program exists to support an action, the Board will develop a strategy to provide one.

*Continue to the next page for Table 3.16*

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| CATEGORY | KEY STRATEGIES |
|---|---|
| **WATER MANAGEMENT:** Ensure effective management of reliable water supply of sufficient quality and quantity to meet CVJV conservation objectives. | |
| **Water acquisition** | Engage in water policy and management actions to promote annual and long-term acquisition – through purchases, transfers or exchanges – of water rights to supply wetland water supplies. |
| **Infrastructure** | Promote CVJV priorities in the analysis, planning and implementation of infrastructure programs and projects (including natural infrastructure). |
| **CVPIA** | Ensure complete and effective implementation of the environmental provisions of CVPIA, including full delivery of Level 4 water supplies annually. |
| **Groundwater** | Ensure that groundwater management addresses habitat water needs and contributions at the local and statewide levels. |
| **Water Supply Insecurity** | Predict, prepare and plan for the impacts of long-term water supply insecurities on habitat availability. |
| **Planning** | Ensure that local, regional and statewide plans and policies that will potentially affect bird habitat incorporate CVJV water objectives. |
| **LAND MANAGEMENT AND CONSERVATION:** Develop, guide and implement land use planning programs and practices to achieve CVJV habitat objectives. | |
| **Protection** | Identify important unprotected landscapes and work to permanently protect them through land acquisition and conservation easements. |
| **Restoration and Enhancement** | Restore and enhance habitat to meet conservation objectives identified for various bird groups. |
| **Management** | Identify, prioritize and implement actions to improve baseline ecological functions and values on existing habitats. |
| **Integrated Planning and Land Use** | Integrate CVJV conservation objectives and priorities into local, state and federal land and resource plans. |
| **Agricultural Lands** | Develop strategies to maintain sufficient wildlife-friendly agricultural landscapes to meet CVJV conservation objectives. |
| **FUNDING AND BUDGETS:** Ensure sufficient, diverse and effectively purposed funding to achieve CVJV conservation objectives. | |
| **Funding Sources** | Secure sufficient investments of state, federal and private funding, and safeguard existing funding sources, to fully meet CVJV conservation objectives and needs. |
| **Operations and Maintenance** | Regularly assess operation and maintenance needs and gaps on public and private lands; work to establish capacity necessary to meet CVJV conservation objectives. |
| **Financial Sustainability** | Regularly assess the scope and financial sustainability of conservation-related funding programs and policies and how they affect achieving CVJV habitat objectives. |
| **HUMAN DIMENSIONS OF CONSERVATION:** Identify and engage key partners to help achieve CVJV conservation objectives. | |
| **Key Conservation Partners** | Identify key conservation supporters and practitioners who can effectively help the CVJV achieve its conservation objectives. |
| **Actions** | Identify actions that will engage conservation supporters and practitioners to achieve CVJV conservation objectives effectively. |
| **Engagement** | Engage conservation supporters and practitioners in the work of the CVJV in order to further its conservation objectives. |

**TABLE 3.16 Priority strategies identified by the CVJV to advance the migratory bird conservation objectives outlined in this Plan.**

# SECTION II

# SETTING THE STAGE

# 4 ENVIRONMENTAL, SOCIAL AND POLITICAL LANDSCAPE

*San Luis NWR – Anders Ericsson and Light Hawk*

**This chapter gives an overview of the environmental, social and political landscape within which the Central Valley Joint Venture (CVJV) operates, including some of the key issues, concerns, trends and opportunities in these areas.**

## 4.1 BACKGROUND

### CVJV Geographic Area

The CVJV is divided geographically into a primary and a secondary area of focus (Figure 4.1.1). The Primary Focus Area includes the Central Valley floor and the Carrizo Plain and is largely delineated by the Jepson boundary for the Great Central Valley region (Baldwin et al. 2012). It is composed of nine basins and includes Suisun Marsh. The Secondary Focus Area encompasses the foothills that surround the Valley floor and generally extends to the crests of surrounding watersheds. Each area has its own unique conservation challenges.

In its 1990 and 2006 Implementation Plans, the CVJV's Primary Focus Area was the Central Valley floor, based on a 300-foot elevation limit. Because the focus of these plans was waterfowl and wetlands conservation, prioritizing low elevation areas was sufficient. Since the 2006 Plan, the CVJV has expanded its conservation work to include a broader suite of birds. This 2020 Implementation Plan includes a greater emphasis on landbirds than previous Plans, with an expanded chapter on riparian birds and new chapters on grassland-oak savannah birds and at-risk bird species. As such, planning above the 300-foot elevation limit is important for identifying and improving habitats for these groups of birds. As the CVJV started to work on this Plan revision, it became important to better align the CVJV geographic area with natural ecological boundaries.

In 2016, the CVJV adjusted its boundaries with adjacent Joint Ventures and extended portions of the western boundary into areas not previously covered by any Joint Venture. With this boundary adjustment, the CVJV now encompasses a 50,000-square-mile area, almost 32 million acres, in the heart of California. The area is approximately 440 miles long and averages 115 miles wide, extending from the northern boundary of Tehama County south to the Pine Mountain ridge in Ventura County. The western boundary generally follows the Coast Ranges and includes Suisun Marsh. The eastern boundary follows the crest of the Sierra Nevada, mostly along county boundaries, south to the Tehachapi Mountains.

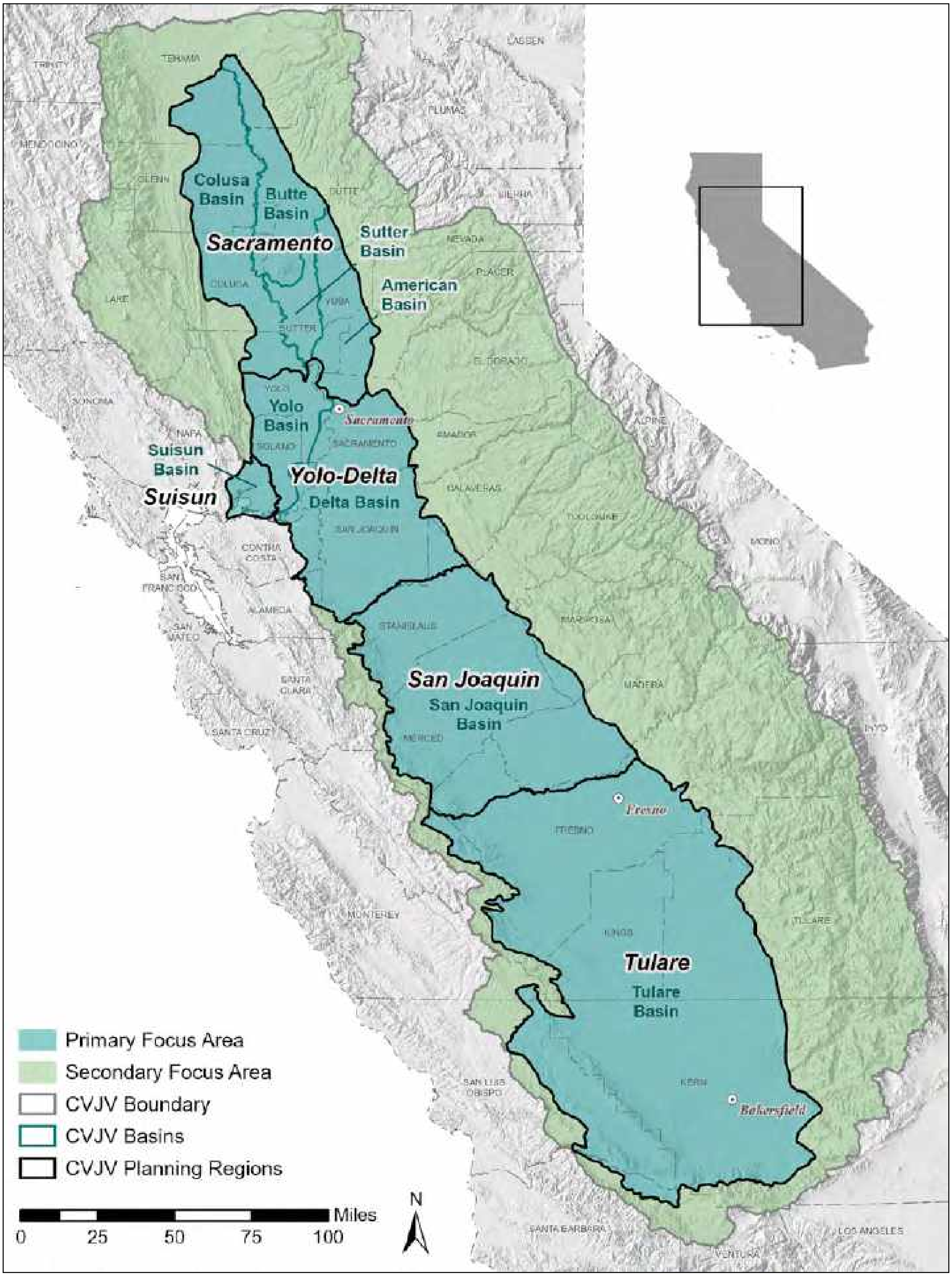


**FIGURE 4.1.1** CVJV planning regions, basins, Primary and Secondary Focus Areas, and counties.

## Planning Regions and Basins

The CVJV prioritizes conservation efforts within nine planning regions and basins in its Primary Focus Area (Figure 4.1.1). Hydrologic, geologic and floristic information determine basin boundaries. Several of the planning regions consist of a single basin, while two incorporate multiple basins. The foothill ring around the Valley floor defines the Secondary Focus Area planning region. Section III further describes the planning regions, in chapters that address CVJV conservation objectives for specific bird groups. Geography and connectivity of the existing or desired habitat, the distribution of a species within the managed area, and management constraints within these areas play important roles in the designations of planning regions.

## Primary Focus Area Overview

The Central Valley of California is the Primary Focus Area of the CVJV. Located in the western portion of the CVJV area, the Valley floor is about 50 miles wide and stretches more than 400 miles down the center of California. The region is bordered mostly by the Coast Ranges in the west and the Sierra Nevada in the east. The area totals approximately 14 million acres, encompasses about 14 percent of the state, and includes portions of 27 counties.

The Central Valley contains California's two largest rivers, the Sacramento in the north and the San Joaquin in the south. These rivers converge in a maze of channels, marshes and islands of the Sacramento-San Joaquin Delta. The waters flow west into Suisun Bay and then San Francisco Bay before reaching the Pacific Ocean. Now predominantly agricultural, the Valley still supports grasslands, marshes, vernal pools, riparian woodlands, alkali sink vegetation, and stands of valley oak. Some desert habitat occurs toward the southern end.

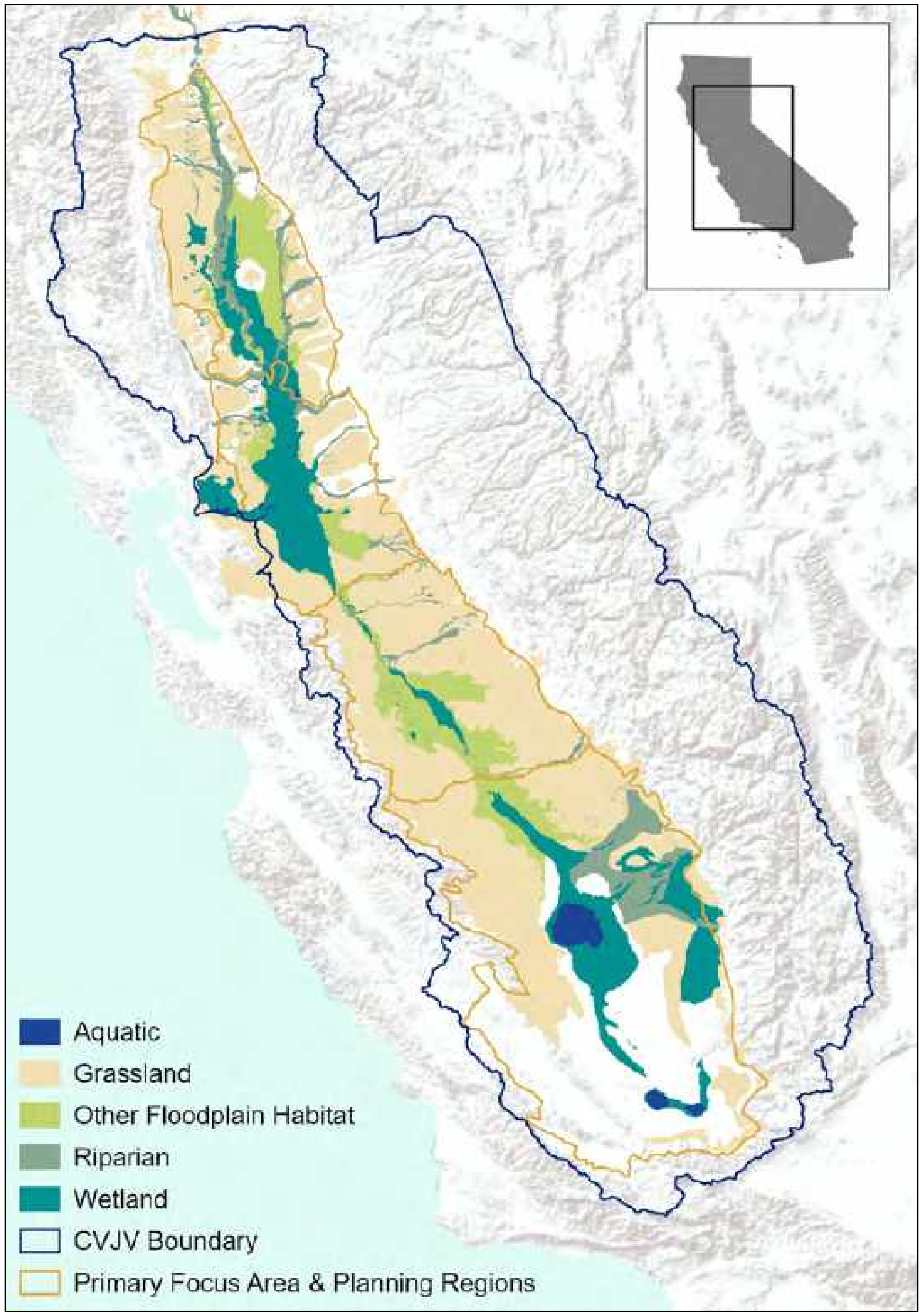


**FIGURE 4.1.2A Central Valley wetlands and other significant bird habitat types, Pre-1900s** (GIC 2003).

The Valley contained an estimated 4 million acres of seasonal and permanent wetland habitats in the 1850s (Dennis et al. 1984) (Figure 4.1.2A). These wetlands greatly expanded in winter, resulting from over-bank flooding of rivers and streams that inundated large expanses of the Valley during the winter and spring. Most of the wetlands were bordered by grassland and wooded habitats. River and stream corridors provided approximately 1.6 million acres of riparian habitats throughout the Valley (Warmer and Hendrix 1985).

Reclamation of wetlands throughout the Valley to agriculture in the 19th and early 20th centuries accounts for the largest loss of wetlands. During this time, the Valley became a rich agricultural region, but at the expense of about 95 percent of the Valley's native wetlands (Dennis et al. 1984) (Figure 4.1.2B). The remnant habitats range from narrow bands of wooded habitats along river and stream corridors to intensively managed wetlands interspersed within intensive agriculture. Today, about 220,000 acres of managed wetlands remain in the Valley; of those, approximately two-thirds are in private ownership. Waterfowl hunting clubs own and manage the majority of Central Valley and Suisun Marsh wetlands as large tracts of waterfowl habitat and for hunting (Frayer et al. 1989).

The Central Valley provides some of the most important bird habitat in North America, hosting one of the largest concentrations of migratory birds in the world during the fall and winter. Acknowledging these bird concentrations, the Western Hemisphere Shorebird Reserve Network designated the Sacramento Valley and the Grasslands Ecological Area (GEA) as internationally important wetland areas. Additionally, the Ramsar Convention designated the GEA as a Ramsar site, a wetland of internal importance. Altogether, surveys have documented approximately 400 species of birds in the Central Valley (CVBC 2010).

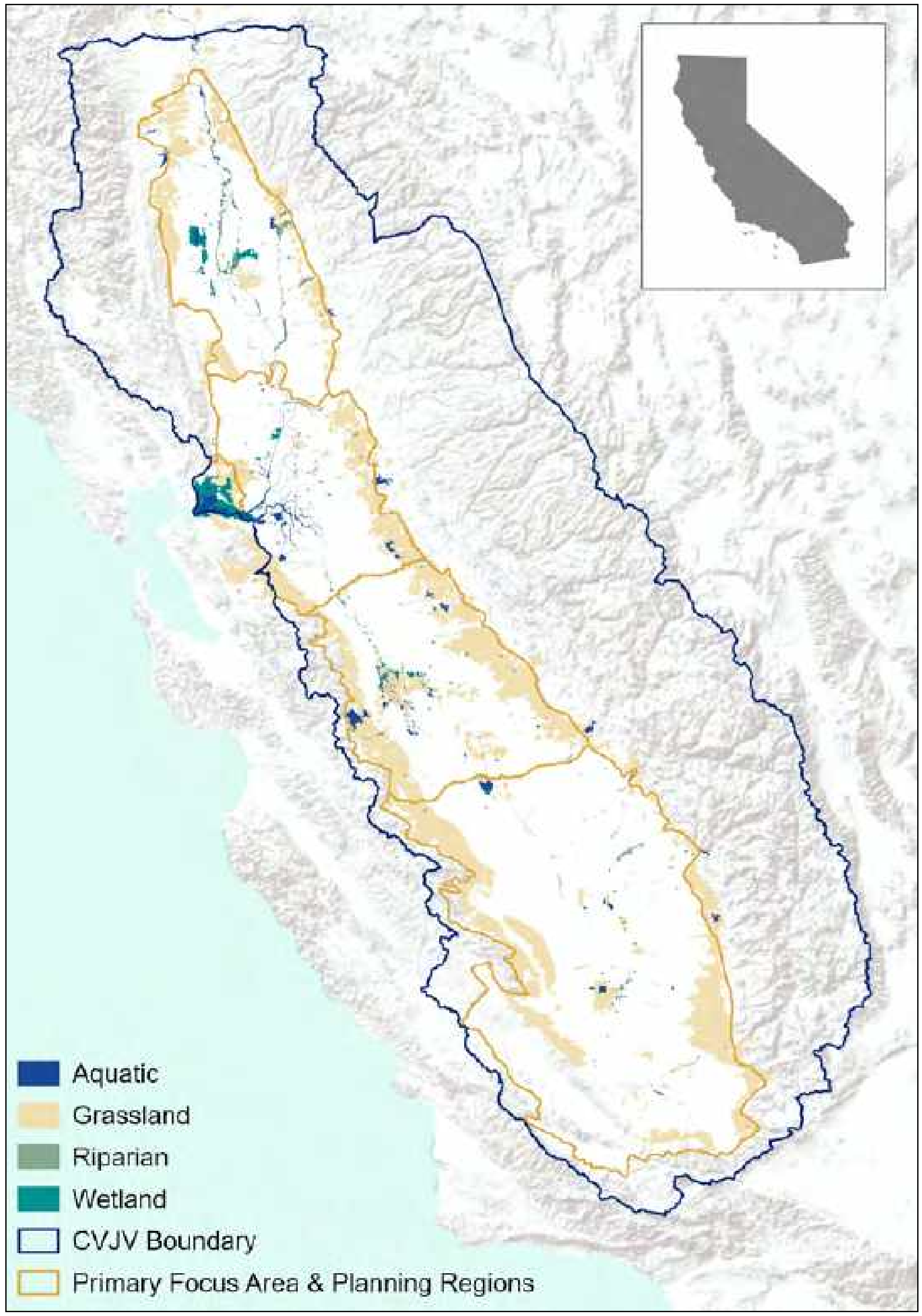


**FIGURE 4.1.2B Central Valley wetlands and other significant bird habitat types, 2000s** (Petrik et al. 2014).

## Primary Focus Area Basin Descriptions

The Sacramento Valley comprises the northern part of the Central Valley and is smaller, wetter, and cooler than the southern part. It contains the Colusa, Butte, Sutter, American, Yolo and Delta Basins. Suisun Basin, which encompasses Suisun Marsh, is located between the saltwater marshes of the San Francisco Bay and the freshwater marshes of the Central Valley. The San Joaquin Valley, located in the southern part of the Central Valley, comprises the larger, drier, hotter area of the Central Valley. It contains the San Joaquin and Tulare Basins.

On the following pages is a brief description of each of the Primary Focus Area basins, listed by its position in the Central Valley from north to south.

## Butte Basin

The Butte Basin (Figure 4.1.3) encompasses approximately 608,000 acres and extends 76 miles from Red Bluff south to the Sutter Buttes. The Sacramento River borders the basin on the west, the Sierra Nevada foothills and Feather River on the east. Butte Creek drains the basin between the city of Chico and the Sutter Buttes. Historically, creeks north of Chico flooded adjacent lands. However, these lands were developed for urban and agricultural use and are now protected by levees. Much of the basin is grazing land and prime farmland with walnuts, almonds, and rice being the predominant crops.

Below Chico, over-bank flooding from Butte Creek and the Sacramento River historically produced large tracts of seasonal wetlands. Some of these overflows reached the Butte Sink, a large marsh in the southern portion of the basin. However, in the early 1900s, a series of levees and drainage facilities was built to contain these floodwaters.

Today, most of the properties in the Butte Sink are privately managed waterfowl clubs. They provide extensive habitat for waterfowl, shorebirds, and other waterbirds.

The southwestern part of the basin is managed by the Sacramento River Flood Control District to convey flood flows into the Sutter Bypass. Thermalito Afterbay, in the southeastern portion of the basin, is a large water storage reservoir that helps control flow into the Feather River and serves as a warming basin for agricultural water delivery to rice and other crops west of the Afterbay.

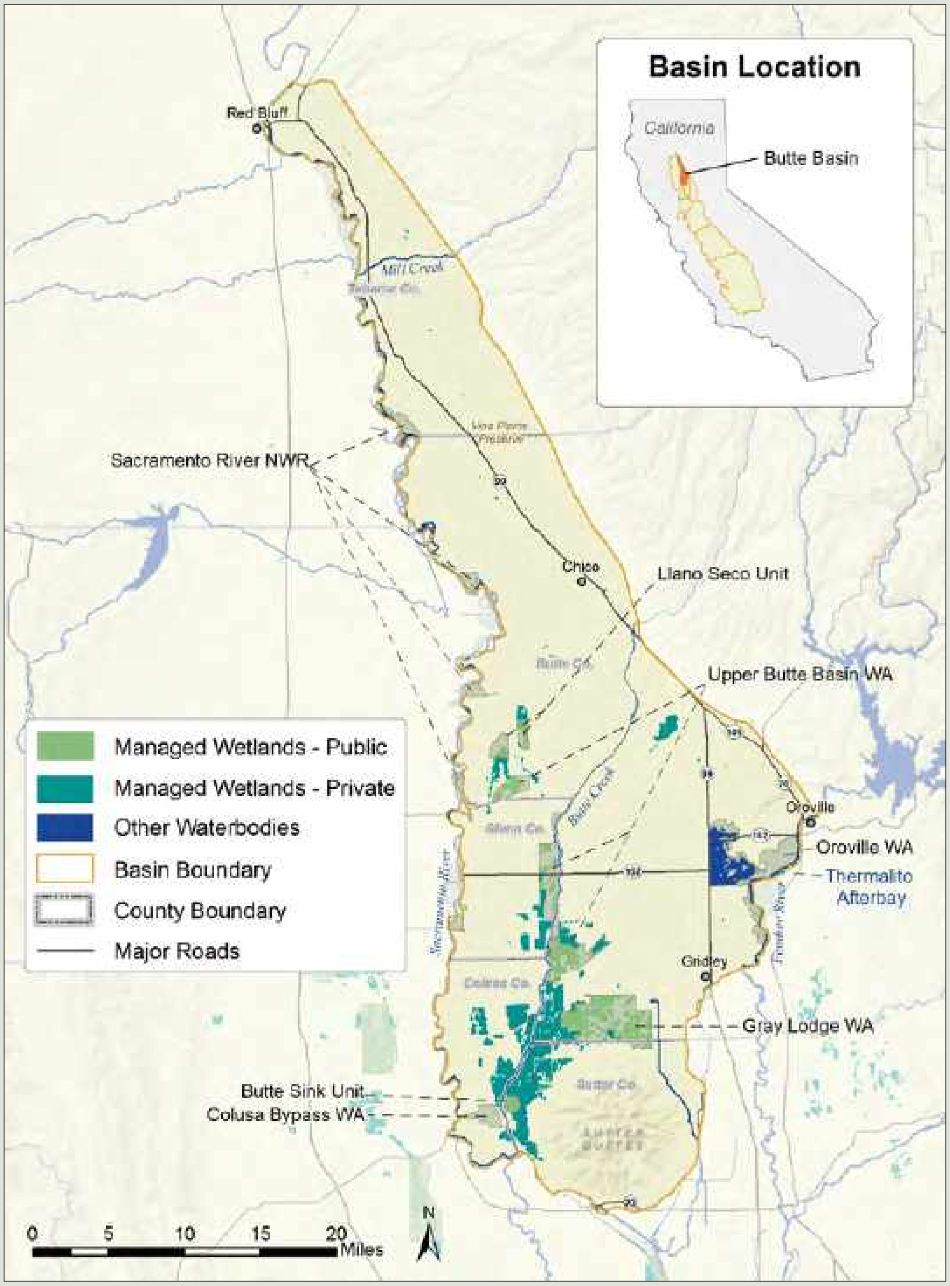


**FIGURE 4.1.3** Butte Basin.

*Protected natural areas in the basin include portions of The Nature Conservancy-owned Vina Plains Preserve and Sacramento River conservation areas; state-owned Gray Davis Dye Creek Preserve, Upper Butte Basin Wildlife Area (WA), Gray Lodge WA, Oroville WA, and Colusa Bypass WA; and scattered parcels of federally protected wetlands.*

*Cities and towns include Chico, Oroville, and Gridley.*

*Butte Sink Wildlife Management Area - Mike Peters*

## Colusa Basin

The Colusa Basin (Figure 4.1.4) extends 106 miles from Red Bluff south to Cache Creek. The Sacramento River borders the basin on the east, the Coast Range on the west. The basin totals approximately 1,149,000 acres; most wetland habitat is located south of the Stony Creek drainage. Historically, overflow from the Sacramento River joined with streams draining the east slopes of the Coast Range to flood basin marshes in winter and spring. The development of levee networks, drains, and pumping stations have eliminated those flood events in all but the wettest years. Colusa Trough, a naturally formed depression that enters the Sacramento River near Knight's Landing, drains the basin.

Almonds and rice are the predominant agricultural crops grown, with most rice located in the southern half of the basin. Postharvest rice field flooding for straw decomposition provides significant waterfowl habitat in the winter months. Water transfers are a concern, especially if they occur in the winter when water could be used for rice straw decomposition or on private wetlands.

The basin contains extensive private wetlands, most of which are protected by federal conservation easements.

*Other protected areas in the basin include the state-owned Thomas Creek Ecological Reserve (ER), Sacramento National Wildlife Refuge (NWR), Delevan NWR, Colusa NWR, and portions of the Sacramento River NWR.*

*Major cities and towns include Red Bluff, Corning, Orland, Willows, Williams, and Colusa.*

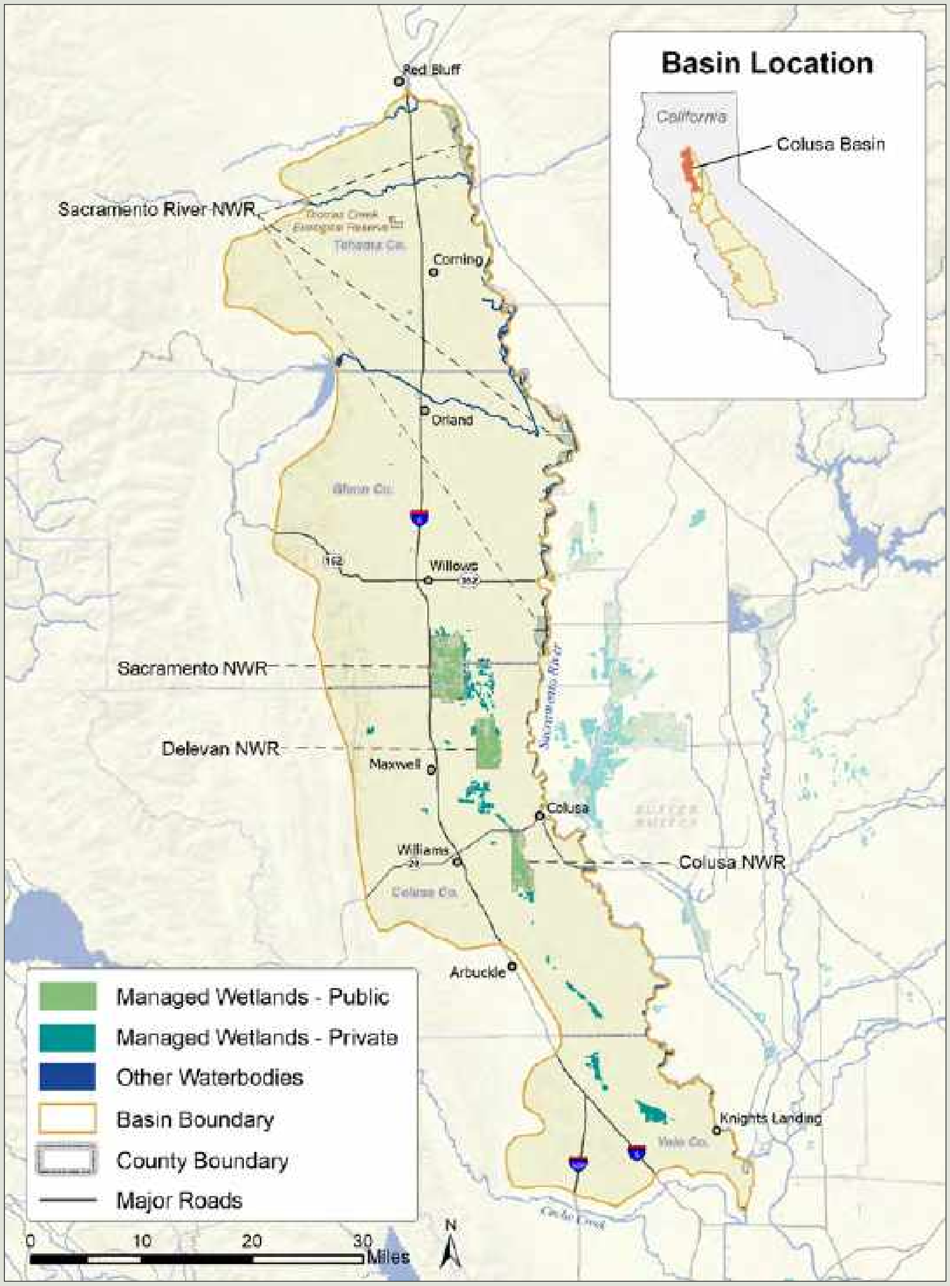


**FIGURE 4.1.4** Colusa Basin.

*Mixed waterfowl species, Colusa Basin - USFWS*

## Sutter Basin

The Sutter Basin (Figure 4.1.5) totals approximately 237,500 acres and extends south 42 miles from the Sutter Buttes to the confluence of the Feather and Sacramento Rivers. These rivers also border the basin to the east and west. Historically, overflow from the Sacramento River, Butte Sink, and Feather River flooded the Sutter Basin in winter and spring. A large portion of the basin was flooded year-round, providing significant waterfowl habitat. Although construction of the Sutter Bypass and flood control systems on the Sacramento and Feather Rivers have eliminated most of this overflow, portions of the bypass continue to provide wetland habitat. Today, most of the basin is prime agricultural and grazing land, with rice and walnuts being the predominant crops.

*Many private waterfowl hunting clubs in the Sutter Basin are located within the levees of the Sutter Bypass. Protected natural areas in the basin include the Feather River WA, Sutter Bypass WA, and the Sutter NWR.*

*Cities and towns include Live Oak, Yuba City, and the southern portion of Gridley.*

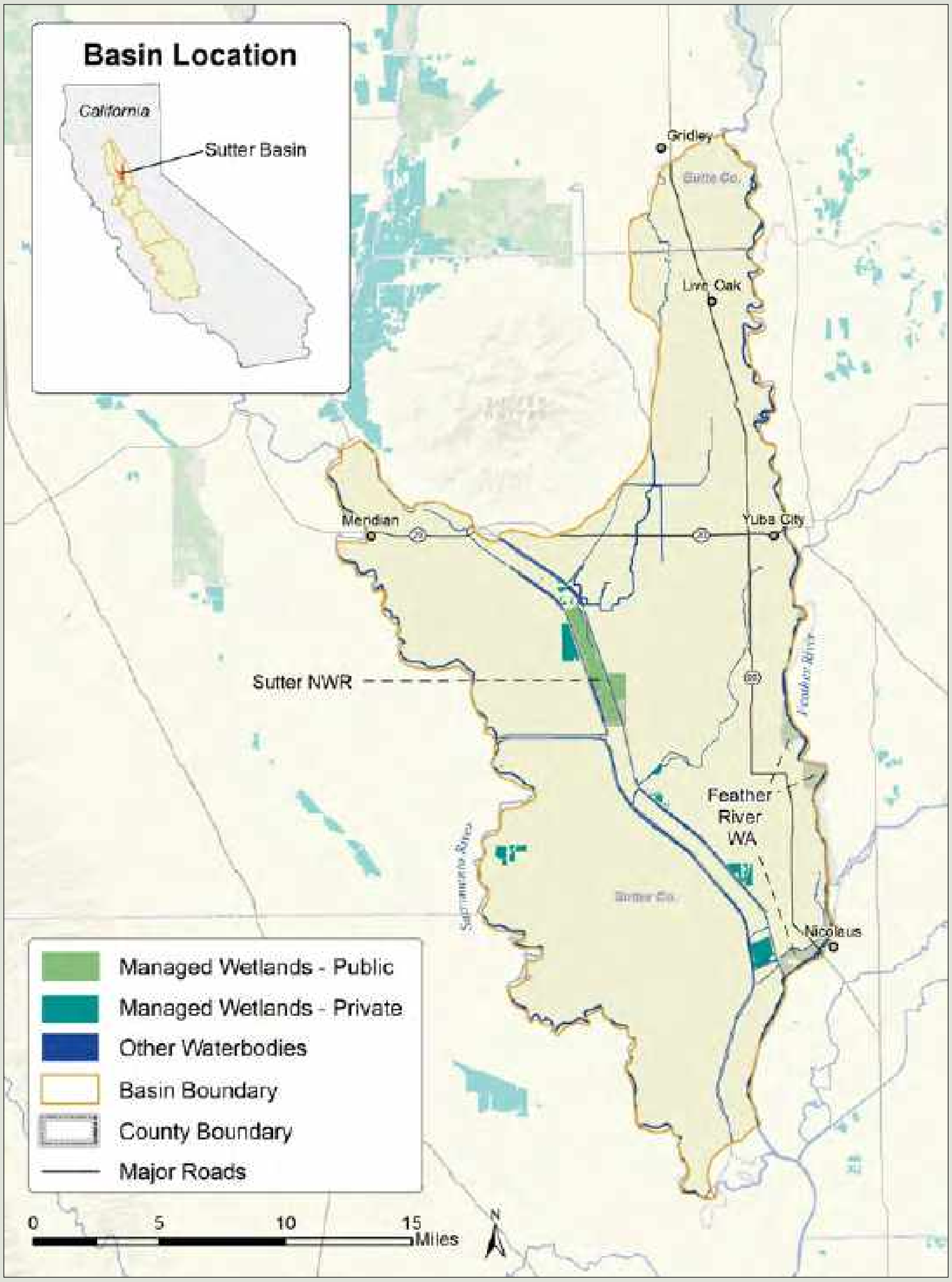


**FIGURE 4.1.5** Sutter Basin.

*Sutter Bypass - Daniel Nylen/American Rivers*

## American Basin

The American Basin (Figure 4.1.6) lies east of the Sacramento and Feather Rivers and west of the Sierra Nevada foothills. It is about 65 miles long from Oroville in the north to the American River in the south, totaling approximately 519,500 acres. Historically, water from the American, Yuba, Feather, Sacramento, and Bear Rivers flooded this area, but construction of flood control reservoirs, levees, and dams have eliminated most of this over-bank flooding.

The predominant agricultural crops in the northern portion of the basin include walnuts and rice, with rice and livestock in the southern portion.

The basin includes Reclamation District 10 and Honcut Creek areas, which constitute a large block of privately-owned wetlands in the northern portion of the basin. District 10 is a rice farming area; most of the private waterfowl clubs consist of lands that are flooded, harvested rice fields. Development pressure, high land values, and the lack of publicly protected lands have resulted in limited habitat conservation opportunities in the southern portion of the basin. Loss of rice lands to urban development has been extensive in this basin.

*Cities and towns include the southern portion of Oroville, Marysville, Wheatland, Lincoln, Rocklin, Roseville, Citrus Heights, and northern portions of Sacramento.*

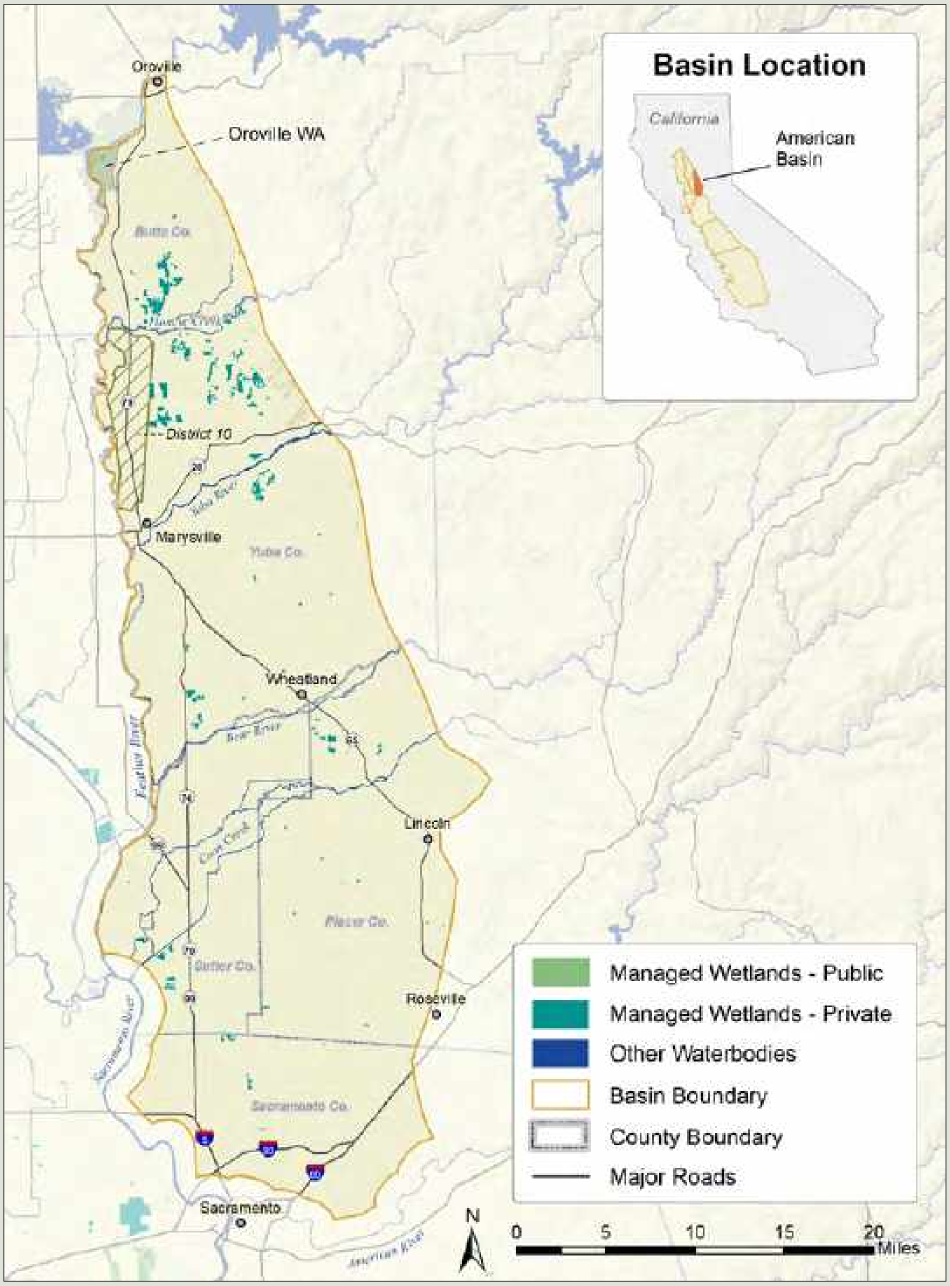


**FIGURE 4.1.6** American Basin.

*High Ridge Ranch Conservation Area: Wetland and rice fields permanently protected through CVJV- Jake Messerli/California Waterfowl Association*

## Yolo Basin

The Yolo Basin (Figure 4.1.7) lies west of the Sacramento River and is approximately 50 miles long from Cache Creek to the north to the Montezuma Hills and the Delta Basin to the south. It totals approximately 508,000 acres.

Historically, the Yolo Basin received overflow water from the Sacramento and American Rivers and the Cache, Putah, and Ulatis Creeks. Low-lying areas near the Sacramento-San Joaquin River Delta were tidally influenced and supported permanent marshes, while flooding at higher elevations produced seasonal wetland habitat.

Like much of the Central Valley, the hydrology of the Yolo Basin has been modified by levees and flood control structures. The Yolo Bypass was developed along the east side of the basin to provide flood protection for adjacent lands when flows in the Sacramento River are high. Land use in this area primarily consists of rice, pasture-land for cattle grazing, a limited amount of field crops, and freshwater wetlands and grasslands for private waterfowl clubs. Agricultural use in the western portion of the basin primarily consists of row crops, rice, and increasing acreages of nut tree crops. The southern portion of the basin has windmills for power generation.

*Most of the state-owned Yolo Bypass WA is located in the Yolo Basin, as is the Fremont Weir WA. Other protected areas include Russell Ranch (University of California) and Jepson Prairie Preserve and Wilcox Ranch (Solano Land Trust).*

*Cities and towns include West Sacramento, Woodland, Davis, Winters, Dixon, Vacaville, and Rio Vista.*

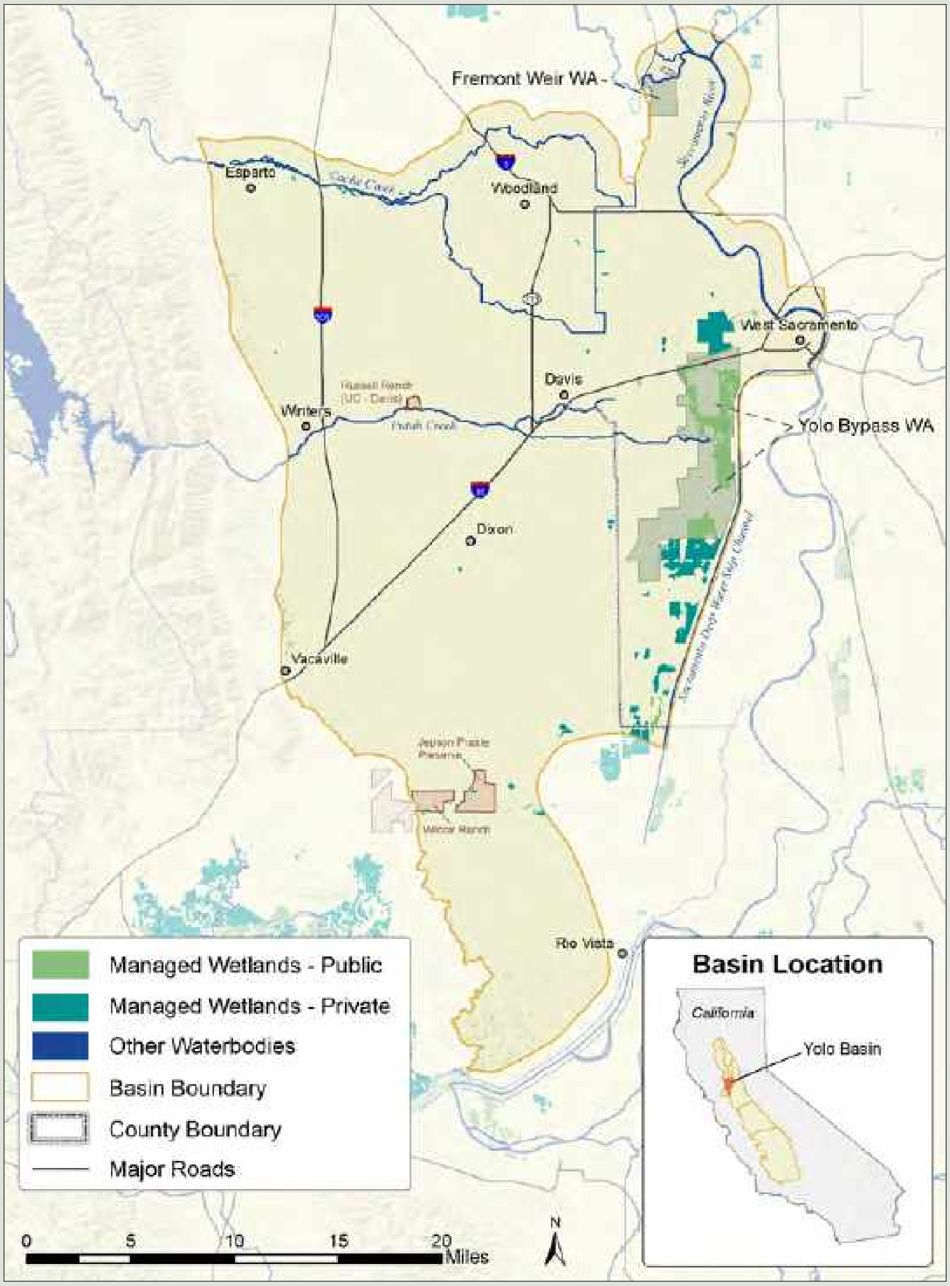


**FIGURE 4.1.7** Yolo Basin.

*Fremont weir and adjacent agriculture - Daniel Nylen/American Rivers*

## Suisun Basin

Suisun Basin (Figure 4.1.8) is approximately 20 miles long from the southern end of Vacaville on the north to the Contra Costa County line on the south. It totals about 152,000 acres and is adjacent to the San Francisco Joint Venture eastern boundary. The Carquinez Strait and Coast Range border this basin on the west, the Sacramento-San Joaquin Delta on the east. The basin is dominated by Suisun Marsh, the largest contiguous estuarine marsh in the United States. The marsh is brackish and lies between the freshwater wetlands of the interior Central Valley and the saltwater marshes of the San Francisco Bay and coast, encompassing approximately 88,000 acres of wetlands, bays and sloughs in southern Solano County. The 115,000-acre Suisun Resource Conservation District (SRCD), established in 1963 as a Special District of the State of California, includes 52,000 acres of publicly and privately managed wetlands, 6,000 acres of unmanaged tidal wetlands, 30,000 acres of bays and sloughs, and 27,000 acres of upland grasslands. There is a long tradition of waterfowl hunting in Suisun Marsh (since the 1890s), and the conservation of the marsh's managed wetland habitats is key to maintaining hunter heritage. Agriculture does not have a significant presence in the marsh, but the upland grasslands and rangeland in the eastern Suisun Basin support livestock grazing.

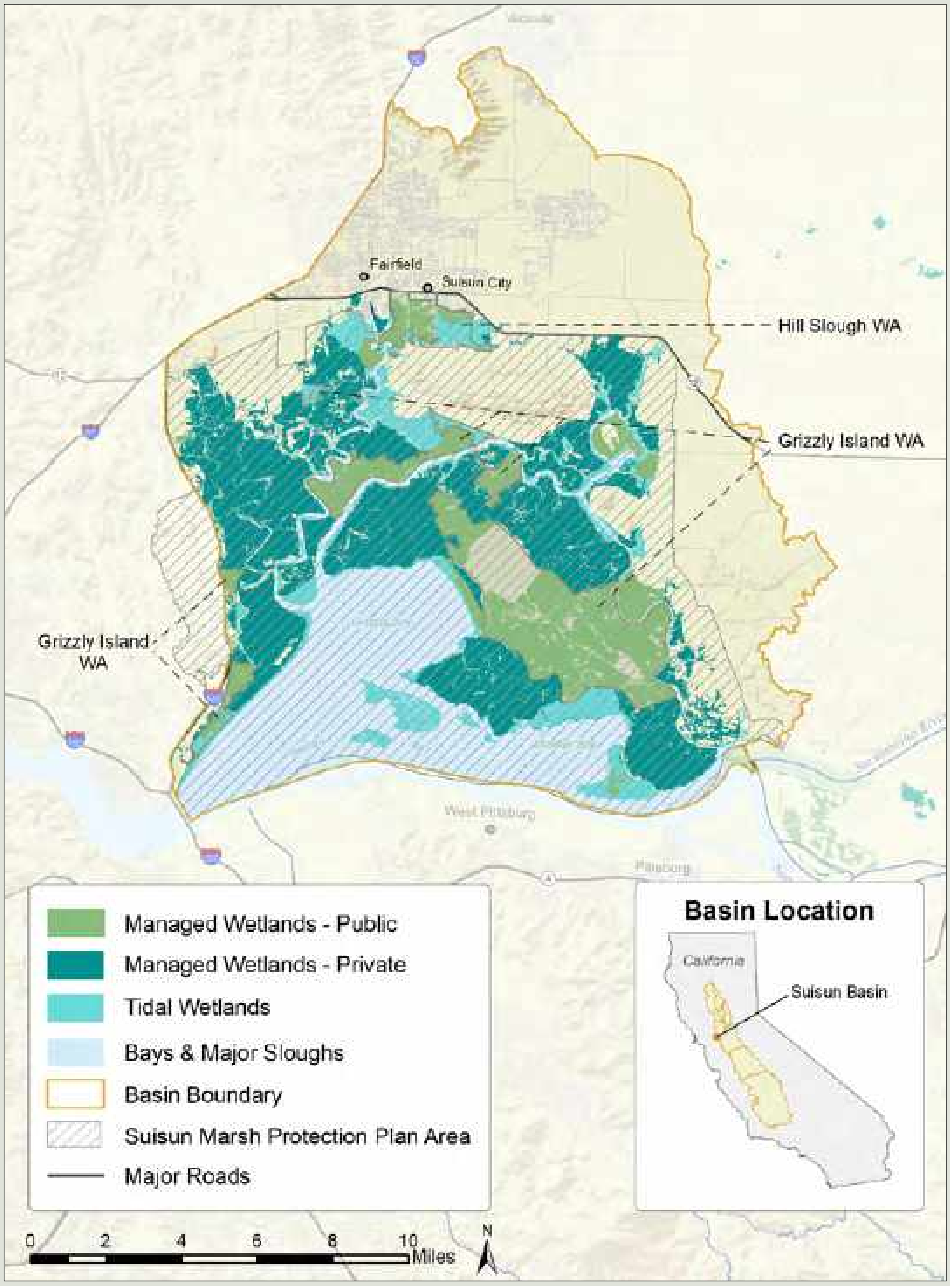


**FIGURE 4.1.8** Suisun Basin.

Historically, Suisun Marsh was tidally influenced with large portions of the marsh submerged regularly (Moyle et al. 2014). Levee construction in the 1850s restricted tidal flows for agricultural and waterfowl hunting purposes. Tide gates and levees currently protect the managed wetlands from tidal flooding; however, salinities have gradually increased because of freshwater diversions upstream of the marsh from the San Joaquin and Sacramento Rivers. Costs to maintain managed wetland habitat in the Suisun Basin are higher than in other parts of the Central Valley, due to the cost of exterior levee maintenance and the effects of the corrosive brackish environment on infrastructure. Suisun Marsh has a dependable water supply even in drought years, providing reliable habitat for resident and early migrating waterfowl and stable hunting opportunities. Suisun Marsh is also an important breeding area and supports one of the highest densities of nesting ducks in North America (McLandress et al. 1996).

The Suisun Marsh Preservation Act of 1974 (California Public Resources Code 29000-29612) and the resulting Suisun Marsh Protection Plan (1976) protect the marsh from development to preserve its integrity. The Suisun Basin also has state-managed public lands, including the Grizzly Island WA, the Hill Slough WA, and the Peytonia Slough Ecological Reserve.

*Cities and towns include Fairfield, Suisun City, and the southern portion of Vacaville.*

## Delta Basin

The Delta Basin (Figure 4.1.9) totals approximately 1,687,000 acres and extends 75 miles from the American River in the north to the Stanislaus River in the south. The Sierra Nevada foothills border the basin to the east, the Sacramento River to the northwest, and the Coast Range to the southwest.

Prior to the mid-1800s, the Delta Basin was part of a larger estuary that included Suisun Marsh and San Francisco Bay. Development of the basin began in the 1850s, when the Swamp Land Act transferred ownership of all "swamp and overflow land" from the federal government to the state. By the early 1900s, nearly all the Delta's wetlands had been converted to agriculture.

The convergence of the Sacramento, San Joaquin, Cosumnes, Mokelumne, and Calaveras Rivers forms this basin. The Lower Sherman Island WA riparian marshlands sit at this confluence. Numerous other creeks and rivers also contribute to this Delta matrix. This confluence is subject to tidal movement and water diversions as it flows into the San Francisco Bay. A 1,000-mile network of levees has reclaimed 60 former wetland islands in the Delta. These islands are intensively leveed and farmed, and land subsidence, potential levee failure, and saline water intrusion are threats to many of these properties. Some are managed as waterfowl hunting clubs after crop harvest, with corn a major contributor to habitat values for waterbirds in the basin. Land conversion in the southern part of the Delta Basin, from pasture to permanent crops, has resulted in lost habitat for grassland birds and the loss of late winter/early spring foraging habitat for geese. Predominant crops include wine grapes, fruit trees and grains. The dairy industry follows grape production as the second highest grossing commodity.

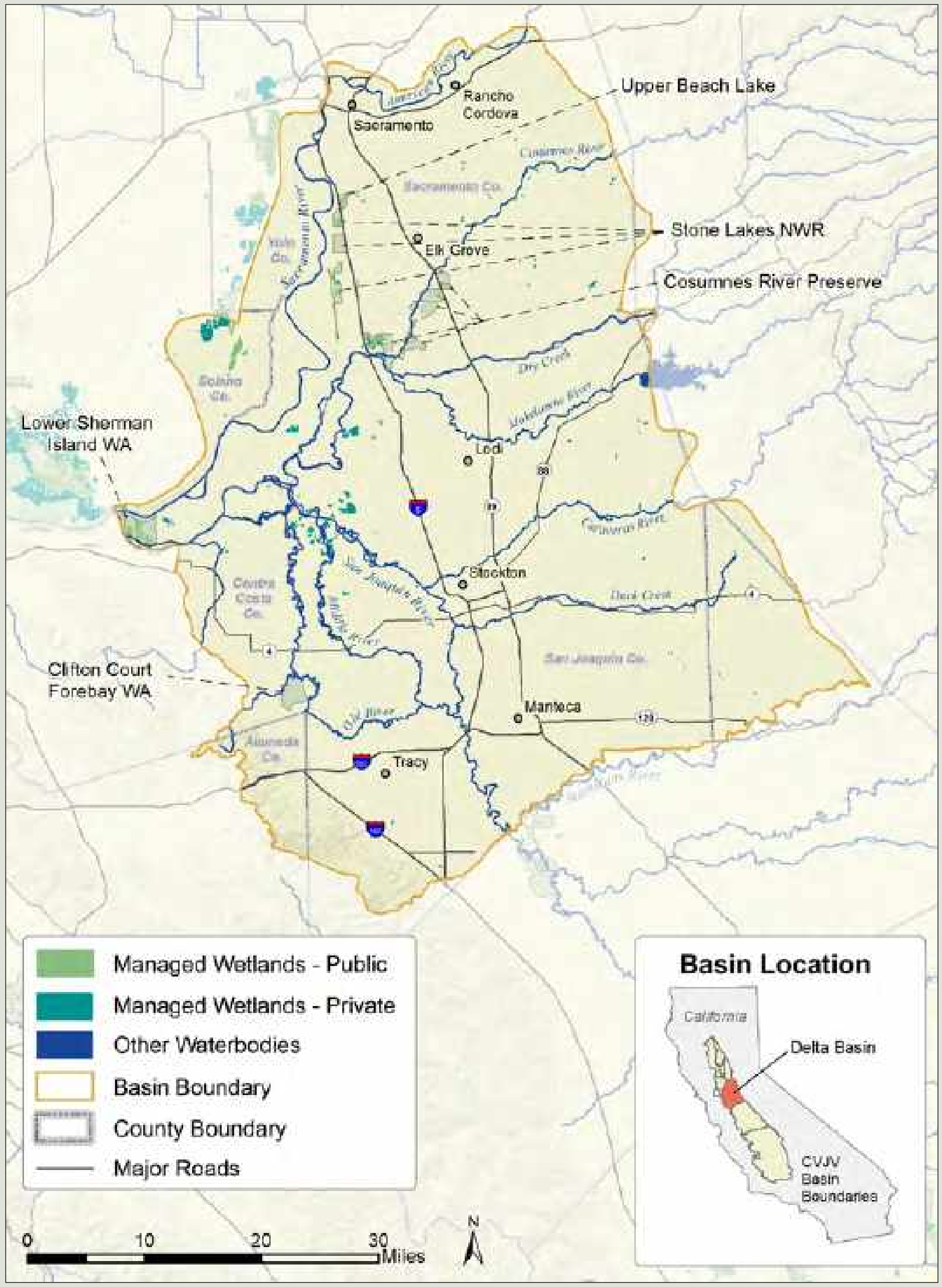


**FIGURE 4.1.9** Delta Basin.

*Protected areas in the basin include the jointly-owned (state, federal, county, and non-governmental organization) Cosumnes River Preserve; the state-owned Lower Sherman Island WA and Clifton Court Forebay; Upper Beach Lake (Sacramento County); and Stone Lakes NWR.*

*Cities and towns include Rancho Cordova, Sacramento, Elk Grove, Lodi, Stockton, Manteca, and Tracy.*

*Cosumnes River Preserve - BLM*

## San Joaquin Basin

The San Joaquin Basin (Figure 4.1.10) totals approximately 2,845,000 acres, extending 80 miles from the Stanislaus River in the north to the San Joaquin River in the south. The Coast Range borders the basin on the west, the foothills of the Sierra Nevada on the east. Where it turns north, the San Joaquin River bisects the basin from north to south, with major tributaries including the Chowchilla, Merced, Fresno and Tuolumne Rivers.

The basin contains several federal and state wildlife refuges as well as extensive private wetlands located in the Grassland Resource Conservation District (GRCD) on the western side of the basin. Many of these private wetlands are permanently protected by state and federal conservation easements, and most wetlands in this area have reliable water supplies. The hunting culture in the basin has deep roots in the community, contributing substantially to the local economy during waterfowl season.

Soils on the western side of the San Joaquin Basin are derived from marine sediments that are high in salts and trace elements. Postharvest irrigation was formerly used to leach these substances from the upper soil, and return flows were used as a wetland water source. Selenium concentrations in this tailwater proved damaging to a wide range of birds. In this regard, it is important to consider the long-term future of the San Luis Drain. The drain once carried contaminated subsurface agricultural drainage water into adjacent wetlands. Although used less frequently today, the drain still serves as an important "bypass" of the wetlands, discharging drainage water and storm water into Mud Slough (north) and the San Joaquin River.

Public and private wetlands rely on a relatively small amount of well water. These wetlands are currently undergoing a planning process to comply with the Sustainable Groundwater Management Act of 2014.

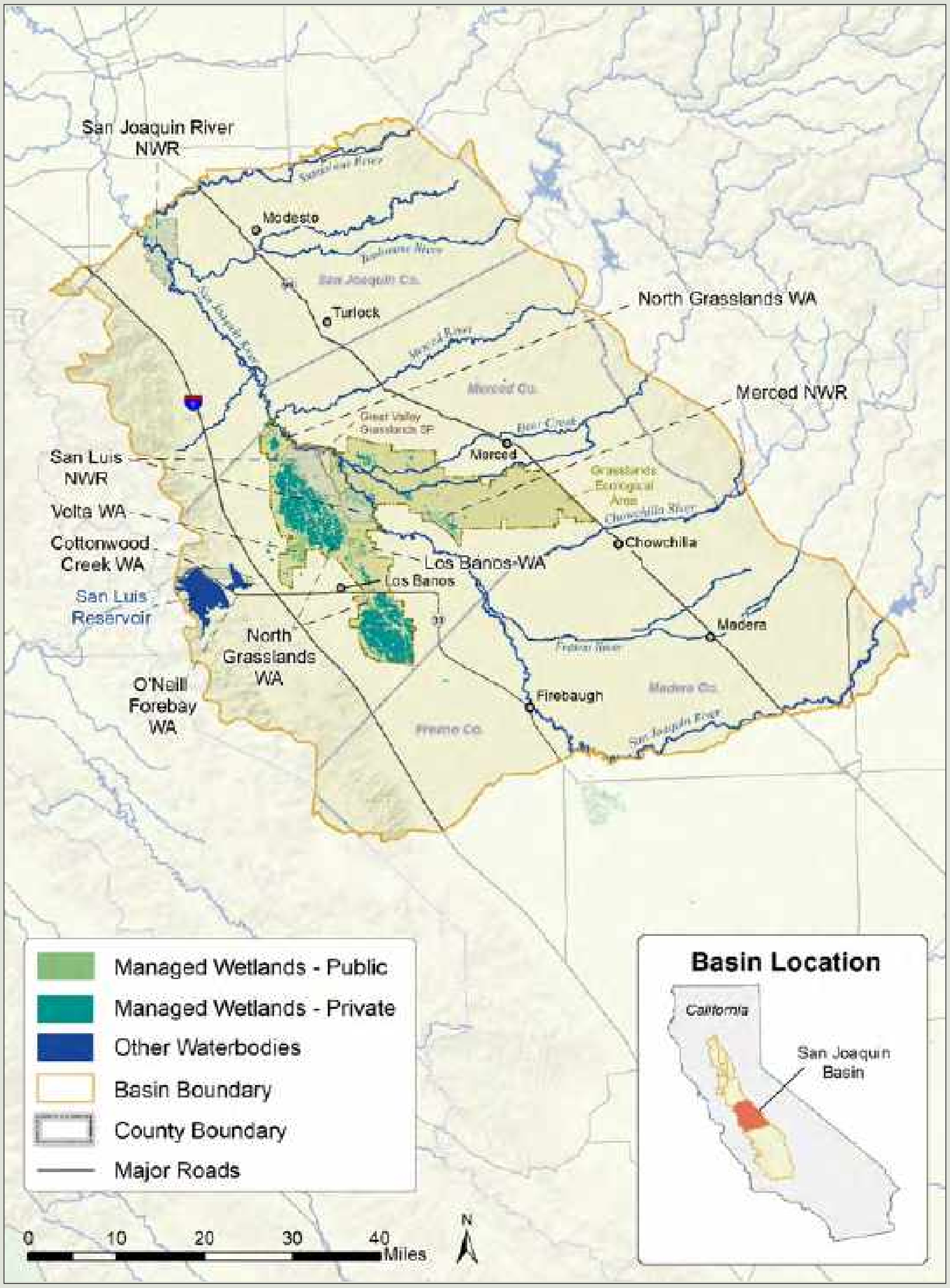


**FIGURE 4.1.10** San Joaquin Basin.

Wildlife-friendly agricultural crops are limited in the San Joaquin Basin, even though agricultural production is a primary land use.

*Protected areas include federally-owned San Joaquin River NWR, San Luis NWR Complex; state-owned Los Banos WA, Volta WA, North Grasslands WA, and Cottonwood Creek WA; Great Valley Grasslands State Park; and the federal and state jointly-owned San Luis Reservoir and O'Neil Forebay WA. The 2017-approved expansion of San Joaquin River NWR includes 11,000 acres of river corridor that could join the current refuge area with the GEA and riparian corridors.*

*Cities and towns include Modesto, Turlock, Merced, Los Banos, Chowchilla, and Madera.*

## Tulare Basin

The Tulare Basin (Figure 4.1.11) is the largest basin in the Central Valley, totaling approximately 6,655,000 acres bordered by the Coast Range to the west and the southern Sierra Nevada foothills to the east. This basin is 150 miles long, extending from the San Joaquin River on the north to the Sierra Madre Mountains, the Cuyuma Valley, and the Tehachapi Mountains on the south. The basin includes the Carrizo Plain at its south-western end, a large enclosed grassland plain approximately 40 miles long and 20 miles across, located in southeastern San Luis Obispo County. It is the largest native grassland remaining in California.

Despite being the driest region of the Central Valley, the Tulare Basin once contained the largest single block of freshwater wetland habitat in the United States west of the Great Lakes (Garone 2011), and it provided over 500,000 acres of permanent and seasonal wetlands. During most years, the basin functioned as a sink, where water from the Sierra Nevada flowed down a number of waterways, including the Kern, Kings, and Tule Rivers, into a series of shallow lake basins. During exceptionally wet years, water flowed north from these lakes into the San Joaquin River. Diversion of water for agricultural and municipal purposes ultimately drained the Tulare Basin lakebeds and allowed these wetlands to be reclaimed for agriculture. These lakebeds now remain dry in all but the wettest years, and the amount of wetland habitat remaining in the Tulare Basin is less than one percent of historical levels. Surface water in the basin is limited, and reduced flows in water channels contribute to native tree mortality in riparian areas and severely reduce the ability of private wetlands to access this water.

Historically, the Tulare Basin had over 200 private waterfowl hunting clubs. Today, only a fraction of those clubs remains. Some of the habitat is protected under federal conservation easements, but most are unprotected, and most rely on groundwater with high pumping costs. The wetlands in the Tulare Basin receive

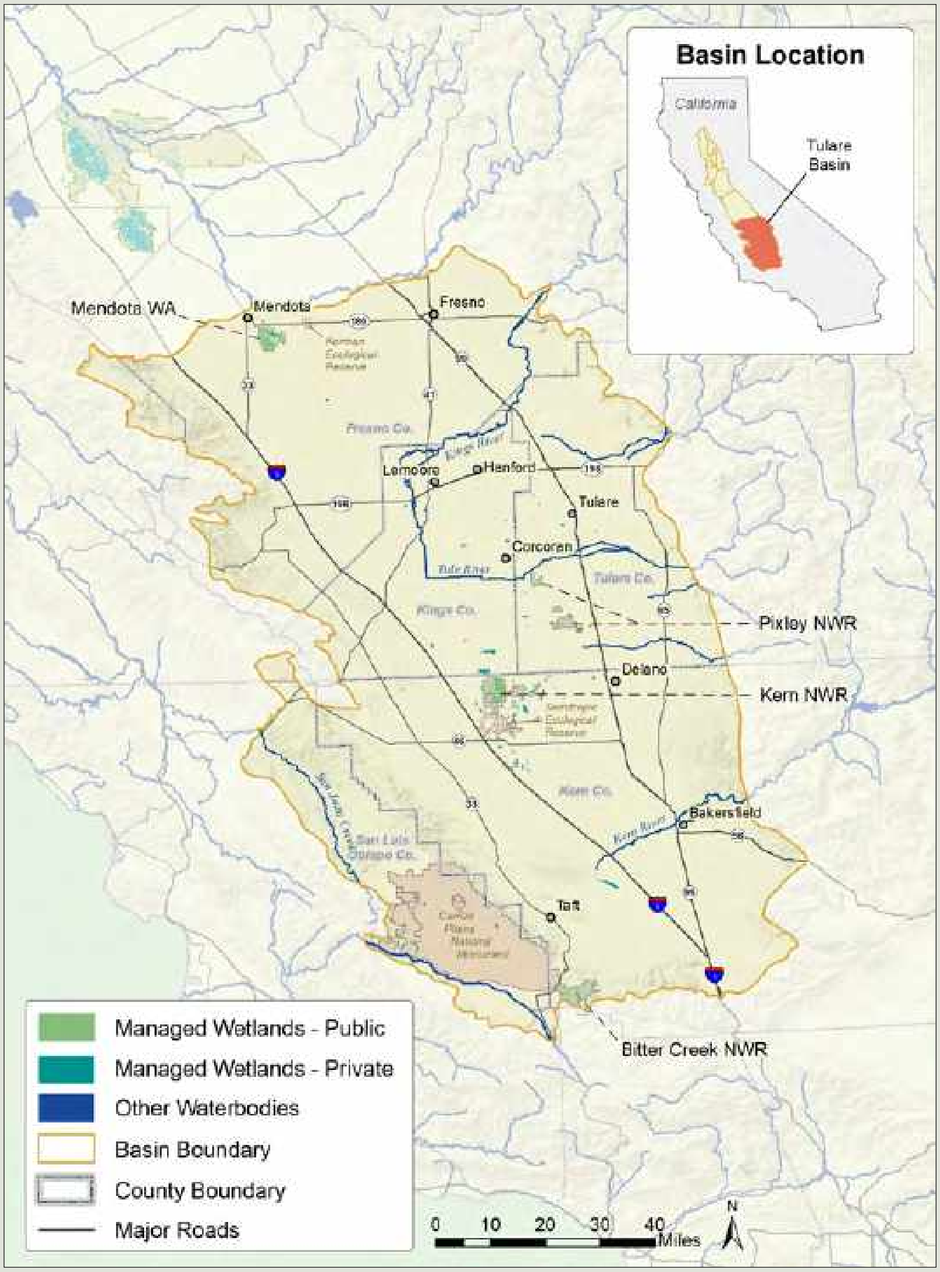


**FIGURE 4.1.11** Tulare Basin.

*Sunset over grasslands in the San Joaquin Valley. - BLM* floodwaters more unpredictably than in other parts of the Valley, and although this water is periodically plentiful, private wetlands' infrastructure restricts the ability to accept and store this water.

The Sustainable Groundwater Management Act of 2014 requires that critically over-drafted groundwater basins, like the Tulare Basin, come into compliance with the law within 20 years. It is likely that groundwater users will eventually have to reduce their use to only a fraction of the amount they are currently using. Land prices are limiting acquisition of fee-title and easement lands for the purpose of habitat conservation; however, substantial agricultural acreage is projected to be fallowed due to new groundwater requirements, and this may result in increased options for upland protection and restoration opportunities in this basin.

*Protected areas include federally-owned Kern NWR, Pixley NWR, and Bitter Creek NWR and Atwell Island; state-owned Mendota WA, Kerman ER, and Semitropic ER; Semitropic Ridge Preserve (Center for Natural Lands Management); and county-owned Kern County Valley Floor Habitat Conservation Plan lands.*

*Cities and towns include Mendota, Fresno, Visalia, Tulare, Hanford, Lemoore, and Bakersfield.*

## Secondary Focus Area

The CVJV's Secondary Focus Area (Figure 4.1.1) is approximately 27,400 square miles (17, 537,000 acres) bordering the Central Valley and generally following the crest of the mountain ranges that rim the Valley, descending in elevation as it approaches the Sacramento-San Joaquin River Delta and Suisun Marsh. This area is surrounded by grasslands and oak woodland habitat at lower elevations and a variety of habitats as the terrain ascends in elevation including scrublands, montane hardwood woodlands, meadows, and coniferous forest habitats. Grassland and oak savannah ecosystems are important upland components, particularly the open country low-elevation foothills and rangelands that surround the perimeter of the Valley floor (DiGaudio et al. 2017). The CVJV's bird conservation work currently concentrates in this "foothill ring."

About 60 percent of the Central Valley's historical grasslands have been lost due to urban development and conversion to intensive agriculture, such as orchards, vineyards, and row crops. Historical data on the extent of oak savannah ecosystems in the Valley are lacking, but the magnitude is probably similar. Oak woodlands face threats such as habitat loss, lack of oak regeneration, fire, over-grazing, and sudden oak death disease. Today, both ecosystems are still at risk of conversion (CPIF 2000; DGP-GIC 2003).

Annual grassland habitat occurs mostly on flat plains to gently rolling foothills and is dominated by non-native grasses. There is evidence to suggest that many of the areas dominated by non-native annual grasses may have formerly been dominated by different vegetation types such as woodlands, chaparral, or coastal scrub. Over time, the "foothill ring" area was modified to provide rangeland habitat, and today non-historical grass species constitutes the major portion of the present grassland range (Hamilton 1997). Perennial grasses are still found in moist, lightly grazed, or relic prairie areas. Lands within this area are predominantly composed of private working ranches that include a rich and varied landscape of grasslands, oak savannah and woodlands, vernal pools, riparian areas, and wetlands. The state's large rangeland areas provide continuous open space critical for wildlife movement and ecological function (Spencer et al. 2010), yet rangelands are among the least protected habitats in the state.

The Secondary Focus Area includes protected lands such as the state-owned Tehama WA and federally-owned Folsom Lake and Auburn State Recreation Areas. Portions of Lassen, Mendocino, Plumas, Eldorado, Stanislaus, Sierra, Sequoia, Los Padres National Forests, and the Yosemite and Kings Canyon National Parks are also in this area.

Major cities and towns include Clearlake, Red Bluff, Paradise, Grass Valley, Nevada City, Auburn, Ione, Placerville, Sonora, and Tehachapi.

## 4.2 WATER

Adequate water supplies are critical for wetland-dependent bird habitat, which includes both managed wetlands (such as refuges) and flooded agricultural lands. Water creates the well-recognized flooded ponds and moist, marshy soils that characterize wetlands everywhere. Maintaining healthy and productive wetlands requires adequate and reliable access to water. In the Central Valley ("the Valley"), wetland-dependent bird habitat is almost entirely "managed," either as semi-permanent or seasonal wetlands, or on flooded agricultural lands that provide a wetland habitat function. These wetland habitats are distributed across state and federal refuges, privately-owned conservation easement lands, other private property (such as duck clubs), and agricultural land, particularly rice.

The prevalence of each wetland habitat type is important to ensure that adequate habitat – as well as recreation, education, and other services – is provided every year by wetlands collectively, regardless of precipitation, regulatory and political environment, funding availability, commodity prices and land use decisions, and other factors. Each type of wetland habitat has different water needs, both in amount and timing of applied water.

### WHY DO WETLANDS NEED WATER?

In the spring, water provides nesting and foraging habitat for breeding waterbirds (including waterfowl, shorebirds and other water-dependent bird species), germinates seeds, and irrigates perennial plants on managed wetlands that will later provide food and shelter for birds. Summer water nurtures these plants and improves the productivity of wetland soils, provides foraging for young birds, and creates mudflat conditions important for migrating shorebirds. In the fall and winter, water is used to flood managed wetlands and some agricultural land, such as rice and corn after harvest, making waste grain and invertebrates available as food to waterfowl and shorebirds, as well as providing places to rest.

After creating these important environmental benefits, as well as numerous recreational, educational and economic benefits, most wetland water either percolates through the soil to recharge local groundwater basins or returns to rivers and streams with nutrients to enhance the aquatic food web or supplying water for other uses downstream.

Ensuring reliable and affordable water supplies for wetland habitat management may be the Central Valley Joint Venture's (CVJV) greatest challenge. Since publication of the 1990 Central Valley Habitat Joint Venture Implementation Plan (CVJV 1990), overall demand for water in the Valley has increased at an alarming rate. At the same time, complicated factors have led to reduced water supplies for many wetlands. These factors include in-stream dedication for threatened and endangered fish species, human population growth, and changing agricultural practices. The economic and political competition for water has intensified, and the cost of water in some basins has risen tenfold. In addition, climate trends are leading some wetland water supply managers to change how they plan for resiliency.

The CVJV plays several significant roles in ensuring the reliability and sustainability of wetland water supplies. These roles include communicating the extent to which bird habitat is fundamentally linked to water availability; understanding the implications of constantly changing factors related to wetland water supply; advising agencies involved in implementing significant legislation; and facilitating and encouraging advocacy, creative thinking, and on-the-ground solutions.

This subchapter first provides important historical and political context for understanding the water supply needs and challenges faced by the Valley wetlands today. Next, it explains the water needs of different wetland types and describes the water supplies that are needed to meet those needs. Water needs are extrapolated to estimate the water necessary to meet the waterfowl and shorebird population targets and the associated habitat objectives determined for this Implementation Plan. Finally, the constraints and opportunities around acquiring, delivering, and managing water to meet wetland habitat needs are explained.

## History of Central Valley Wetland Water Supplies

The extent of habitat for wetland-dependent bird species in the Central Valley has changed extraordinarily over the last 150 years. The amount of water available to create wetlands and the way wetlands receive that water have also changed. Inundation and flooding in the Central Valley in the winter and spring, caused by confining rivers within artificial levee systems, requires flooding and irrigations to be managed through human-made structures to divert or pump water from rivers, ditches and groundwater wells. The very existence of most wetlands now relies on conveyance and delivery systems. Understanding this context and how much water wetlands need is critical to their sustainability and protection.

### Wetland water before development

Prior to the Gold Rush of the mid-1800s, the Valley contained more than four million acres of dynamic wetland complexes that included and were bordered by flooded riparian and grassland habitats (Frayer et al. 1989). Many wetlands were seasonal in nature and resulted from over-bank flooding of rivers and streams that inundated large areas of the Valley during winter and spring. The timing and duration of these waters also supported the productivity of moist soils and germination of beneficial food plants for the following year as well as supporting riparian vegetation. Slowly receding water provided habitat for a variety of bird species throughout the summer and fall months until rains returned in the late fall and winter, when the cycle began again.

### Wetland water from development through 1992

In less than a century, large-scale gold extraction techniques, flood control projects, and land reclamation projects for agriculture and urban development led to the conversion of over 90 percent of the Valley wetlands to other uses. Human settlement increased the need to control annual flooding of the major river systems to protect developing cities, homesteads and associated infrastructure. As flood control levees were built to tame the rivers, agricultural lands expanded, and dams were constructed to provide additional flood control and water storage for expanding urban, industrial and agricultural needs.

As the population of California increased, so did the demand for agricultural products and other services. The Central Valley Project (CVP), a federal water project, was initially authorized in 1935 as a long-term plan to control floods and develop and manage water for industrial, municipal and agricultural uses. The CVP and California's companion State Water Project (SWP) constructed major dams and conveyances to store water during wet years, release water when needed by agriculture during the dry summer months, and convey water to farms and cities throughout the Valley. The CVP is capable of storing over 11 million acre-ft of water and transporting it through 500 miles of canals. By the 1950s, expanding agricultural development and water projects that redirected water historically available to wetland areas had decreased Valley wetlands to an estimated 290,000 acres (CVJV 1990).

Resident and migratory bird populations were severely impacted during this time (Frayer et al. 1989). The first wildlife refuges were established in the early 1930s. As the extent of natural wetlands continued to decline into the 1970s, more public and private lands were set aside to be managed as wetlands. Water supplies for managed wetlands during this period were not secure. Most managed wetlands depended upon agricultural irrigation return flows, low-priority water contracts, or non-binding agreements with water districts. Some of those historical agreements continue to this day[1]. With few exceptions, these contracts and agreements provided water supplies on an "if and when available basis," with supplies being severely reduced, or eliminated, during drought years.

Severe drought during the latter part of the 1970s greatly reduced wetland water supplies and, in some instances, eliminated all water deliveries to remaining wetlands in the Valley. The combination of drought and poor water supply reliability resulted in significant negative impacts to wetland habitat

1. Examples include wetlands in the Butte Sink area that receive fall and winter water via a 1922 agreement with Western Canal Company and Pacific Gas & Electric Company; the Sacramento, Delevan, and Colusa National Wildlife Refuges, which receive water through agreements with Glenn-Colusa Irrigation District; and the Gray Lodge Wildlife Area, which receives a portion of its water needs from the Biggs-West Gridley Water District for lands allocated "Class 1" Feather River settlement water. Another example involves the Grassland Mutual Water Association, which filed suit against the U.S. Department of the Interior after losing San Joaquin River supplies when the Friant Dam Project began diverting flows from the San Joaquin River for agriculture and municipal and industrial uses in the Tulare Basin. A settlement provided 50,000 acre-ft of water (if and when available) for wetlands within the Grassland Water District during the fall and winter months. The California Department of Fish and Wildlife also negotiated agreements with the U.S. Bureau of Reclamation and various local water districts for many of its wildlife areas.

and to waterbird populations, and especially to non-breeding waterfowl.

By the end of the 1970s, political pressure from concerned landowners and wildlife agencies led to investigations and peer-reviewed publications that made the case for more reliable supplies of water for remaining Valley wetlands. These studies, along with passage of the National Environmental Policy Act and State and Federal Endangered Species Acts, set the stage and provided a critical basis for environmental protections for the Valley wetlands. These protections were codified in new legislation, which was under development as the U.S. Bureau of Reclamation (USBR) renewed water supply contracts with its CVP customers.

As these investigations progressed, other actions were underway that would significantly affect the Valley's wetlands. The North American Waterfowl Management Plan, an international treaty between the United States and Canada, was signed in 1986 and identified the Central Valley as one of the six priority habitat areas for North American waterfowl. The CVJV was subsequently formed in 1988. Recognizing the importance of sufficient, reliable water supplies for waterfowl health, as demonstrated by many scientific studies, one of the objectives stated in the CVJV 1990 Implementation Plan was to secure reliable water supplies for publicly-owned Central Valley wetlands, the privately managed wetlands within the Grassland Resource Conservation District (GRCD), and elsewhere in the Valley. (For more details, see text box: "The science-based need for reliable wetland water supplies.")

## CVPIA mandates wetland water

The Central Valley Project Improvement Act (CVPIA), Title 34 of Public Law 103-575, was passed in 1992. This Act amended previous authorizations of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses, and fish and wildlife enhancement as a project purpose equal to power generation.

## WATER SUPPLY TERMS

**L2 – Level 2 refuge water supply:** The minimum amount of water necessary to maintain wetlands and wildlife habitat benefits based upon average water deliveries occurring prior to 1992. This amount totals 422,251 acre-ft per year.

**IL4 – Incremental Level 4 refuge water supply:** The additional quantity of water, above L2, that each habitat area needs to reach Full L4.

**Full L4 - Full Level 4 refuge water supply:** The total amount required by CVPIA for optimal habitat management. Some habitat areas will need investments to improve or develop infrastructure necessary to receive Full L4 supplies.

*Flooded wetlands, Grasslands Ecological Area - USFWS*

# THE SCIENCE-BASED NEED FOR RELIABLE WETLAND WATER SUPPLIES

Severely declining populations of resident and migratory birds in the 1970s and 1980s led to a number of studies on Central Valley wetland water needs. One of the first studies published during this period was the Total Water Management Study for the Central Valley Basin of California (USBR, unpublished report, 1978, see "Notes"). This study included Working Document No. 12, "Fish and Wildlife Problems, Opportunities, and Solutions" (USBR, unpublished report, 1978, see "Notes"), a survey of major fish and wildlife problems and improvement opportunities within the geographical area encompassed by the CVP. As a result of the study's findings, the USBR initiated the Central Valley Fish and Wildlife Management Study of 1979 (USBR, unpublished report, 1979, see "Notes"). The study established a comprehensive baseline of Central Valley fish and wildlife resources and recommended specific solutions to water related issues.

These studies continued into the early 1980s and resulted in a report, Refuge Water Supply, Central Valley Hydrologic Basin, California 1986 (USBR 1986) that addressed waterfowl and wetland habitat. This study served as the basis for the 1989 Report on Refuge Water Supply Investigations, Central Valley Hydrologic Basin, California (USBR 1989), estimated average historical managed wetland water supplies ("Level 2" water supplies) and developed ecologically sound estimates of wetland water needs for optimal habitat management ("Level 4" water supplies). This report provided a critical basis for codified environmental protections that were under development and required adequate water supplies to support the 19 refuges that became part of the environmental baseline requirements as USBR renewed water supply contracts with its CVP customers.

Following passage of the Central Valley Project Improvement Act (CVPIA), many CVP water users were concerned about how the refuge water supply provisions would be implemented. To address those concerns, best management practices and efficient use plans were developed for the managed wetlands covered by CVPIA. In 1996, Deputy Secretary of the Interior John Garamendi directed that an Interagency Coordinated Program Task

*Eared grebe - Tom Grey*

Force be instituted to provide a common methodology for water use planning and efficient water regimes for all wetland areas receiving water authorized by CVPIA. Their final report, An Interagency Coordinated Program for Wetland Water Use Planning: Central Valley, California (USBR et al. 1998), estimated monthly and annual water supplies needed to properly manage state, federal and GRCD seasonal and semi-permanent wetlands for each basin.

CVPIA Section 3406 (d)(6)(A,B) required the investigation of water and conveyance needs for private wetlands not covered by the other provisions of the Act. The 2000 Central Valley Wetlands Water Supply Investigations, CVPIA 3406 (d)(6)(A,B), A Report to Congress (USFWS 2000) was produced as a result. Central Valley water suppliers were interviewed and their comments incorporated into the Water Report. Most expressed concern over the long-term shortages of water supplies resulting from a statewide lack of new water development (e.g., groundwater banking, new reservoirs, and new conveyance infrastructure); a reduction of Colorado River water supplies; and increasing urban and environmental demands that reduce supplies for agricultural and other uses. Although most suppliers face no legal obstructions to providing wetland water, many believed that agriculture would have priority if water shortages develop.

Collectively, these studies provided a scientific and peer-reviewed basis for wetland water needs estimates in CVPIA and water contracts, and many of these publications are still referenced today by wetland and water managers throughout California and the West.

| REFUGE NAME | LEVEL 2 (ACRE-FT) | INCREMENTAL LEVEL 4 (ACRE-FT) | FULL LEVEL 4 (ACRE-FT) |
|---|---|---|---|
| **Colusa Basin** | | | |
| **Sacramento National Wildlife Refuge**[a] | 46,400 | 3,600 | 50,000 |
| **Delevan National Wildlife Refuge**[a] | 20,950 | 9,050 | 30,000 |
| **Colusa National Wildlife Refuge**[a] | 25,000 | 0 | 25,000 |
| **Subtotal** | **92,350** | **12,650** | **105,000** |
| **Sutter Basin** | | | |
| **Sutter National Wildlife Refuge**[a] | 23,500 | 6,500 | 30,000 |
| **Subtotal** | **23,500** | **6,500** | **30,000** |
| **Butte Basin** | | | |
| **Gray Lodge Wildlife Area** | 35,400 | 8,600 | 44,000 |
| **Subtotal** | **35,400** | **8,600** | **44,000** |
| **San Joaquin Basin** | | | |
| **San Luis Unit**[b] | 19,000 | 0 | 19,000 |
| **West Bear Creek Unit**[b] | 7,207 | 3,603 | 10,810 |
| **East Bear Creek Unit**[b] | 8,863 | 4,432 | 13,295 |
| **Kesterson Unit**[b] | 10,000 | 0 | 10,000 |
| **Freitas Unit**[b] | 5,290 | 0 | 5,290 |
| **Merced National Wildlife Refuge** | 13,500 | 2,500 | 16,000 |
| **Los Banos Wildlife Area** | 16,670 | 8,330 | 25,000 |
| **China Island Unit**[c] | 6,967 | 3,483 | 10,450 |
| **Salt Slough Unit**[c] | 6,680 | 3,340 | 10,020 |
| **Volta Wildlife Area** | 13,000 | 3,000 | 16,000 |
| **Grassland Resource Conservation District** | 125,000 | 55,000 | 180,000 |
| **Subtotal** | **232,177** | **83,688** | **315,865** |
| **Tulare Basin** | | | |
| **Mendota Wildlife Area** | 27,594 | 2,056 | 29,650 |
| **Kern National Wildlife Refuge**[d] | 9,950 | 15,050 | 25,000 |
| **Pixley National Wildlife Refuge**[d] | 1,280 | 4,720 | 6,000 |
| **Subtotal** | **38,824** | **21,826** | **60,650** |
| **Contract Total** | **422,251** | **133,264** | **555,515** |

*Source: CVPIA Refuge Water Supply Program*
*[a] Part of the Sacramento National Wildlife Refuge Complex*
*[b] Part of the San Luis National Wildlife Refuge Complex*
*[c] Part of the North Grasslands Wildlife Area*
*[d] Part of the Kern National Wildlife Refuge Complex*

**TABLE 4.2.1** Water deliveries to refuges required by the CVPIA.

Due in part to an investment in the legislative process by CVJV partners, provisions were made in CVPIA Section 3406 (d)(1-5) to meet wetland water needs. The law authorized water supplies for those wetland areas covered by the 1989 Report and the San Joaquin Basin Action Plan/Kesterson Mitigation Action Plan, a plan developed to mitigate the habitat losses resulting from the Kesterson National Wildlife Refuge (NWR) selenium contamination of the 1980s, and to implement the objectives of the CVJV. The CVPIA mandated delivery of historical water supplies, referred to as "Level 2" supplies, and two-thirds of the full water supply requirements for lands identified in the Action Plan from the CVP. In addition, "Incremental Level 4" water supplies were to be acquired through purchase from willing sellers and provided in increasing 10 percent increments per year until 2002, when full water supply requirements were authorized. Table 4.2.1 lists the water deliveries mandated by the CVPIA.

In addition to requiring water delivery, Section 3407(d) established the CVP Restoration Fund as a critical funding source for CVPIA activities. The Restoration Fund contributes about $50 million annually to support salmon restoration activities and water delivery to 19 critical state and federal wildlife refuges and private wetlands within GRCD in the Central Valley. Water from the CVP and hydropower users make annual payments into the Restoration Fund, and the USBR administers the program.

Several long-term water conveyance/supply contracts and agreements were negotiated during the 1990s that increased the reliability of CVPIA water supply delivery. These contracts and agreements called for the establishment of an Interagency Refuge Water Management Team (IRWMT). Comprised of USBR, USFWS, CDFW,

## CVPIA: LANDMARK LEGISLATION FOR CENTRAL VALLEY WETLAND RECOVERY

To date, the CVPIA is one of the most important legislative actions taken to protect and restore Central Valley wetland habitat, and it has laid the foundation for many significant and beneficial conservation activities in subsequent years. Since 1992, delivery of adequate, suitable quality water to certain NWRs, WAs and the private wetlands of the GRCD through CVPIA has improved wetland habitat quality and benefited many wetland-dependent wildlife populations, including waterfowl, shorebirds, colonially nesting waterbirds, and several threatened and endangered species. Annual reports to Congress and a variety of studies and reports conducted by the USFWS and CDFW have documented these benefits:

- A 600% increase in waterfowl food production within the GRCD (USBR and USFWS 2004).
- An 89% reduction in avian disease outbreaks on the Sacramento NWR Complex since 1992 (USBR and USFWS 2004).
- A 49% increase in fall shorebird use Central Valley-wide (M. Wolder, personal communication, 2012, see "Notes").
- A 50% increase in the number of heron and egret rookeries at Kern NWR (D. Hardt, personal communication, 2004, see "Notes").
- A 61% increase in visitor use on the Sacramento NWR Complex between 1992 and 2006 (USBR and USFWS 2004).
- Increases in non-waterfowl species such as the western pond turtle, as well as some threatened or endangered species (e.g., tricolored blackbird and giant garter snake) on Central Valley refuges (USBR and USFWS 2004).
- Marked increases in populations of white-faced ibis and sandhill cranes. Ibis populations increased from 100 birds in 1991 to 15,000 in 2002 at the Sutter NWR; sandhill cranes at Pixley NWR increased from 200 in 1992, to 2,000 in 1993, to 5,000 in 2001 (USBR and USFWS 2004).
- The Agricultural Waterfowl Incentive Program, CVPIA 3406 (b)(22), funded the flooding of an average of 40,000 acres of agricultural lands each winter between 1997 and 2003, providing a substantial portion of the annual waterfowl energetic need within the Pacific Flyway during that time (USBR and USFWS 2004).

These habitat improvements have led to research by universities, government agencies, and non-governmental conservation organizations such as the California Waterfowl Association; Ducks Unlimited, Inc.; Point Blue Conservation Science; University of California, Davis; United States Geological Survey's Biological Research Division, Dixon Field Station; and others that cite the benefits of refuges and the water that creates those wetlands.

*California black rail - Philip Robertson*

Despite these benefits, the CVPIA mandated water supply levels have never been fully achieved, due in large part to state and federal budget shortages, inconsistency in the timing of water deliveries, and increases in the cost of blocks of water made available annually from willing sellers on the open market, also known as the "spot market." Budgetary constraints within USBR's annual CVPIA Restoration Fund and the state's past inability to cover their 25% cost-share mandate, required by CVPIA, have restricted the amount of Level 4 water supplies that can be acquired each year. At the same time, water costs have escalated as water acquisitions to meet CVPIA, urban, and agricultural needs have influenced sharp increases in spot market prices, further stressing limited budgets.

Budget shortfalls have also inhibited the ability to complete the construction of conveyance facilities necessary to deliver water to refuge boundaries. In some cases, conveyance facilities to provide water delivery to the property boundary are still awaiting construction.

Although the future of the Restoration Fund is still uncertain, public funding through state bond measures was dedicated in November 2014 to support CVPIA refuge-related expenses. This development has expedited progress on some conveyance and water acquisition projects. The Refuge Water Supply Program will complete a Strategic Plan that identifies priority projects and opportunities to achieve Full Level 4 water supplies as quickly as possible, creates an adaptive management decision tool, and outlines likely funding needs.

and the GRCD, the IRWMT meets regularly, collaborating on the acquisition and allocation of incremental water supplies necessary for wetlands to operate at full habitat development levels (Level 4) and other wetland water related issues. The IRWMT has invited a representative from the CVJV to regularly participate in team meetings, collaborate on refuge water strategies, and convey a broader view of how refuge habitat contributes to meeting the CVJV's valley-wide objectives.

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**The CVPIA statutorily obligates the Secretary of Interior to consult with the CVJV in matters involving wetland water acquisition and delivery. Considering this obligation, the CVJV maintains a unique responsibility to consider water supply issues related to the implementation of this 2020 Plan by participating in forums where water issues and policies are being discussed, to assure that policy makers address wetland water needs.**

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### Development of water supplies for private wetlands and other wetland habitat lands

The CVPIA directed the U.S. Department of the Interior to provide firm water supplies to the 19 critical wetland complexes that include 18 federal and state refuges and the private wetlands within the GRCD, but these lands account for only one-third of the managed wetlands in the Central Valley. The CVPIA also identified additional wetlands as key components of habitat needed for birds and other species in the Central Valley, and it identified specific actions and investigations to assess water needs and water supply opportunities for these wetland areas.

Habitat provided by postharvest-flooded agricultural land, particularly postharvest rice, benefits waterfowl, shorebirds and a variety of other wildlife species and grew exponentially in the 1990s. It is the largest component of the wetland habitat mosaic today. Rice straw is high in silicate and other components that make it difficult to decompose, and straw left over from the previous harvest must be eliminated prior to the subsequent growing season. Before the 1990s, removal of rice straw was primarily achieved through burning, but air quality impacts led the legislature to mandate a phase-down of burning. The CVPIA Section (b)(22) established an incentive program for farmers to flood postharvest rice. Winter flooding provided an alternative and relatively cost-effective method of decomposing rice straw at a time when growers were unfamiliar with other methods.

By the early 2000s, postharvest flooding became the principle means of rice straw decomposition. At that time, 70 percent of the planted rice acres, or approximately 350,000 acres of harvested rice fields, were winter-flooded. A win-win for agriculture and the environment, winter flooding of rice also provides food for ducks, geese and shorebirds and provides habitat for millions of migrating waterfowl and shorebirds.

The Central Valley Wetlands Water Supply Investigations – Final Report (USFWS 2000), required by CVPIA (Section 3406(d)(6)(A,B)), reported to Congress on the adequacy of and needs for water supplies to existing private wetlands; on the water supply and delivery requirements to permit full habitat development on 120,000 acres of supplemental wetlands (public or private); and on feasible means of meeting those requirements.

Many private wetlands were developed on lands that were difficult to farm and did not have firm water supplies, water rights, or even wells. Water supplies to private wetlands were developed primarily by connecting to drains from local agricultural lands; establishing easements with farmers who agreed to flood land with water supplies available to them; pumping groundwater on-site; or more recently for many wetlands, by working with local landowners to pump or exchange groundwater to flood up wetlands. The water needs in the Water Supply Investigations report were based in part on CVJV's 1990 Implementation Plan goal for 120,000 acres of additional supplemental wetlands.

## Central Valley Wetland Water Supplies Today

Today, a variety of surface and groundwater sources supply water to Central Valley wetlands. In the Central Valley, the great majority of wetland acres are irrigated with surface water supplies. The surface water supplies available in a given year can be correlated with precipitation received in the Central Valley and Sierra Nevada, with the "water year type," a classification that accounts for precipitation over the wet season (from October through about May), and with water storage levels in reservoirs. Water rights also drive the availability of water and vary depending on the type of water right a parcel might have. Inter-annual water variability presents challenges as well as opportunities for wetland water supply management. More broadly, many Central Valley wetland water supplies are not secure and face several challenges as the demand for this highly managed but scarce resource increases, as water costs increase, and as shifts in climate and

| ENTITLEMENT OR SUPPLY SOURCE | DESCRIPTION |
|---|---|
| **Central Valley Project (CVP) Contracts** | Contractual allocation of CVP's annual water supply. Five separate CVP contracts provide Level 2 supplies for CVPIA refuges. |
| **State Water Project (SWP) Contracts** | Contractual allocation of a portion of the SWP's annual water supply. |
| **Pre-1914 Appropriative** | Right to divert specific quantity, to specific location, for specific purpose(s). Right holder can provide evidence of original use prior to 1914 and continued use thereafter. More senior than rights granted after the passage of the Water Commission Act of 1913, Appropriative rights are often used by CVP and SWP contractors for winter water supplies (such as for rice decomposition) after October 1. |
| **Post-1914 Appropriative** | Right to divert specific quantity, to specific location, for specific purpose(s). Granted by what is now the State Water Resources Control Board (SWRCB) after the passage of the Water Commission Act. Seniority determined based on year granted. Appropriative rights are often used by CVP and SWP contractors for winter water supplies (such as for rice decomposition) after October 1. May be subject to Term 91[a] in drier years. |
| **Riparian** | Right of landowner of land located adjacent to surface water, to use the natural flow of the watercourse to meet needs of that land. This water cannot be stored, leased or assigned another place of use. May be used as a source for some wetland or riparian bird habitats when that habitat is located adjacent to a watercourse. |
| **Banked** | Contract for right to surface water stored underground as a groundwater banking facility. Not common as a wetland water source. |
| **Tailwater** | Not an established right under the SWRCB, but tailwater was a major source of wetland water prior to construction of the CVP and SWP. Chemicals in tailwater also led to ecological damage near Kesterson in the late 1980s, resulting in mitigations and water supply replacements specified in CVPIA and the San Joaquin Basin Action Plan/Kesterson Mitigation Action Plan (USBR et al. 1989). Tailwater is still a significant source of supply to many private wetlands, especially in the Sacramento Valley. Reductions can occur from water use efficiency measures implemented upstream. |
| **Surplus flows** | Wetland management may have (or could apply for) an appropriative right from the SWRCB for surplus flows, such as storm flows. Typically, these flows would only be available from December through March in above normal or wet years, and timing is not guaranteed. Access may be constrained by agricultural operations that may shut down in winter when not being used for irrigation, or by irrigation districts that close water delivery canals for annual maintenance[b]. |
| **Recycled water** | Some wetlands are supplied with recycled water through a contract with the recycled water managing entity, such as through the North Valley Regional Recycled Water Program. |
| **Groundwater** | Groundwater is an important source of water for some Central Valley wetlands. Pixley NWR, for example, currently relies on groundwater for 100% of its water supply. As SGMA is implemented, groundwater use in some areas of California, including at some wetlands, will be severely restricted. |

*[a] Term 91 is a condition of a water right that requires the user to cease diversions under the permit or license when noticed by the State Water Board.*
*[b] Surplus flows are also important for fish migration at certain times of year, which presents a challenge, but return flows from wetlands can also provide additional river flow if timed to meet fish needs.*

**TABLE 4.2.2** Water rights and other wetland water sources.

aging infrastructure force reconsideration of water management regimes (Matchett and Flekes 2017).

The CVJV has confronted these water challenges by working collaboratively with partners on the ground; creating sophisticated spatial management tools to understand habitat availability in real time; and developing creative, science-based, multi-benefit approaches to providing reliable wetland water.

This section provides an overview of wetland water sources, the water needs of different wetland types (both by acre and the total needed to meet CVJV population targets), and the timing of those needs; and discusses the extent to which those needs are currently being met.

## Sources of wetland water

At different times of year, surface water is applied or groundwater is pumped to meet wetland habitat needs, either directly for that purpose (e.g., a contracted water delivery to a refuge) or indirectly to meet other needs. For example, flood irrigation of pastures and other crops benefit shorebirds, and rice fields flooded in summer provide brood habitat. Also, postharvest flooding in fall and winter benefits non-breeding waterfowl. Precipitation and uncontrolled flood water may also create wetland conditions, but managed wetlands and postharvest-flooded croplands, the focus in this section, typically rely on developed and applied water supplies.

Wetland water supplies vary widely in terms of the water source and the type and seniority of water right, which in turn affect the reliability of the water delivery. For example, a portion of water delivered to CVPIA refuges by means of CVP water supply contracts has typically been reliable except during extreme droughts. Conversely, drain flows (tailwater) that supply some duck clubs may literally "dry out" when upstream agricultural districts implement a "no discharge" policy or water use efficiency measures that reduce drain flows.

Various Central Valley wetlands may rely on numerous different water supplies (Table 4.2.2).

## Wetland water needs

The timing and amount of water needed to create the necessary habitat conditions to support waterfowl, shorebird and other waterbird populations at goal levels in the Valley depend on:

- The waterfowl, shorebird or other waterbird population that must be supported at different times vary throughout the year because of such things as life stage requirements or migration chronologies.
- What kind and how much habitat (acres) is needed to support those populations.
- The amount of water needed per acre of habitat type in specific planning regions to support a given population.
- Where and when the water must be provided to create the needed habitats.

Generally, for migratory waterfowl, depths of 4 to 10 inches of water (NRCS et al. 2007) are required to create suitable habitat conditions during the peak migration and wintering period between August and March. Water is also required from April through August to maintain moist soil conditions, germinate seeds and maintain wetland plants, irrigate rice to meet waterfowl energy needs during the winter months, and provide nesting and brood rearing habitat.

Nonbreeding shorebirds require shallower water depths (mudflat to 4 inches) than waterfowl. Shorebirds typically find habitat on managed wetlands and winter-flooded rice, when flooding begins, and late in the season during drawdown, when water recedes. Breeding shorebirds nest adjacent to shallow water in managed wetlands and rice. But in general, the flooding and drawdown schedules of managed wetlands and winter-flooded rice are more consistent with the needs of waterfowl than shorebirds in the Central Valley.

| HABITAT TYPE | UNIT WATER NEED (ACRE-FT/ACRE) | TIME PERIOD |
|---|---|---|
| **Seasonal wetlands** | 5.1 | August through March, with irrigations in June |
| **Semi-permanent wetlands** | 7.4 | October through mid-July |
| **Flooded rice** | | |
| Winter flooding (for rice straw decomposition) | 2.5 | October through December |
| Growing rice (prior to winter flooding) | 5.0 | April through September |

**TABLE 4.2.3 Wetland water needs by habitat type (supply needed for full annual cycle)** (USBR et al. 1998; USFWS 2000; UC Davis 2019).

The water needs of other waterbirds, such as egrets, ibises, cranes and terns, vary widely by species, as detailed in the Breeding and Non-Breeding Waterbirds chapter.

In general, the quantity of water needed per acre of habitat depends on the wetland type – seasonal wetland, semi-permanent wetland, or flooded rice – and the depth and duration of flood most suited to waterfowl or shorebird needs. The comprehensive Central Valley Wetlands Water Supply Investigations Report to Congress (USFWS 2000) in December 2000 presented monthly water needs for seasonal and semi-permanent wetlands by drainage basin and the timing and rate at which these wetlands are flooded and maintained. Based on the information in this report and other sources, approximate annual water needs are summarized by habitat type in Table 4.2.3.

The more precise need varies depending on soil characteristics, topography, location in the Valley, and other factors. For example, due to higher evaporation rates experienced in the southern Central Valley, habitats in the Tulare Basin typically have a higher water demand than in the Sacramento Valley. Also, rice fields located on more permeable soils may require more water to maintain a flooded condition than those overlying less permeable soils.

To maintain optimal conditions for non-breeding waterbirds on seasonal wetlands, approximately 5.1 acre-ft/acre is needed per year. This water is typically applied from August through March, with one or two irrigations between April and July to ensure adequate seed production by moist soil plants.

Approximately 7.4 acre-ft/acre is needed per year to meet the needs of locally breeding ducks and other waterbirds. Water is applied for flooding from October through mid-July, including maintenance flows to offset evapotranspiration.

Flooded rice fields contribute a critical percentage of wetland habitat in the Valley. Winter-flooding requires 2.5 acre-ft/acre (M. Petrie, personal communication, 2016, see "Notes") of applied water throughout the postharvest season to promote straw decomposition and provide waterbird habitat. Applying this water between October and January corresponds to peak waterfowl habitat needs (M. Petrie, personal communication, 2016, see "Notes"). Applying the water earlier, from September (or earlier, though this is not possible unless rice is harvested atypically early) to October, provides habitat for shorebirds as they arrive in the Central Valley from more northern breeding areas (Dybala et al. 2017). Most of this water either percolates into the ground or drains as tailwater in early spring, returning to the system for other downstream uses.

Water is also needed to flood and grow the rice that eventually provides the fall and winter habitat for waterfowl and shorebirds. Growing rice requires approximately 5 acre-ft/acre (UC Davis 2019), applied between April and early September. The consumptive use of this water by the crop is about 2.8 acre-ft/acre, with the remaining evaporating, percolating into the ground or draining as tailwater spill at the end of the irrigation season, returning to the system to support other uses downstream.

Shorebirds need habitat at times that do not coincide with the time when rice fields are typically flooded postharvest. If the shorebird population reached the long-term objective, additional habitat would be particularly critical in the fall (late July to September) and spring (mid-March to April) (Dybala et al. 2017). Idled fields could be shallowly flooded in late July through August, prior to when other habitat would be flooded, and in March through April, after other habitats are drained, to make up for these shortfalls. Seasonal wetlands could also be managed, particularly on refuges, specifically to provide habitat during these time periods. Willing agricultural or refuge partners and supplemental water supplies would be needed to support these practices on the landscape.

Several CVJV partner organizations participated in a collaborative analysis to describe the water needs of Central Valley fish, waterfowl, shorebirds, and the giant garter snake, on a semimonthly basis, upstream of different control points in the Sacramento River watershed and Sacramento-San Joaquin River Delta. The annual hydrographs developed for this effort were informed by and built on the CVJV's assessment of bird habitat needs (objectives). These hydrographs (Figures 4.2.1 – 4.2.4) are presented here to illustrate the approximate pattern of Central Valley waterfowl and shorebird water needs over the course of a water year (starting in October).

Figure 4.2.1 presents the total water needs patterns of waterfowl and shorebirds, including all habitat types, from the Sacramento River watershed upstream of the American River confluence. Referred to here as the Sacramento Valley, this watershed roughly corresponds to the CVJV's Sacramento planning region. Figure 4.2.1 includes the water needed to grow the acres of rice that must later be flooded to provide adequate bird habitat.

Figure 4.2.2 breaks out the waterfowl water need in this area by habitat type. Note that the water needed for winter-flooded rice habitat has two components: water used for irrigation to grow the rice that will be winter-flooded, and water used to flood the fields postharvest. Note that more rice is grown than can be flooded. So, to estimate the water used for irrigation, only the volume of water needed to inundate lands that actually become (are later flooded for) habitat for wildlife was incorporated into the estimate of water needed for wildlife needs.

The timing of these water diversions between April and the first half of September is assumed to be proportional to a typical delivery pattern of the Sacramento Valley Settlement Contractors, who grow the majority of rice in the Sacramento Valley (pattern adapted from Sacramento Regional Water Management Plan, January 2007 and personal communication with Thad Bettner, GCID: T. Bettner, personal communication, 2016, see "Notes").

Figure 4.2.2 shows that water needed to grow rice and subsequently flood that rice in winter comprises the largest volume of water needed of all habitat types. Flooded rice fields provide over 60 percent of the food resources available to ducks and

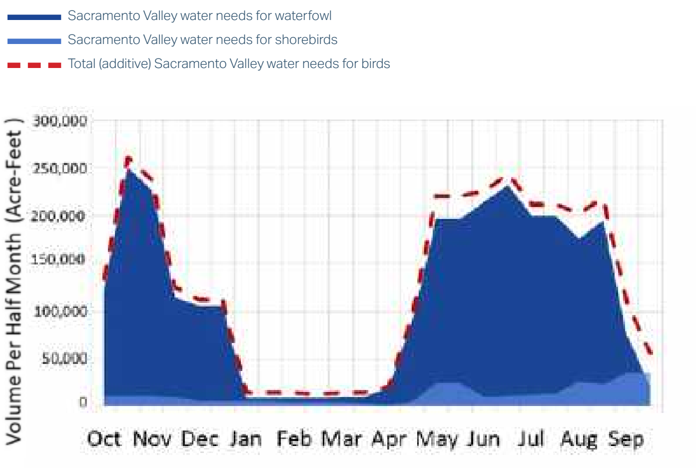


**FIGURE 4.2.1 Semimonthly waterfowl and shorebird water needs from the Sacramento River watershed upstream of the American River confluence.** The dashed line shows the sum of these needs.

geese in the Central Valley, with refuges, managed wetlands and harvested corn fields typically providing the rest. It is important to note that rice and corn must not only be grown but also winter-flooded to make food resources fully available to birds.

Figure 4.2.3 presents the total water needs pattern of both waterfowl and shorebirds including all habitat types from the Delta, San Joaquin, and Tulare Basins. Although proportionally small, water needed to grow the acres of rice that must later be flooded for birds is also included here.

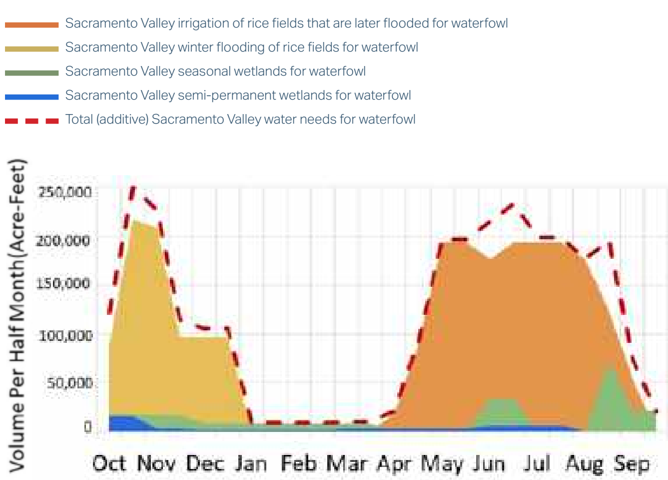


**FIGURE 4.2.2 Semimonthly waterfowl needs from the Sacramento River watershed upstream of the American River confluence: Breakout of water needed to grow rice and winter flood post-harvest for habitat.** Only the water needed to grow the rice that is later winter-flooded is included. The dashed line shows the sum of these needs.

The water needs of refuges are a component of the seasonal and semi-permanent water needs for waterfowl and shorebirds presented in the previous figures. Figure 4.2.4 presents these refuge water needs (assuming optimal water supplies required by CVPIA are available) both in the Sacramento Valley and in the San Joaquin and Tulare Basins.

These figures illustrate the general pattern of water needs at the CVJV's current acreage targets for each habitat type. The water supplies available to each of these wetland types may vary from year to year. The next section describes the availability and reliability of these water supplies by wetland type, followed by the challenges and opportunities for increasing those supplies to achieve the target water needs.

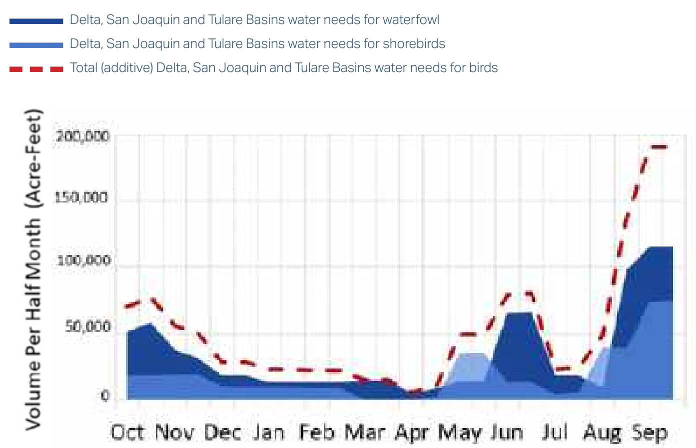


**FIGURE 4.2.3 Semimonthly waterfowl and shorebird water needs in the Delta, San Joaquin and Tulare Basins.** Dashed line shows the sum of these needs.

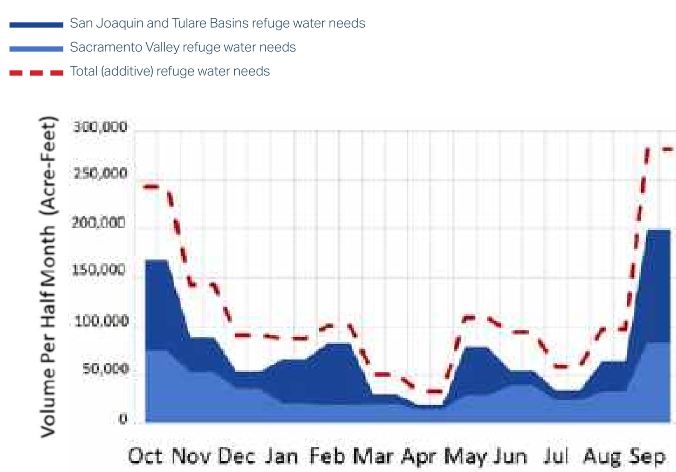


**FIGURE 4.2.4 Semimonthly refuge water needs in the Sacramento, San Joaquin and Tulare Basins.** The dashed line shows the sum of these needs.

## Meeting wetland water needs: current status

In some areas of the Central Valley, existing wetlands with reliable water supplies may receive enough water in wetter years to support best management practices. But in other areas and in drier years, water supplies are uncertain at best and not available at worst, leaving important wetland habitat dry and impacting its productivity for years to come. This section describes the extent to which CVJV partners and Central Valley land managers are providing the water necessary to meet habitat objectives on managed wetlands and winter-flooded agricultural land. The section also identifies particular gaps with respect to water supplies.

### CVPIA-covered federal refuges, state wildlife areas, and the GRCD

The CVPIA directs the U.S. Department of the Interior and the state of California to provide adequate, reliable water to 19 Valley refuges, hereafter termed "CVPIA refuges." Included are the 14 National Wildlife Refuges in the Valley; the Gray Lodge, Los Banos, Volta, and Mendota Wildlife Areas; and the GRCD. But on average, only half of the spring and summer water required to meet the needs of wildlife is delivered. Far less water is delivered to refuges in drought years, especially in the San Joaquin Valley.

Water supplies required by CVPIA have never been fully delivered to all refuges because of several physical and institutional challenges. Most CVPIA refuges receive a portion of their water supply (their "Level 2" supply) with a reliability that has, to date, matched that of senior CVP contractors. However, total water deliveries show a declining trend over the years, particularly with respect to Incremental Level 4 supplies (Figure 4.2.5).

According to delivery records through 2018 maintained by the Refuge Water Supply Program, an average of 422,000 acre-ft has been delivered to CVPIA refuges annually since 2002 (USBR, personal communication, 2017, see "Notes").

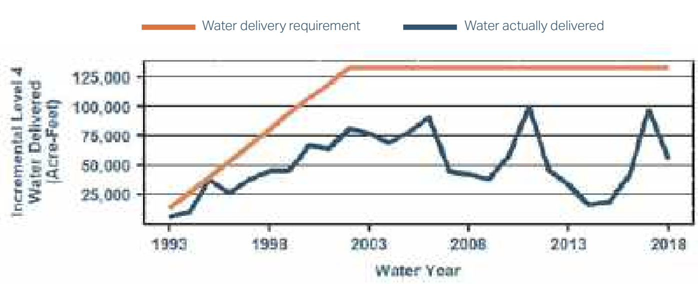


**FIGURE 4.2.5 Water supplies acquired for refuges show a declining trend.** Red line shows Incremental Level 4 water delivery requirement; blue line shows water actually delivered.

| | **UNMET WATER NEED** (ACRE-FT) | **CONSTRAINT** |
|---|---|---|
| **SACRAMENTO VALLEY** | | |
| ***Sacramento National Wildlife Refuge Complex*** | | |
| **Sacramento National Wildlife Refuge** | - | |
| **Delevan National Wildlife Refuge** | - | |
| **Colusa National Wildlife Refuge** | - | |
| **Sutter National Wildlife Refuge** | 15,900 | Infrastructure |
| **Gray Lodge Wildlife Area** | 8,600 | Infrastructure |
| **SAN JOAQUIN VALLEY** | | |
| ***San Luis National Wildlife Refuge Complex*** | | |
| **San Luis Unit** | - | |
| **West Bear Creek Unit** | 3,200 | Acquisitions |
| **East Bear Creek Unit** | 9,800 | Infrastructure, acquisitions |
| **Kesterson Unit** | - | |
| **Freitas Unit** | - | |
| **Merced National Wildlife Refuge** | - | |
| **Kern National Wildlife Refuge** | 7,200 | Acquisitions |
| **Pixley National Wildlife Refuge** | 4,700 | Infrastructure, acquisitions |
| **Volta Wildlife Area** | 2,700 | Infrastructure |
| **Los Banos Wildlife Area** | 4,600 | Acquisitions |
| ***North Grasslands Wildlife Area*** | | |
| **China Island Unit** | 1,400 | Acquisitions |
| **Salt Slough Unit** | 1,300 | Acquisitions |
| **Mendota Wildlife Area** | 1,400 | Infrastructure, acquisitions |
| **Grassland Resource Conservation District** | 19,700 | Acquisitions |
| **Subtotal** | **80,500** | |
| **Estimated average 15% carriage loss** | **12,100** | |
| **Total** | **92,600** | |

**TABLE 4.2.4 CVPIA Refuges: Average water needs and constraints (rounded to the nearest 100 acre-ft (E. Wehr et al., unpublished report, 2017, see "Notes").**

This is the Full Level 2 water supply historically delivered to refuges. The total amount required by CVPIA for optimal habitat management, known as Full Level 4, is 555,000 acre-ft. The difference between the Full Level 4 and Full Level 2 amounts is 133,264 acre-ft and is known as the Incremental Level 4 (IL4) amount. While the L2 amount is very reliable, supplied mostly via CVP yield, the Refuge Water Supply Program purchases a portion of the IL4 every year. (This is considered "applied water use" and does not account for return flows or seepage to maintain groundwater conditions in underlying aquifers.)

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**Delivery shortfalls reduce the habitat contribution these refuges could make to the overall mosaic of wetland habitats needed to support resident and migrating bird populations in the Central Valley. Without these deliveries, other wetland types must provide additional acres to make up for the habitat shortfall, or bird populations could be impacted.**

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The CVPIA refuges that are chronically short of water or those that face particular water supply challenges include Sutter NWR and Gray Lodge WA in the Sacramento Valley; and Kern NWR, Pixley NWR, Los Banos WA, North Grasslands WA, units within the San Luis NWR Complex, and GRCD in the San Joaquin Valley and Tulare. Table 4.2.4 lists water-short CVPIA refuges, approximate individual water needs, and whether those needs must be met through infrastructure investment or water acquisition. Note that water needs expressed are averages; needs in dry and critical years are higher.

### Other public and private non-CVPIA Refuge wetlands

Approximately two thirds of the managed wetlands in the Central Valley do not have a contract for water through the CVPIA. These seasonal wetlands are privately managed, most as "duck clubs," and they access developed water through a variety of water rights or incidental water supplies such as runoff or tailwater. Many private wetland managers rely on water supplies that are reduced in below-average water years, depend on return flows from agriculture, and/or are provided with contracts between water purveyors and federal or state agencies. Therefore, the water supplied to these wetlands and the extent of habitat may vary from year to year.

Water supplies available to these privately managed wetlands are deficient in some years and may be declining. In general, water supply deficiencies to these wetlands tend to occur during the fall flood-up period from September through November, and throughout the winter, when maintenance flows are needed to maintain flooded conditions. Wetlands could and do acquire rights to natural surplus flows from the SWRCB. However, as described previously, flows are typically only available from December through March after winter rains begin and are not available for September flood-up.

Tailwater from rice fields being drained in the fall is the source of water supply for 45,000 acres (approximately 56 percent) of the seasonal wetlands in the CVJV Sacramento planning region (Petrie and Petrik 2017). Some wetlands that rely on tailwater from agricultural operations are experiencing a reduction in supply as water use efficiency measures are implemented or as rice or row crops are converted to orchards. Refuges are experiencing similar challenges.

Wetland managers may also be reliant on operational conveyance facilities and drains to receive their water supplies. These facilities may shut down for maintenance activities when not being used for agricultural irrigation in fall and winter, which is typically when wetland water demands are highest.

### Agricultural habitats

The largest portion of non-breeding wetland dependent bird habitat in the Central Valley is now provided by agriculture, especially postharvest-flooded rice in the Sacramento Valley and, to a lesser extent, corn in the Delta Basin. Over the last few decades, migratory birds have increasingly relied on a mosaic of surrogate, temporary habitats outside of protected managed wetlands. These habitats include compatibly managed, seasonally flooded private agriculture lands.

Each year, approximately 550,000 acres of rice are planted in the Sacramento Valley and are used as breeding habitat. In a typical fall and winter, around 350,000 acres of this rice land is flooded intentionally as one way to promote decomposition of rice straw and create migratory bird habitat, as discussed previously. This acreage provides up to 50 percent of the food resources for waterfowl in the Central Valley (see the Non-Breeding Waterfowl chapter). Harvested corn crops also provide habitat and food benefits for waterfowl. In the Delta Basin, approximately 30,000 acres of corn are grown each year. This corn acreage provides roughly four percent of the food resources available for waterfowl in the Central Valley and is also especially important to sandhill cranes.

While much of the habitat provided by agriculture is used by birds in the fall and winter, creating this habitat and additional breeding habitat requires year-round water supplies. For example, starting as early as April, water is required to flood up rice fields for planting. In the spring and summer months, reliable and timely water supplies are necessary, both to cultivate the crop and to maintain breeding habitat. Once the crop is harvested, additional water supplies must be delivered to flood the fields to promote decomposition of rice straw and make waste grain accessible as food for birds. This winter flooding comes at a critical time when birds need to refuel for long migrations back to northern breeding grounds. Usually in February and March, the fields are drained and dried prior to planting, and the cycle begins again.

Most of the rice grown in the Sacramento Valley relies on surface water from the Sacramento River through CVP Settlement Contracts or Agricultural Service Contracts, or from the Feather River through State Water Project contracts. These contracts have provided relatively reliable water to grow rice in all but very dry and critically dry years. Access to water supplies in winter months for flooding fields can be limited by the lack of a right or contract to divert water, the relative priority of a winter water right, the terms of the water supply contract, reservoir operations, and other water management conditions. Therefore, although water supplies for growing rice have been relatively reliable, water supplies to flood rice fields postharvest and create habitat conditions are generally less reliable, especially in dry years and during droughts.

Trends indicate that winter flooding may decline both overall and as a percentage of rice acreage grown. Reasons for this decline include reduced water availability (whether real due to actual water curtailments or merely predicted in a given year), increased grower familiarity with dry incorporation methods, a growing market for rice straw (such as for fiberboard manufacturing), and other economic reasons. Some of these challenges are described in the Non-Breeding Waterfowl chapter.

*Lower Riley Slough on Faith Ranch: Water levels managed for bird habitat on private conservation-easement land - Gary Zahm, Faith Ranch*

## Wetland Water Supply Challenges

Many significant factors limit wetland water supplies now and they will continue to challenge habitat and natural resource managers into the future. Broadly, the primary water challenges facing both private and public wetland managers in the Central Valley are: (1) maintaining and increasing the reliability of water for wetland management, both quantity and quality; and (2) ensuring that funds for water supplies cover the increasing costs of water. Even CVPIA refuges that were guaranteed firm water supplies by Congressional action are limited in their ability to receive adequate water supplies. (Many of these challenges were described in detail in a report entitled "Undelivered Water: Fulfilling the CVPIA Promise to Central Valley Refuges" [CVPIA IRP 2009].) The challenges described in this section currently restrict or impair wetland water supplies or funding, or they will do so if not proactively addressed. The next section will discuss potential opportunities that could address these challenges.

### Refuge water conveyance

Most CVPIA Refuge managers depend upon water being conveyed to them through local water or irrigation districts to the refuge boundary. These districts needed improvements or expansions to their infrastructure for them to meet the individual CVPIA Refuge needs in their area, while also serving the ongoing needs of their own landowners. Construction and conveyance agreements were negotiated between these districts and the USBR so that these improvements could take place.

### Refuge water funding limitations and other challenges

The CVPIA Restoration Fund is the primary source of funding for CVPIA refuge water supply acquisitions, water conveyance rights, and infrastructure projects. It is funded by USBR's collection of environmental mitigation fees from CVP water and hydropower customers and is supplemented by contributions from the state. Approximately half of the $50 million annual fund is allocated to the CVPIA Refuge Water Supply Program each year. One challenge associated with the CVPIA Restoration Fund is the unpredictable nature of annual collections and appropriations. Various proposals to address the problem have been advanced. Any proposal to reform the Restoration Fund must be designed to preserve and enhance its ability to provide needed water supply to managed wetlands.

Another funding challenge is that federal and state budgets are unable to keep up with the increasing costs of water and the costs of maintaining reliable infrastructure on refuges. Although more permanent sources of Level 4 refuge water supply are under development, the majority of Level 4 refuge water is purchased on a year-to-year or "spot-market" basis. Increasing demands for water coupled with less water available in storage, on average, has resulted in higher water prices, reducing the amount of water that the program can acquire on an annual basis within its current budget. Costs for both permanent water rights and spot-market water are likely to continue to rise in the near future as groundwater users are increasingly forced to look to surface water supplies with the implementation of the Sustainable Groundwater Management Act. The Sustainable Groundwater Management Act of 2014 (SGMA) requires governments and water agencies of high and medium priority basins in California to halt overdraft (if it exists) and bring groundwater basins into balanced levels of pumping and recharge. This trend will further increase pressure on the Refuge Water Supply Program to provide adequate water to meet refuge needs.

## Droughts and climate trends

Droughts are a fact of life in California, but recent severe droughts have brought more attention to the potential and real impacts droughts can have on waterbird habitat in the Central Valley, a region that has lost so much available habitat over the last 150 years.

Drought impacts Central Valley wetland habitat in several ways. During a drought, water supplies are often curtailed to agricultural crops, an action that affects wetlands both directly and indirectly. Crops that may otherwise have directly provided postharvest-flooded habitat may be fallowed if water supplies are unavailable that year. Tailwater that would have otherwise flowed to supply some seasonal wetlands may be unavailable if irrigated field crops are fallowed or if "no water release" efficiency measures are implemented. Water supplies may also be curtailed to refuges, or unavailable or too expensive to purchase on the spot market, ultimately reducing wetland extent and/or food production at refuges.

Different regions of the Central Valley experience different levels of drought impact in terms of the extent of open water habitat available to birds. For example, studies found that in the Tulare and San Joaquin Basins, the amount of open water declined almost immediately in the fall/early winter following a drought water year, whereas several consecutive years of drought occurred before the Sacramento Valley experienced changes in the extent of open water. The Yolo-Delta and Suisun Planning Regions were generally unaffected by drought in terms of open water extent (Reiter, Elliott, Veloz et al. 2018). Contributing to the resiliency of the Sacramento Valley to drought is the availability of waterbird-compatible crops like postharvest-flooded rice, and senior water rights and policies such as Area of Origin that apply in the Sacramento Valley. Habitat south of the Delta, especially on refuges and private seasonal wetlands in the San Joaquin and Tulare Basins, may be more at risk during droughts.

California sustained an extreme drought between 2013 and 2015. During this lengthy drought, water supplies to wildlife-compatible agriculture and to managed wetlands and refuges were more severely curtailed than water supplies to other uses[2]. A recent study based on satellite imagery found up to 80 percent declines in postharvest-flooded agriculture and 60 percent open-water declines in managed wetlands compared to non-drought years (Reiter, Elliott, Jongsomjit et al. 2018). In 2014-2015, it was estimated that only 10 percent of wetlands were irrigated in summer. This low water supply level can result in a 44 percent decline in food production on non-irrigated wetlands (Petrie et al. 2016). During that season, avian disease outbreaks were prevented in part as a result of collaboration across refuges, coordination of water management and regulatory efforts by water agencies and the agricultural community to maximize value of limited water supplies, and incentive programs which, on average, provided 35 percent of the available habitat on the landscape and up to 100 percent of the habitat on some days during the drought (Reiter, Elliott, Jongsomjit et al. 2018). Some

2. The State Water Resources Control Board and other water managing agencies made water allocations decisions for the 2015 water year that attempted to balance available and anticipated water storage and the water needs of cities, agriculture, and the environment. Ultimately, water managers decided that Settlement Contractors (Sacramento Valley) and Exchange Contractors (San Joaquin Valley) would receive 75% and 65% of their contracted supplies, respectively, but more junior water rights holders throughout the Valley would receive 0%. On par with those contractors, CVPIA refuges were allocated 75% of Level 2 supplies (which are CVP project supplies) north of Delta and 65% of Level 2 supplies south of Delta, but this represented much less than "optimal" Level 4 water supplies to these refuges. Kern NWR, for example, received less than one-third of its Full Level 4 water supply.

research evaluating impacts of future scenario projections through year 2099 indicated that several regions in the Central Valley may require additional conservation to support summer irrigation of seasonal wetlands and winter-flooding of cropland habitats. San Joaquin and Tulare regions would become increasingly vulnerable to future impacts of water limitation, and similarly, habitats in some areas in the Sacramento Valley also would experience more frequent and severe effects of drought than historically (Matchett and Fleskes 2018).

CVJV partners responded to this drought by facilitating communication among wetland managers, studying the impact of drought on waterbird habitat availability, improving drought preparedness and response through scenario planning, recommending strategies to bolster habitat resiliency, and developing approaches to dynamically deploy habitat more efficiently and precisely when and where birds need it.

Climate trends indicate that severe droughts – as well as significant storm events and floods – may occur more frequently over the next 50 to 100 years (IPCC 2013; Diffenbaugh et al. 2015). CVJV partners can provide information on habitat impacts and needs to conservation practitioners and policymakers and develop strategies to ensure wetland habitat resiliency as these changes occur.

## Rice decomposition trends and changes in agricultural practices

As described previously, the average amount of winter-flooded rice has decreased in recent years.

In 2007 and 2008, dry incorporation of harvested rice fields – that is, plowing or disking with no intentional flooding – reached peak levels (Miller et al. 2010). Growers may have thought less water would be available those years because previous winters were dry. Although water supply curtailments were ultimately not enacted, the growers planned ahead on a more reliable method. When normal water supply conditions returned in 2009, 50,000 to 60,000 fewer acres of rice was winter flooded than it had been at its peak, with a corresponding number of fewer acres available as habitat for migratory birds. Rice growers may also have been learning how to better incorporate rice straw into soil to achieve acceptable levels of decomposition even without flooding, and thus did not wish or could not afford to return to a less reliable method (CRC 2015).

The drought from 2013-2015 resulted in water supply reductions in much of the Sacramento Valley. These curtailments and other water management decisions, including transfers to other agricultural water users, resulted in a significant decline in winter-flooded rice, especially in areas west of the Sacramento River. Reductions grew over each subsequent dry year. In 2014, although 424,350 acres of rice were harvested, it was estimated that as little as about 12 percent of those acres were postharvest-flooded, a 51 percent reduction from a typical year (Petrie et al. 2016).

Adding to these declines, and possibly in response to recent drought conditions that made winter flooding less viable, farmers have recently chosen to provide rice straw to a new state-of-the-art medium density fiberboard (MDF) manufacturing facility that is under development. This and other novel uses of rice straw offer rice growers alternatives to postharvest flooding.

Ultimately many rice growers may choose what decomposition method to use based on economics, convenience, and reliability. If the costs to winter flood increase due to rising water costs, labor, or other factors, or if water becomes less reliable and less convenient, incentive programs may be needed to encourage rice growers to reconsider the multiple benefits of winter flooding. See “New Public and Private Funding” below.

## Groundwater regulation

Local stakeholders are forming Groundwater Sustainability Agencies to manage basins and develop Groundwater Sustainability Plans. Under SGMA, these groundwater basins should reach sustainability within 20 years of implementing their sustainability plans (CDWR 2019).

Some Central Valley wetlands, particularly in the southern San Joaquin and Tulare Basins, rely on groundwater as a source – and for some the only source – of water supply. These wetlands may have no other water rights or access to surface water supplies. Implementation of SGMA in these areas is likely to reduce groundwater availability to a fraction of what is needed to manage wetlands. For example, in some parts of the Tulare Planning Region, early estimates suggest that groundwater allocations will be set at roughly only 0.5 acre-ft/acre per year of consumptive use. Some basins are developing a credit trading system enabling some land within a basin to pump more groundwater while others use less. The demand for these credits by non-wetland water users is likely to put pressure on wetland managers politically or financially, affecting continuing wetland viability.

Participation in the development of Groundwater Sustainability Plans by wetland managers or their advocates requires investments of time and funding to be sure that wetland water supply interests are accurately reflected in the basin water budgets and allocations.

### Water management projects and regulatory processes

Ensuring that ongoing federal, state and local water management projects and regulatory processes account for wetland water needs requires significant time investment by wetland and natural resource managers and their advocates. These projects and processes often pose challenges to the wetland conservation community, but they also may present opportunities if the CVJV engages strategically.

Although the duration and ultimate resolution of these ongoing processes is difficult to predict, the following are examples of planning and regulatory processes that could affect the ability of the CVJV – for better or worse – to achieve the Implementation Plan objectives over the next 10 years.

- Bay-Delta Water Quality Control Plan Update
- Reinitiation of Consultation on the Long-Term Operations of the SWP and CVP
- WaterFix and EcoRestore
- SWRCB Wetlands Policy

## Wetland Water Opportunities

CVJV partners have achieved a great deal of success working collaboratively on the ground to secure and restore new wetland habitat and to develop new ways to provide habitat on working lands. Securing and maintaining water supplies for this habitat, and developing ways to stretch existing wetland water supplies to achieve conservation targets, is also critically important, especially to confront the challenges described above. Strategic planning, funding and market-based solutions, and harnessing state-of-the-art technology and data are just some of the opportunities that can lead to better wetland water management and more resilient wetland water supplies.

### Strategic planning

Given the challenges described in this chapter, it is important to use available resources (funding, time and water) as strategically as possible. To help with this, the Refuge Water Supply Program (RWSP) is undertaking a stakeholder strategic planning process, managed collaboratively by agency staff and some CVJV partners.

The resulting Strategic Plan will identify a path for meeting the full CVPIA refuge contractual obligations. The intent of the Strategic Plan is to set a prioritized program budget, schedule, and expectations for implementing the refuge water supply component of the CVPIA, with partner agencies and stakeholders in the shortest possible timeframe. The plan will also provide a tool for managers to assess potential projects and expenditure of resources as conditions change or new project opportunities develop.

*Manager checking a water control structure at Twin Lakes Partners for Fish and Wildlife project - Shawn Milar*

### New public and private funding

Funding is needed to address water supply shortfalls on refuges and to encourage water-related agricultural practices, such as winter flooding, on private lands. Funding mechanisms could include bond measures, tax credits, and other creative strategies.

Some recent bond measures have allocated billions of dollars to water projects that could provide wetland benefits, and other bonds have allocated millions directly to bird habitat conservation.

Creating private wetlands or supplying wetland water could also be encouraged through tax credits or other financial incentives. As discussed previously, as winter flooding becomes more expensive or less reliable as a method for disposal, incentives may be needed to encourage growers to continue to winter flood their rice fields.

## Enhanced wetland water conservation and productivity

Implementing water conservation measures on wetlands must be done with an understanding of what the water needs are to support a particular function, or suite thereof. Discussions for achieving water efficiency should go hand in hand with discussions on desirable outcomes and the values obtained from dedicating water supplies for wetland habitat purposes. An increase in reliability and/or volume of water supplies delivered to a wetland may result in enhanced or additional beneficial uses of that wetland, measured in habitat and species diversity, caloric output, disease control, waterfowl body conditions, visitor days, recovered populations of listed species, etc. Any conservation measures implemented must not be detrimental to those outcomes, but rather be tied to achieving those same outcomes with less water.

One example of how managed wetlands can increase productivity with less water is by installing water recirculation infrastructure. Several CVPIA refuges have done so, and more projects are underway, including the Grassland Water District's North Grassland Water Conservation and Water Quality Control Project. This water recirculation project, funded through a partnership with San Luis Water District and a grant from the State of California, includes 18,000 feet of buried pipelines and three pump stations in the northern area of the GRCD, which will capture and recirculate an estimated average of 14,000 acre-ft of refuge water per year. The project will conserve water for delivery to approximately 8,000 acres of habitat.

## Improved access to and participation in the water market

As described previously, managed wetlands, both public and private, typically rely on long-held water rights or water project contracts (such as those established following the passage of CVPIA), or on incidental return flows. These are critically important supplies that must be maintained. In addition, buying, selling and exchanging water with other water users within the Valley, and even exchanging water between different wetlands, may open doors that lead to increased overall water deliveries to wetlands. A few examples of how CVJV partners are pursuing these types of opportunities are highlighted below. During the course of this Plan, new projects and water deals will continue to be identified and achieved.

### Direct water purchases

The Refuge Water Supply Program regularly acquires water from willing sellers to provide refuges with Incremen-

## WATER TRACKER

Water Tracker is an open source, publicly accessible, near real-time assessment of open surface water in the Valley derived from remotely sensed data. Semimonthly, this automated system maps, quantifies and summarizes surface water in the entire Valley by cover type and by Joint Venture planning basin and these data are made available online (www.pointblue.org/watertracker). Development of the system involved engagement by wetland managers, conservation non-governmental organizations, and water districts throughout the Valley.

The information provided by the Water Tracker is timely and useful for deciding how best to allocate water across refuges and agricultural wetlands, providing benefits for wildlife and human communities.

The data provided by the Water Tracker has been used in combination with avian bioenergetics modeling to estimate the amount of different habitats available and needed by multiple species of waterbirds – and thus to inform the current CVJV habitat objectives. Also, it will soon be linked with other resource information (groundwater recharge potential, freshwater ecological diversity, distribution of threatened and endangered wildlife and other factors, for now and future projections) to create a spatially explicit and actionable conservation prioritization framework for the resource community.

Importantly, Water Tracker was used to assess patterns in open surface water during drought (2013 to 2015) in comparison with historical years (2000 to 2011) in habitats known to support wetland-dependent birds (Reiter, Elliott, Jongsomjit et al. 2018). The study found that the agricultural landscape had significantly less area of open water during the recent drought than during non-drought years. For example, rice growing areas showed as much as a 46% reduction in open water (particularly in February and March). The reduction in corn was as much as 80%. In rice, this effect was partially mitigated by precipitation, which had a significant positive effect on open water and was prominent in non-drought years. Seasonally managed wetlands showed about 50% declines in open water, largely observed between October and March.

In a warming climate, extreme conditions and extended droughts are forecasted to become more of the norm for California, making it increasingly difficult to meet the many demands for water in the state. Integrating current and accurate water science into state and regional decision-making processes is critical for sustaining healthy ecosystems and human communities into the future.

tal Level 4 supplies. Water is frequently acquired on the spot market as a single-year transaction, if and when water is available at prices the RWSP believes it can afford. Some multi-year agreements with entities such as the San Luis and Delta Mendota Water Authority have been negotiated, which provide the RWSP with a more predictable source of supply – at a more predictable cost – in most years. However, purchasing water in dry years, especially on the spot market, remains an expensive option. Additional permanent, reliable water supplies are needed, either through direct purchases or donations of water rights or contract reassignments. Funding for such purchases – and adequate capacity to identify, negotiate, and demonstrate the opportunities – is a critical need.

### Recycled water

As the demand grows for limited water in the Valley, recycled water is emerging as a potential source of supply for municipal and agricultural water users, as well as for wetlands. Projects like the North Valley Regional Recycled Water Program promise to provide reliable and relatively inexpensive water supply for both agriculture and wetlands in the upcoming years by recycling water. As the population grows and more water is allocated for urban use (depleting current water sources for wetlands), more recycled water potentially will be available and could become an increasingly important water supply for flooded habitats. On a case-by-case basis, more study is needed to ensure that the wide range of biological, inorganic, and organic constituents that may cause water quality concerns when wastewater is reused are adequately addressed and that recycled water projects do not further harm wetlands or riverine ecosystems.

### Water exchanges with other water users

The RWSP and GRCD have independently conceptualized and executed creative water exchanges, in which Level 2 surface supplies have been traded for a greater amount of groundwater. These exchanges take advantage of different demand timing – agricultural water users use surface water during the growing season, and in exchange they pump a greater amount of groundwater for refuges at other times of the year. While a creative potential win-win strategy to achieving additional wetland water supplies, potential water quality impacts and other issues must be considered and weighed when negotiating the deals.

### Inter-refuge exchanges and transfers

CVPIA refuge managers strive to make the most of the water supplies available to them, and to work together to ensure that each refuge has access to adequate water to the extent practicable. CVJV partners continue to look for creative and flexible water management opportunities across refuge lands that would enable habitat managers to be more responsive to the dynamic needs of migratory birds, as well as adapt to changing landscapes and climate.

| CHALLENGES | OPPORTUNITIES | REGIONAL APPLICABILITY |
|---|---|---|
| **Refuge water conveyance constraints** | Strategic planning<br>Enhanced wetland water conservation and productivity<br>New public and private funding | Sacramento Valley<br>San Joaquin Valley<br>Tulare Basin |
| **Refuge water funding limitations** | Strategic planning<br>Improved access to and participation in the water market<br>New public and private funding | Sacramento Valley<br>San Joaquin Valley<br>Tulare Basin |
| **Droughts and climate trends** | Strategic planning<br>A variety of approaches to deploying habitat<br>Water-related habitat data and tools | All |
| **Rice straw decomposition trends and agricultural practices** | New public and private funding<br>A variety of approaches to deploying habitat | Sacramento Valley |
| **Groundwater regulation** | Water-related habitat data and tools | San Joaquin Valley<br>Tulare Basin |

**TABLE 4.2.5 Summary of wetland water challenges, opportunities and applicable regions.**

## Water-related habitat data and tools

New science is providing more information and tools to inform dynamic and real-time management of water supplies. This field of study, which relies on remote sensing techniques and new interfaces, can allow refuge and system managers to better understand where on the landscape water is present at any given time and pair that information with bird presence and numbers to tailor bird habitat based on current need. This type of real-time, dynamic management promises to allow managers to use water more strategically.

## Gauging habitat availability in real time

CVJV partners are developing tools to help habitat managers understand how much habitat is available in the Central Valley at a given time, and new approaches to address habitat shortfalls when and where they occur in the Valley. One example is a system called "Water Tracker", launched in 2017 by Point Blue Conservation Science to assess the extent of Central Valley open surface water, a surrogate for habitat availability, in near real-time using remote sensing technology. (See Water Tracker box for more information.)

## Robust wetland water budget estimates

Implementation of SGMA could affect wetland water availability. Some CVJV organizations are engaging in the development of groundwater policy, science, and project implementation to ensure that the needs of migratory birds are met alongside new requirements to sustainably manage groundwater. For example, some CVJV partners are working with consultants to develop more robust wetland water budget estimates, including broadly applicable methods and tools, with the objective of enabling managed wetlands to fully participate or to have water use and recharge contributions be reflected in groundwater sustainability plans. These tools, along with more robust estimates of wetland evapotranspiration or consumptive use, may also help wetland managers be more targeted and efficient in managing available water supplies and uses, both on the individual wetland scale and across multiple wetland units or refuges.

## A variety of approaches to deploying habitat

The CVJV recognizes that a variety of wetland types contribute to the mosaic of habitat that waterfowl, shorebirds, and other wetland-dependent wildlife rely on each year. Each wetland type requires different water management, both in terms of the overall volume of water that must be applied and timing of delivery. The exact composition of the habitat mosaic may change from year to year, but the overall objective is to ensure enough water is available for each wetland type when and where needed. With California's unpredictable, fluctuating hydrology and changing socioeconomic and cultural factors, flexibility may be the key to provisioning adequate wetland habitat over time.

Acquiring new, permanent easement lands and working with farmers to compatibly manage their land and water favorably for birds are two strategies that Migratory Bird Joint Ventures have used repeatedly and successfully to achieve habitat objectives. Easement managers and farmers can ensure water is available to support habitat when necessary as part of their routine management strategy. However, annual and long-term fluctuations in water supply and agricultural practices can occasionally reduce the amount of habitat that can be provided by these lands. A complimentary strategy is to dynamically and adaptively provision short-term habitat (and water) when and where migratory birds most need it. By incentivizing farmers to modify their activities or apply water for only short periods, additional habitat can be efficiently provided to address occasional critical needs.

## Summary and basin applicability

Table 4.2.5 summarizes wetland water challenges, opportunities that may help address each challenge, and the CVJV basin to which each challenge is relevant.

## 4.3 POLICY

**Public policy decisions, whether through federal or state legislation, regulatory agency rules or administrative action, historically have played a significant role in bird conservation efforts in California.**

Even before the passage of the implementing legislation for the Migratory Bird Treaty Act in 1918, which established international cooperation for the conservation of migratory birds, federal laws and regulations existed to help conserve bird populations. These include the Lacey Act (1900), prohibiting trade in wildlife, fish and plants illegally taken, possessed, transported or sold, and the Weeks-McLean Act (1913), regulating waterfowl hunting.

The federal Duck Stamp Act was passed in 1934 to acquire lands for waterfowl habitat protection and restoration efforts, while the federal Pittman-Robertson Act was approved in 1937 to create an annual funding source for state fish and wildlife agencies to conduct wildlife conservation projects. California uses these funds for restoration, population monitoring, as well as for operation and maintenance of state Wildlife Areas, relied upon by many migratory waterfowl and other birds.

In 1971, California lawmakers established a California State Duck Stamp to provide a separate state funding source for waterfowl conservation efforts. State lawmakers have also protected critical waterfowl habitat areas, notably in Suisun Marsh through the Suisun Marsh Preservation Act in 1977. State conservation easements critical to conserving waterfowl habitat on private lands were given additional protection from urban growth pressures by the state legislature in 2001 through the passage of Assembly Bill 910 (Wayne) Wildlife Conservation Easements.

The Farm Bill, reauthorized every 5 years, increasingly provides funding for migratory bird conservation nationally and in California. The 1985 Farm Bill was the first to have a

*California state capitol building - Wayne Tilcock, California Waterfowl Association* specific title devoted to conservation and to emphasize the importance of soil conservation for reasons other than crop productivity. USDA programs such as the Wetland Reserve Easement (WRE) and Regional Conservation Partnership Program (RCPP) have provided significant conservation benefits for birds in the Central Valley.

The North American Waterfowl Management Plan (NAWMP), originally signed in 1986 and recently updated in 2018, was the genesis for the national Migratory Bird Joint Ventures program (MBJV 2017). The NAWMP is an international treaty signed by the United States, Canada and Mexico to promote international cooperation in the recovery of North American waterfowl populations. In 1989, the North American Wetlands Conservation Act (NAWCA) was passed, in part, to support activities under the NAWMP. The Act is funded at the federal level and requires reauthorization by the U.S. Congress.

The Central Valley Project Improvement Act (CVPIA), passed in 1992, mandated changes in management of the Central Valley Project, particularly for the protection, restoration, and enhancement of fish and wildlife. Title 34 (d) of Public Law 102-575 identifies wetlands as a key component of wildlife protection and enhancement in the Central Valley and specifies actions to improve water supplies in support of the objectives of the CVJV.

## What is the CVJV's Role in Public Policy?

The CVJV partners focus on policy issues that affect the habitat goals and objectives of its Implementation Plan on both public and private lands. During regular board meetings and committee meetings, the CVJV leverages its diverse membership by discussing and sharing information about public policy initiatives that may affect its priorities. The CVJV Management Board sends letters to state and federal agencies and other decision makers to express positions or share information regarding administrative actions that may affect birds and their habitats in the Central Valley. The CVJV partners regularly meet with state and federal agency officials about issues affecting CVJV priorities. When permitted under applicable laws and policies, some CVJV members also lobby the California Legislature and U.S. Congress regarding proposed legislation that would affect CVJV priorities.

## CVJV Committees That Address Policy Issues

The CVJV Board maintains a Legislative Affairs Committee that examines state and federal bills, regulations, and policy decisions that affect CVJV interests. The Committee then recommends positions and actions to the CVJV Board on issues with the greatest impact on CVJV habitat goals and objectives. The Legislative Affairs Committee is the primary committee that works on public policy issues on behalf of the partners.

The Legislative Affairs Committee works closely with the Water Committee, whose members examine a wide range of water policy issues relating to both wetlands and wildlife-friendly agriculture for their effect on CVJV priorities, goals, and objectives, to formulate strategies for water-related policy engagement. Similarly, the Legislative Affairs Committee works with the Lands Committee to consider policy issues that impact bird conservation efforts on both public and private lands. Recommendations by any of the committees must receive approval by the CVJV Board prior to any coordinated action taking place. Actions by partners may include such things as comments on public documents and contact with legislative bodies and policymakers.

# Programs and Regulatory Actions That Affect CVJV Habitat Goals and Objectives

The CVJV Management Board (as well as the boards of many of the other Joint Ventures across the United States) is actively engaged on many different public policy issues, particularly those that affect funding for bird habitat conservation efforts. Some important public policy issues are described here.

## State and Federal Funding for Bird Habitat Programs

Several key federal and state programs currently help the CVJV fulfill its habitat goals and objectives as identified in this Implementation Plan. Funding for all of these programs is dependent on annual federal or state budget appropriations. In recent decades, the state has relied almost entirely on general obligation bonds to provide funding for state environmental programs.

### North American Wetlands Conservation Act (NAWCA)

This U.S. Fish and Wildlife Service (USFWS) program provides grants for wetland conservation projects in the United States, Canada, and Mexico. There is a Standard Grants Program and a Small Grants Program. Both are competitive grant programs and require that grant requests be matched by partner contributions at no less than a 1-to-1 ratio.

Since 1992, there have been more than 120 NAWCA projects either completed or underway in the Central Valley. These projects have conserved over 800,000 acres of wildlife habitat. NAWCA funding of more than $80 million stimulated partner contributions of more than $300 million.

### Partners for Fish and Wildlife (PFW)

This program is the U.S. Fish and Wildlife Service's habitat restoration cost-sharing program for private landowners. The program was established to provide technical and financial assistance to conservation-minded farmers, ranchers and other private (non-federal and non-state) landowners who wish to restore fish and wildlife habitat on their land. The PFW program emphasizes the restoration of historical ecological communities for the benefit of native fish and wildlife in conjunction with the desires of private landowners.

### The Agricultural Conservation Easement Program (ACEP)

This USDA Natural Resources Conservation Service (NRCS) program provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands on private lands, many of which provide significant buffers adjacent to National Wildlife Refuges.

### Regional Conservation Partnership Program (RCPP)

This NRCS program encourages conservation partners to work with agricultural producers and private landowners to restore and improve the sustainable use of soil, water, wildlife and related natural resources on regional or watershed scales. RCPP participants leverage funding to design, implement and maintain voluntary conservation solutions.

### California Waterfowl Habitat Program (Presley Program)

This California Department of Fish and Wildlife (CDFW) program provides economic incentives to private landowners who agree to manage their properties in accordance with a wetland management plan developed cooperatively by CDFW biologists and the participating landowner.

CDFW started the program with an original enrollment of 6,500 acres in the Sacramento Valley and San Joaquin Valley. Since that time, the Presley Program has steadily grown to include over 29,000 acres of habitat for wintering and breeding waterfowl in the Central Valley, including the Tulare Basin, Grasslands Ecological Area, Suisun Marsh, and numerous locations in the Sacramento Valley.

### California Winter Rice Incentive Program

The purpose of this program is to incentivize the flooding of rice fields after harvest. The practice has a variety of benefits, including air quality, waterfowl habitat, and the production of invertebrates that provide nutrients for out-migrating salmon smolts.

### Permanent Wetland Easement Program

This program, administered by the CDFW in cooperation with the Wildlife Conservation Board's Inland Wetland Conservation Program, pays willing landowners approximately 50 to 70 percent of their property's fair market value to purchase the farming and development rights in perpetuity. The landowner retains many rights including trespass rights, the right to hunt and/or operate a waterfowl hunting club and the ability to pursue other types of undeveloped recreation (e.g., fishing, hiking). Easement landowners are required to follow a cooperatively developed wetland management plan and meet bi-annually with CDFW biologists to discuss habitat conditions and management.

## Landowner Incentive Program (LIP)

This CDFW program is funded by the USFWS Wildlife and Sport Fish Restoration Program and is an effort to reverse the decline of at-risk species in the Central Valley through enhancement and management of private lands. LIP focuses on the Central Valley's three predominant historical habitat types: wetlands, native grasslands, and riparian habitats. LIP assists landowners with enhancing these three habitat types by providing annual incentive payments in return for implementing habitat management plans that benefit special status species.

## Shared Habitat Alliance for Recreational Enhancement (SHARE) Program

CDFW administers the SHARE Program to provide financial incentives to landowners to open their property to the public for hunting and other wildlife-dependent recreation. These types of land uses support bird habitat conservation. The program helps to recruit and retain hunters, including waterfowl and upland game bird hunters, by providing additional low-cost but high-quality opportunities. In surveys, members of the public frequently cite a lack of access to land as a prime reason why they no longer hunt or hunt less often.

The 2018 North American Waterfowl Management Plan, which helps guide waterfowl management efforts in the United States, Canada and Mexico, calls for greater recruitment and retention of waterfowl hunters.

## Nesting Bird Habitat Incentive Program

This landowner incentive program in the Fish and Game Code, administered by CDFW, focuses on establishing upland nest cover for waterfowl, other gamebirds and songbirds. For implementation, this program needs start-up and annual funding sources. The program pays farmers and other landowners to maintain vegetative cover on fallowed lands. Priority is given to lands adjacent to waterfowl brood water, such as flooded rice or semi-permanent wetlands on national wildlife refuges and state wildlife areas.

## Wildlife Conservation Board – Inland Wetlands Conservation Program (IWCP)

The Inland Wetlands Conservation Program was created in 1990 to assist the CVJV in its mission to protect, restore and enhance wetlands and associated habitats. The IWCP has a wide range of options to accomplish CVJV goals relating to wintering waterfowl, breeding waterfowl, non-breeding shorebirds, breeding shorebirds, waterbirds, and breeding riparian songbirds. Options include acquisitions of land or water for wetlands or wildlife-friendly agriculture, acquisition of conservation easements, restoration of public or private lands, or enhancement of existing degraded habitats. In addition, the program works toward providing long-term reliable water for wetlands and winter-flooded agricultural lands. The IWCP jurisdiction matches that of the CVJV and includes most of the watershed of the Central Valley.

## Wildlife Conservation Board – California Riparian Habitat Conservation Program (CRHCP)

The California Riparian Habitat Conservation Program (CRHCP) was created to protect, preserve and restore riparian habitat throughout California. The CRHCP has a wide range of options to accomplish CVJV goals relating to waterfowl and breeding riparian songbirds. Options include acquisition of land for riparian habitat and floodplains, acquisition of conservation easements, protection of riparian habitat from agricultural land uses, restoration of public or private lands, or enhancement of existing degraded habitats. In addition, the program requires long-term management plans for habitat types protected, restored or enhanced under the CRHCP. The CRHCP jurisdiction overlaps that of the CVJV and includes the watersheds of the Central Valley.

## The State Duck Stamp, Upland Game Bird Stamp and related bird hunting validations

The California State Duck Stamp was created by legislation in 1971 (Fish and Game Code §3702) and the Upland Game Bird Stamp was created by legislation in 1992 (Fish and Game Code §3682.1). Licensed hunters are required to purchase state duck and upland gamebird validations when hunting waterfowl and upland game birds. Stamp collectors and conservationists can also purchase the state duck and upland game bird stamps. Revenue from the sale of these items generates significant funding for bird conservation projects in California and is a traditional source of funding for CDFW. In 2018, duck stamp sales generated $1.25 million and upland game bird stamp sales generated $1.4 million (CDFW 2019).

## The Federal Duck Stamp

Waterfowl hunters are required to purchase federal duck stamps every year with their hunting license; other outdoor recreationists can also buy the collectible federal stamps to support waterfowl habitat conservation. Revenue from this program is used to acquire and protect wetland habitat and purchase conservation easements for the National Wildlife Refuge System. In the Central Valley, these funds have been instrumental in purchasing refuge lands and for establishing conservation easements on private wetlands adjacent to refuges.

### The Federal Aid in Wildlife Restoration Act of 1937 (Pittman-Robertson Act)

This Act generates funds from an excise tax on sporting firearms, pistols, ammunition, and bows and arrows. The funds are distributed to state fish and wildlife agencies based on the geographic area of the state and its population of license-buying hunters. In 2018, CDFW was apportioned more than $26 million in Pittman-Robertson grant funds (USFWS 2018), much of which was used to establish and manage state wildlife areas that are operated for waterfowl and other wildlife conservation, hunting, and compatible public access.

### Hunting Licenses

California hunting license revenue is used by CDFW for a variety of conservation purposes, most notably for fish and wildlife law enforcement. In 2018, hunting licenses generated about $11.4 million (CDFW 2019).

## State and Federal Water Programs

Effective water management is essential for achieving the CVJV's objectives because most Central Valley wetlands require water deliveries and because wildlife-friendly agricultural lands are a key part of the Central Valley's bird habitat mosaic. There are several state and federal water-related laws, policies, and programs that affect the CVJV's interests, as discussed in the Water subchapter.

### Central Valley Project Improvement Act (CVPIA) Restoration Fund

This federal fund is administered by the U.S. Bureau of Reclamation and USFWS using annual appropriations based on the collection of mitigation and restoration fees from Central Valley Project water users. The CVPIA Restoration Fund is used to pay the costs of acquiring and delivering water to 19 identified wetland habitat areas in the Central Valley, including state, federal and private wetlands. The Restoration Fund is also used for water infrastructure and conveyance projects that benefit these wetlands.

## Habitat Management Costs, Permitting and Regulations

Active management is required in order to maintain desired habitat conditions and can be costly. These expenses can prove especially problematic for budget-limited state and federal landowners such as CDFW and USFWS. Major regulatory expenses for wetland and other habitat managers include the following:

### The Irrigated Lands Regulatory Program (ILRP)

The ILRP is a regulatory program, administered by the State Water Resources Control Board, that prevents non-source pollution from irrigated lands. It requires irrigators to join "coalitions" that fund the testing and remediation of pollutant discharges from irrigated lands. The ILRP also requires irrigators to report on nitrate and sediment discharges. Because managed wetlands seldom discharge nitrates or sediment, the Central Valley Regional Water Quality Control Board has exempted managed wetlands from these reporting requirements, thanks to the efforts of CVJV members.

### Dredge and Fill Procedures

The State Water Resources Control Board has adopted dredge and fill procedures that apply to waters of the state. With respect to Environmental Restoration and Enhancement Projects (EREP), which include the type of wetland restoration and maintenance projects generally undertaken by CVJV partners, permits may be obtained from regional water quality control boards by presenting funding agreements entered into with state and federal agencies who distribute wetland restoration funding. EREP projects are also exempt from alternatives analysis and compensatory mitigation.

### Mosquito Abatement

Spraying or implementing best management practices (BMPs) to control mosquitoes not only constitute a significant wetland management cost in many counties throughout the Central Valley and Suisun Marsh; they also may limit the ecological function and productivity of managed wetlands (Kwasny et al. 2004). These negative ecological impacts can occur through pesticide impacts to the base of the food chain (e.g., invertebrates), which may reduce ecological productivity; habitat manipulation that degrades the quality of wetlands; or delaying or changing the duration of the flooding of wetlands. In addition, many wetland managers have limited operating budgets. More time and money dedicated to mosquito control means fewer resources available for other wetland management activities.

### Noxious Weed Control

The spread of invasive non-native plant species can significantly degrade habitats important to waterfowl and other bird species, often requiring annual control efforts (Fredrickson and Taylor 1982). As an example, non-native or undesirable plants such as cocklebur and joint grass in managed wetlands reduce the production of key waterfowl food plants like smartweed and watergrass. Water conveyance systems in managed wetlands are also impeded by the overgrowth of non-native plant species such as water primrose and parrot's feather, requiring expensive and labor-intensive chemical or mechanical control.

## SUCCESS STORY

# WETLAND HABITAT RESTORATION ON FAITH RANCH

Faith Ranch, in the CVJV's San Joaquin planning region, is a privately-owned property under conservation easement with the USFWS. The easement allows cattle grazing and wildlife-friendly agricultural production while encouraging habitat restoration. Wetland restoration on Cocklebur Pond was completed in 2002 and cattle were excluded from the pond. Restoration was conducted with cost-share funding from two CVJV partners, the USFWS through the Partners for Fish and Wildlife Program, and the NRCS through the Wetland Reserve Program. Faith Ranch has received several NAWCA grants administered by the USFWS for its wetland conservation projects.

### BEFORE WETLAND RESTORATION EFFORTS BEGAN

*Cocklebur Pond in 2001 - Gary Zahm, Faith Ranch*

### AFTER CATTLE WERE EXCLUDED

*The pond in 2002 - Gary Zahm, Faith Ranch*

### WITH WETLAND VEGETATION RE-GROWING

*The pond in 2004 - Gary Zahm, Faith Ranch*

## 4.4 CLIMATE

**California's climate conditions are changing, and those changes are predicted to accelerate over the next century. Extreme weather events are likely to significantly affect bird and human communities alike in the Central Valley. These changes could include increasing air temperatures, decreasing water availability, and more frequent floods and droughts, all of which will negatively affect many bird species. For example, a previous study documented that an increase in mean daily temperature caused a decline in nest survival of Central Valley mallards and gadwalls (Ackerman et al. 2011).**

**These climate-induced stressors will add to the already-significant existing threats to bird populations and, in many cases, are likely to become the most significant factors influencing bird populations in the Central Valley. Hence, there is an urgent need for natural resource managers to incorporate projected changes in climate patterns into conservation planning efforts to provide for bird populations in a changing future. Managers must consider how these patterns could affect the environment of the Central Valley, how human populations might respond to those changes, and what impact these combined factors could have on bird populations.**

**This subchapter describes the major changes in climate projected to occur over the next century in the Central Valley and summarizes the vulnerability of the region's bird populations to a shifting climate.**

*(1) Flooding in the Yolo Bypass - Daniel Nylen, American Rivers (2) Least Bell's vireo, a federally endangered species, collecting nesting material - Robert A. Hamilton*

## Shifting Climate Conditions

### Increasing temperatures

Mean annual temperatures in the Central Valley increased by nearly 2°F since the start of the 20th century (Bureau of Reclamation 2016), though mean annual maximum temperatures decreased in the San Joaquin Valley (Rapacciuolo et al. 2014). In California, average temperatures are projected to increase significantly over the next century (Figure 4.4.1). Climate models project average annual temperatures in California to increase by 1.8°F to 5.4°F by mid-century, and by 3.6°F to 9°F by the end of the century (Cayan et al. 2012).

Increasing air temperatures will lead to increasing water temperatures of rivers, reservoirs, and ephemeral or vernal pools (Bureau of Reclamation 2016).

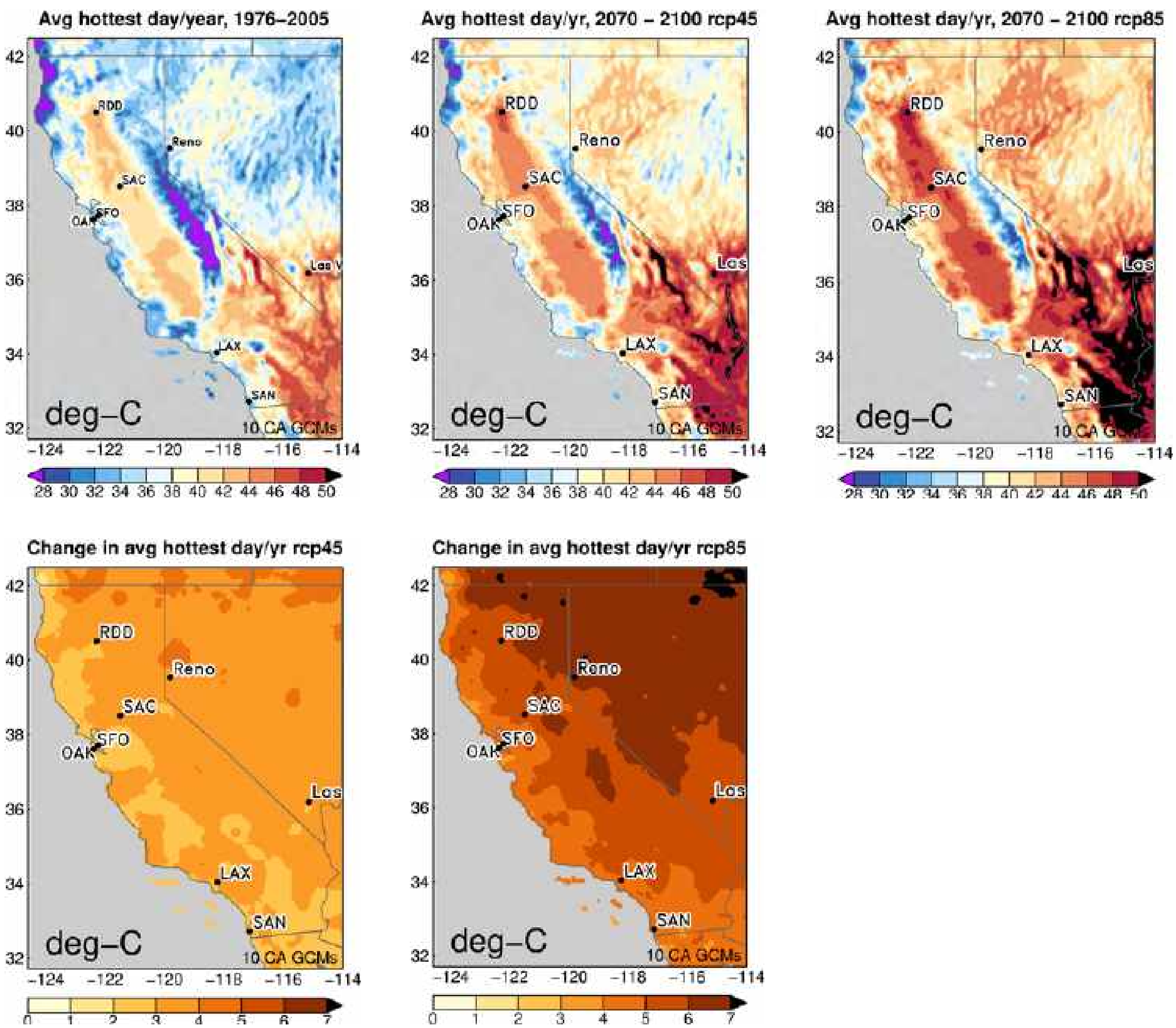


**FIGURE 4.4.1 Predicted 21st century temperature increases in California.** GCM = Global Circulation Model; RCP = Representative Concentration Pathways. Top row: Average hottest day of the year (°C), averaged over 10 GCMs, for the historical period (top left) and for late-21st century for RCP 4.5 (top middle) and RCP 8.5 (top right) emissions scenarios. Bottom row: the increase (°C) of the late-21st century over the historical values, for RCP 4.5 (bottom center) and RCP 8.5 (bottom right). Results are from the 10 California GCMs (Pierce et al. 2018).

## Uncertain changes in average precipitation

Whether the average annual precipitation will increase or decrease in California over the coming century is not clear. Model projections indicate a wide range of potential future changes in precipitation for California and the Central Valley. Despite a drying trend in California since the late 1970s, there is no appreciable trend towards either wetter or drier winters over the full record beginning in 1895 (Funk et al. 2014; Seager et al. 2014). A slight trend toward decreasing and more variable precipitation has been detected in central and southern California over the last 100 years (Hunsaker et al. 2014). The north-south gradient from higher to lower annual precipitation is predicted to continue in the Central Valley (Cayan et al. 2009). Despite this uncertainty, there are other changes expected in the hydrological conditions of the Central Valley as described below.

## Decreasing water availability in the dry season

The Central Valley receives most of its annual precipitation during the rainy, cooler season between November and March (Scanlon et al. 2012). During the typically dry months (April – October), the Sierra Nevada snowpack serves as the primary source of water for irrigation and for wetland management (Domagalski et al. 2000; Scanlon et al. 2012). However, the availability of this source of water during the dry season is projected to change. Despite the uncertainty in projections of average annual precipitation, there is relatively high confidence that overall landscape aridity will increase with warmer temperatures (Flint et. al. 2013). In short, the dry season will become drier. Several factors will cause this shift, including warmer summer temperatures that will cause drier conditions, warmer winter temperatures that will decrease accumulated snowpack, and warmer winter and spring temperatures that will lead to earlier snowmelt.

The warming trend projected during the dry season will further increase evapotranspiration: evaporation of water from the soil and transpiration of water from plants to the atmosphere. This process will increase the aridity of soils in most areas and will cause drier conditions overall (Cook et al. 2015).

Historically, the Sierra Nevada snowpack has released meltwater gradually, refilling reservoirs, recharging aquifers, and flowing downstream into the Central Valley during the spring and summer. Projections using the best available climate models show that, even during years with an average amount of snowpack in the winter, increasing spring temperatures will cause earlier snowmelt. Warmer temperatures are already leading to earlier spring snowmelt in the Sierra Nevada (Hayhoe et al. 2004; Thorne et al. 2015), changing the timing of water availability in lowland regions that receive much of their water from snowmelt (Moser et al. 2009; Yarnell et al. 2010; Thorne et al. 2015). With earlier snowmelt, April to July runoff volume has already decreased over the last 100 years by 23 percent and 19 percent in the Sacramento and San Joaquin Basins, respectively (Anderson et al. 2008). The earlier and higher spring peak flows are typically followed by reduced summer flows and longer periods of summer aridity (Yarnell et al. 2010).

In addition, higher peak flows are likely to increase spring flooding risk (Jackson et al. 2011), which requires dam managers to release more stored water from reservoirs earlier in the season to minimize risk of a catastrophic flood (Kiparsky and Gleick 2003; Anderson et al. 2008).

This shift will further constrain water management by hampering the ability to refill reservoirs after the season of highest runoff has passed, thereby reducing the amount of spring runoff that is normally stored. In turn, this will decrease the availability of water for the summer growing season and for postharvest flooding of rice fields to promote stubble decomposition and provide seasonal habitat for birds and other wildlife (Anderson et al. 2008).

## Increase in severe storm and flooding events

Climate shifts are likely to increase flooding from severe storms (Swain et al. 2018). Natural formations called “atmospheric rivers” transport huge volumes of condensed water vapor through the atmosphere; these atmospheric rivers can create extreme precipitation. An analysis of climate projections for California indicates that the average intensity of atmospheric river events will not increase. However, there may be more years with many such events and occasionally much stronger events than seen in the historical record. Moreover, the length of the season over which atmospheric river events may occur is predicted to increase. These changing patterns are likely to result in more frequent and more severe floods in California (Dettinger 2011). Hydrological models project larger, more frequent winter floods as rain-on-snow events and winter snowmelt become more common in the headwaters of major river systems in the West (Hamlet and Lettenmaier 2007).

Regardless of variation among specific precipitation projections, all models project that by the end of the century, large discharges from the northern Sierra Nevada that were previously classified as probable only once every 50 years (“50-year floods”) will increase in likelihood by 30 to 90 percent compared to historical values. Corresponding flood flows from the southern Sierra are projected to increase in likelihood by 50 to 100 percent (Das et al. 2013). Overall higher peak flows, caused by earlier and more rapid snowmelt, are likely to increase spring flooding in the Central Valley (Jackson et al. 2011).

## Increased frequency and severity of droughts

The combined effect of the changes in the hydrological cycle described above will magnify the impacts of severe droughts in the Central Valley. Compared to the preceding century, drought years in California have occurred twice as often in the last 20 years (Diffenbaugh et al. 2015). Additionally, the 2010–2015 drought was the most severe on record in the Central Valley (Williams et al. 2015), with record high temperatures that worsened its effects. A warming climate is likely to increase the frequency and severity of California droughts (Hayhoe et al. 2004; Cook et al. 2015; Diffenbaugh et al. 2015; Williams et al. 2015; Swain et al. 2018). Severe drought years reduce the open surface water and waterbird habitat in flooded agriculture and managed wetlands across the Central Valley (Reiter et al. 2015; Reiter et al. 2018) and can increase food deficits for waterfowl (Petrie et al. 2016).

*Dry seasonal wetland, Yolo Bypass Wildlife Area - Wayne Tilcock, California Waterfowl Association*

# Effects of a Shifting Climate on Central Valley Bird Populations

## General threats

The predominant effects of a shifting climate on bird populations will likely be from changes in water availability. Climate directly determines water availability. Management actions designed to capture and store water for human use indirectly affect it; these management actions are likely to change as climate-related water stressors increase. At particular risk are species sensitive to the timing, amount, and reliability of water. For example, some bird species have come to rely on certain types of agriculture. These species may be affected if management reduces the extent of wetlands and key agricultural crops (rice, corn, alfalfa, irrigated pasture) used by these birds (PRBO Conservation Science 2011).

Estuarine habitats in the Sacramento-San Joaquin Delta are likely to be degraded because of sea level rise and increasing salinity, but the degree of this loss is not yet well understood (PRBO Conservation Science 2011; Achete et al. 2017).

High temperature events, which are predicted to become more common in summer, are likely to result in thermal stress for species with a narrow range of temperature tolerance (e.g., Ackerman et al. 2011; PRBO Conservation Science 2011).

## Vulnerability

Evaluations by Gardali et al. (2012) and Galbraith et al. (2014) of the vulnerability of various species of birds to a shifting climate are relevant to bird populations in California's Central Valley.

Gardali et al. (2012) ranked a subset of the state's birds for vulnerability in California. Of the 358 taxa (species, subspecies, and distinct populations) ranked, 230 were not considered vulnerable. The remaining 128 were considered climate-vulnerable and were ranked for three categories of priority: low (80), moderate (35), and high (13). Of these 128 taxa, 31 pertain to the Central Valley (Table 4.4.1). In general, birds associated with wetlands had the largest representation on the list relative to other habitat groups, a pattern that also appears to hold for the Central Valley.

## Combined effects of climate and other human stressors

Shifting climate conditions are not the sole determinant of how Central Valley bird populations will fare in the future. Human choices will be important in driving bird population responses to a shifting climate.

Jongsomjit et al. (2013) compared projected spatial impacts of shifting climate patterns and housing development on breeding birds in California. Areas of decreasing climatic suitability for birds and increasing housing density were largely concentrated within the Central Valley. This work suggests that the cumulative effects of future housing development and shifting climate patterns will be significant for many bird species, and that some species otherwise projected to expand their distribution may actually lose ground to development.

Matchett and Fleskes (2017) examined 17 future scenarios for characterizing potential interactions among land use (especially urbanization), water supply management, and shifts in climate conditions with their collective impacts on waterbird habitat. Specifically, they looked at the capacity for the Central Valley to provide additional wetlands to offset modeled impacts of a shifting climate on waterbirds. Most scenarios examined pointed to a loss of options for adequately conserving wetland-dependent birds through wetland restoration after 2065.

The combined impacts of higher temperatures, lower water availability, extreme weather events, and the responses of human populations to these stressors are likely to dramatically impact bird populations in the Central Valley over the next century. It is critically important for natural resource managers to consider these impacts as they develop and enact plans for bird population and habitat conservation.

| BIRD SPECIES ORGANIZED BY CLIMATE PRIORITY | CONSERVATION STATUS[a] |
| --- | --- |
| **High priority** | |
| Yellow rail (winter) (*Coturnicops noveboracensis*) | BCC, BSSC |
| California black rail (*Laterallus jamaicensis coturniculus*) | BCC, ST |
| Suisun song sparrow *(Melospiza melodia maxillaris*) | BCC, BSSC |
| **Moderate priority** | |
| Snowy plover (interior population) (*Charadrius nivosus*) | BCC, BSSC |
| Black tern (*Chlidonias niger*) | BSSC |
| American white pelican (*Pelecanus erythrorhynchos*) | BSSC |
| Swainson's hawk (*Buteo swainsoni*) | ST |
| Yellow-billed cuckoo (western distinct population segment) (*Coccyzus americanus*) | FT, SE |
| Least Bell's vireo (*Vireo bellii pusillus*) | FE, SE |
| San Joaquin LeConte's thrasher (*Toxostoma lecontei macmillanorum*) | BCC, BSSC |
| Song sparrow (Modesto population) (*Melospiza melodia mailliardi*) | BSSC- |
| **Lower priority** | |
| Bufflehead (*Bucephala albeola*) | - |
| Eared grebe (*Podiceps nigricollis*) | - |
| Western grebe (*Aechmophorus occidentalis*) | BCC |
| Clark's grebe (*Aechmophorus clarkii*) | - |
| Whimbrel (*Numenius phaeopus*) | BCC |
| Wilson's phalarope (*Phalaropus tricolor*) | - |
| Red-necked phalarope (*Phalaropus lobatus*) | - |
| Caspian tern (*Hydroprogne caspia*) | BCC |
| Forster's tern (*Sterna forsteri*) | - |
| Double-crested cormorant (*Phalacrocorax auritus*) | - |
| American bittern (*Botaurus lentiginosus*) | - |
| Least bittern (*Ixobrychus exilis*) | BCC, BSSC |
| White-faced ibis (*Plegadis chihi*) | - |
| Osprey (*Pandion haliaetus*) | - |
| Greater roadrunner (*Geococcyx californianus*) | - |
| Lesser nighthawk (*Chordeiles acutipennis*) | - |
| Rufous hummingbird (*Selasphorus rufus*) | - |
| Belted kingfisher (*Megaceryle alcyon*) | - |
| Yellow-billed magpie (*Pica nuttalli*) | BCC |
| Bank swallow (*Riparia riparia*) | ST |

[a] *Conservation Status designations: **FE**, federally endangered species; **FT**, federally threatened species; **BCC**, U.S. Fish and Wildlife's Birds of Conservation Concern (USFWS 2008); **SE**, state endangered species; **ST**, state threatened species; **BSSC**, California Bird Species of Concern (Shuford 2008).*

**TABLE 4.4.1 Conservation status of Central Valley bird taxa classified as vulnerable to the impacts of a shifting climate. These species, subspecies, and distinct populations of birds occur regularly in the Central Valley Joint Venture's Primary Focus Area or Secondary Focus Area up to 3,000 feet elevation (adapted from Gardali et al. 2012).**

Galbraith et al. (2014) assessed all North American shorebirds for vulnerability to changes in climate conditions using life history factors such as migration distance and specialized habitat requirements. They ranked the whimbrel *(Numenius phaeopus)* and the long-billed curlew *(N. americanus)* as critically vulnerable. Other highly climate-vulnerable shorebird species were the mountain plover *(Charadrius montanus)*, dowitcher species *(Limnodromus* spp.*)*, western sandpiper *(Calidris mauri)*, dunlin *(C. alpina)*, and Wilson's phalarope *(Phalaropus tricolor)*. Each of these shorebird species relies on Central Valley habitat during migration or winter, but the most intense climate-related stressors for these species may occur outside the Central Valley.

## 4.5 MULTIPLE-BENEFIT PROJECTS

One proven approach to supporting many of the Central Valley Joint Venture's conservation objectives is to implement intentionally designed "multiple-benefit" projects. Much of California uses the term "multi-benefit" specifically in the context of flood protection projects. In this Implementation Plan (hereafter, "the Plan"), multiple-benefit projects are defined as land use projects designed to meet public safety needs, enhance ecological function, and improve habitat quality for fish and wildlife. Multi-benefit projects can provide benefits such as groundwater recharge, improved water quality, and enhanced access to recreation. Such projects in the Central Valley can combine bird conservation with flood protection, food production, water quality control, groundwater recharge and/or recreational opportunities.

Multiple-benefit projects break away from traditional single-focus management decision-making to use resources efficiently in pursuing multiple compatible public policy objectives. The concept is not new, though the terminology is not always consistent. The terms multi-functionality and co-benefits are often used to capture the same idea (Fisher et al. 2011; Sayer et al. 2013). These approaches are especially critical when land and water are limited resources. They provide a broad suite of benefits to a diverse coalition of stakeholders (Postel 2000; Chan et al. 2006).

The habitat objectives set forth in this Plan are ambitious; thus, funding project implementation will be challenging. By pursuing a strategy of implementing multiple-benefit projects, the CVJV can align the Plan's conservation goals for migratory birds with the needs of California residents in a manner that leverages investments to create added value to conservation projects. This approach is increasingly essential as the demand for and value of land and water in California continues to increase, making conservation projects more costly. A holistic approach to natural resources conservation enables the CVJV to achieve security for future migratory bird populations and their habitats, while also improving ecosystem functionality in a way that benefits people directly.

For multiple-benefit projects to be successful, they should incorporate the following elements:

1. **SMART (Specific, Measurable, Achievable, Relevant, and Time-bound) objectives** (Doran 1981), reflecting the contribution of a project to multiple planning goals within a region. The CVJV objectives for bird populations and habitats provide an excellent tie-in to existing SMART multiple-benefit objectives for water management in the Central Valley.

2. **Engaged stakeholders cooperating in implementation.** For example, cooperation between rice producers and natural resource managers has resulted in management practices that meet both an agricultural need for postharvest straw decomposition and a wildlife need for surrogate wetlands to support migratory birds.

3. **Shared financing that leverages multiple sources of funding.** For example, pooling funds for levee reinforcement projects for flood protection with conservation easement purchases for riparian restoration can bring ambitious projects within reach. Shared funding can facilitate multiple-benefit conservation projects, at scale, by incorporating set-back levees and riparian restoration at the same site and at the same time.

4. **Reduced need for mitigation through improvements in ecological conditions.** A multiple-benefit project can enhance the value of habitat in such a way that it largely offsets or even eliminates the need to mitigate for any environmental degradation caused by the project. For example, a flood-protection setback levee could create benefits for listed salmon.

Policies that may affect development and implementation of multiple-benefit projects are certain to evolve over the lifetime of the Implementation Plan. The CVJV must remain actively engaged in the development of policies and broad programs, not just when planning specific projects. This stance will provide for more opportunities to advocate for a multiple-benefit approach. For example, when the California Air Resources Board was considering greenhouse gas reduction measures for agriculture that included incentives not to flood rice fields during the winter, CVJV partners participated in discussions to inform the conversation. Those incentives would have been detrimental to the large populations of shorebirds and waterfowl that use postharvest-flooded rice fields for food during the non-breeding seasons. The board eventually decided not to adopt the incentives.

Today, there are a number of ongoing planning and restoration efforts that could be transformed into multiple-benefit projects. The following list is not exhaustive, but illustrates some possible opportunities.

### Central Valley Flood Management

The spatial footprint of the Central Valley's flood management system overlaps with many of the best areas for providing habitat for waterfowl, shorebirds, waterbirds, and riparian landbirds. Already, the Central Valley Flood Protection Plan developed by the California Department of Water Resources (DWR) has used the CVJV habitat objectives to develop targets for riparian and wetland restoration within floodways. By working with levee districts and DWR, the CVJV can make sure upcoming flood protection projects integrate these habitat restoration targets, such that the projects also contribute to the CVJV's conservation goals (see Hamilton City text box).

### Conservation of Other Species and Ecosystems

The Central Valley is not only important for migratory birds; it is also the focal point of significant efforts to recover populations of endangered fish, ensure the future of many rare plant species, and protect the unique biodiversity of the San Joaquin Desert. For example, in 2009, the San Joaquin River Settlement Act was passed to restore flows and salmon populations to California's longest river, the San Joaquin River. The settlement addresses the needs of native fish and wildlife, Central Valley farmers, anglers and other recreationists, and Central Valley residents. The settlement has two goals: (1) restoring and maintaining fish populations in the San Joaquin River, and (2) reducing or avoiding adverse water supply impacts to all long-term water contractors who may be affected.

By following the general approach used for San Joaquin River restoration, the CVJV can leverage conservation dollars and the limited land available for wildlife in a way that provides the greatest benefit for entire ecosystems.

### Groundwater Management

California's Sustainable Groundwater Management Act of 2014 is leading to changes in how and where groundwater is used. The Act may lead to fallowing some agricultural land and developing projects designed to recharge groundwater. The CVJV may be able to use these fallowed lands to help meet habitat objectives for grassland or riparian birds and, at the same time, participate in the design and implementation of groundwater recharge projects that also provide waterbird habitat.

Multiple-benefit projects provide a mechanism for tackling the CVJV's ambitious goals. Research is needed to evaluate practices for increasing benefits to people and to wildlife as well as for decreasing the necessity or magnitude of trade-offs in delivery of multiple benefits (Liu 2016). The CVJV is uniquely positioned to identify these research needs. Central Valley-focused agencies and non-governmental organizations are developing growing alliances for implementing multiple-benefit projects. The CVJV has an important role to play in identifying and leveraging win-win solutions that result from these projects. Not every planning process will immediately reveal such synergies. Barriers to achieving multiple-benefit projects may continue or arise anew (Antos 2016). However, the CVJV can provide insight to overcoming these barriers. Complex trade-offs may be in play and require careful management, to ensure that a given project does ultimately serve the needs of migratory birds. Such trade-offs make it even more critical that multiple-benefit projects be identified and implemented to achieve the CVJV's goals.

Examples of multiple-benefit projects that successfully combine wildlife conservation and flood protection can be found at a website supported by a coalition of non-governmental organizations working on wildlife protection in the Central Valley, http://www.multibenefitproject.org/.

# HAMILTON CITY: A BLUEPRINT FOR MULTIPLE-BENEFIT PROJECTS IN CALIFORNIA

Multiple CVJV partners and Reclamation District 2140 are successfully utilizing a non-regulatory approach to construct a new "setback" levee that will provide significant flood risk reduction to the community of Hamilton City, 10 miles west of Chico. The project also includes large-scale restoration of 1,500 acres of native riparian habitat. The project demonstrates multiple benefits supported by the CVJV, including flood risk management, groundwater recharge, conservation of species and their habitats, and opportunities for outdoor recreation.

Hamilton City has long been at risk of flooding from the Sacramento River, with extensive efforts required in multiple years to avoid failure of the 114-year-old levee. After repeated attempts to justify a single-purpose flood risk reduction project, the community took action to develop a cost-effective, multiple-benefit solution that included both economic and environmental benefits.

During the first phase of the project, a new setback levee will be constructed to provide greater flood protection for the community, and the existing "J Levee" (where the gravel road can be seen in the photo) will be removed to reconnect over 500 acres of floodplain to the river. Once this phase is completed, River Partners will restore approximately 770 acres of former agricultural land to high-quality riparian habitat. Levee construction is scheduled for completion in 2020.

The Hamilton City project plays a significant role in meeting the CVJV's conservation objectives in the Sacramento planning region for reestablishment of habitat for waterbirds, riparian landbirds, and grassland-oak savannah landbirds. This habitat will benefit at-risk bird species contained within this Plan, as well as other wildlife. Importantly, reconnecting the floodplain with the river will support the recovery of endangered salmon. It will also allow the river's floodwaters to dissipate, protecting nearby orchards.

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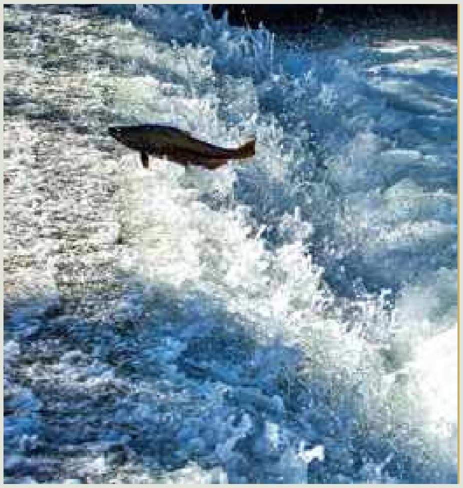
*(1) The Sacramento River above Hamilton City, flowing past the Phase I restoration area/floodplain - River Partners (2) A white alder awaits planting in the now-complete Phase I restoration area - River Partners*

The giant garter snake is listed as a federally- and state-endangered species. The Yolo Bypass Wildlife Area provides habitat for this and other wildlife species, while also providing flood protection and recreation opportunities. *Dave Feliz*

Tule elk, an elk subspecies found only in California, benefit from grassland habitat management in the Central Valley. Hunters, many of whom are active conservationists, benefit in turn. *Dale Garrison*



Native salmon and steelhead benefit from intentionally designed multiple-benefit projects such as riparian restoration. *Steve Martarano, USFWS*

Some multiple-benefit projects can provide habitat for federally-listed species such as the valley elderberry longhorn beetle. *Steve Martarano, USFWS*

Boaters and anglers benefit from bird-friendly riparian habitat on the San Joaquin River. *Steve Martarano, USFWS*

Students help restore wetland habitat near Stockton. Multiple-benefit projects can provide opportunities for education and outreach. *Steve Martarano, USFWS*

High water on the Yolo Bypass floodplain. The Yolo Bypass is a successful multiple-benefit project, diverting Sacramento River floodwaters from Sacramento and other population centers while protecting habitat for birds and other wildlife. *Steve Martarano, USFWS*

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# NOTES

## 4.2 Water


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# 5 HUMAN DIMENSIONS OF BIRD CONSERVATION IN THE CENTRAL VALLEY

*Hiker on Merced Wild and Scenic River - BLM*

**Studying the human dimensions of natural resource conservation broadens the focus outward from wildlife and habitats to encompass the social and political considerations that influence wildlife and habitat management. Human dimensions is "a field of study that applies the social sciences to examine human-wildlife relationships, and, in doing so, provides information that contributes to effective wildlife conservation efforts" (Manfredo 2008). The field of human dimensions includes many disciplines, including psychology, sociology, anthropology, economics, communications, education, geography, social marketing, recreation and leisure, political science and planning. Because human influence permeates every aspect of conservation, collaboration among disciplines is essential to successful wildlife conservation efforts. This is especially true in the Central Valley, where agriculture and other human land uses encompass the overwhelming majority of the planning area, meaning that human decisions have profound influences on ecological conditions.**

Human dimensions can be applied in conservation settings in an adaptive management, or Strategic Habitat Conservation approach, commonly used in the biological sciences. Researchers study what people think and do related to conservation, discern reasons and motivations, incorporate those understandings into policies and programs using best practices for engaging people, and evaluate results. Human dimensions research informs applied work such as education, outreach and communications.

National bird conservation plans now call for more extensive human dimensions research. For example, the 2012 North American Waterfowl Management Plan (NAWMP) Revision (entitled People Conserving Waterfowl and Wetlands; NAWMP 2012) refers to the three-legged stool of conservation as including people, habitat and birds. To implement the NAWMP Revision's goal of "growing the number of waterfowl hunters, other conservationists, and citizens who enjoy and actively support waterfowl and wetlands conservation," the NAWMP Plan Committee and the National Flyway Council jointly organized a Human Dimensions Working Group.

This growing interest in human dimensions is largely due to the recognition of three important aspects of bird conservation:

1. The solutions to our conservation challenges require changes in human behavior. For example, to address habitat loss, a goal could be to have more land under conservation easement (an action by landowners) or change land use policy (an action by local planning boards).

2. Conservation is something that is done for, with, and by people. This idea is familiar to government agencies that manage land and wildlife for the public. To serve the public, it is necessary to understand their interests.

3. Science-based decision making for conservation must be informed by both the biological and social sciences. Conservation professionals make numerous decisions based upon their assumptions about what people think and how to influence human behavior. When these decision-makers understand what motivates people, their knowledge, and thus their decisions, are better informed.

The efforts of Migratory Bird Joint Ventures are largely based on the biological sciences. However, multiple opportunities exist to incorporate human dimensions information and approaches into Joint Ventures' Strategic Habitat Conservation-based work (Figure 5.1; also see: Planning for Conservation Success for more information).

## Strategic Habitat Conservation (SHC) & HD

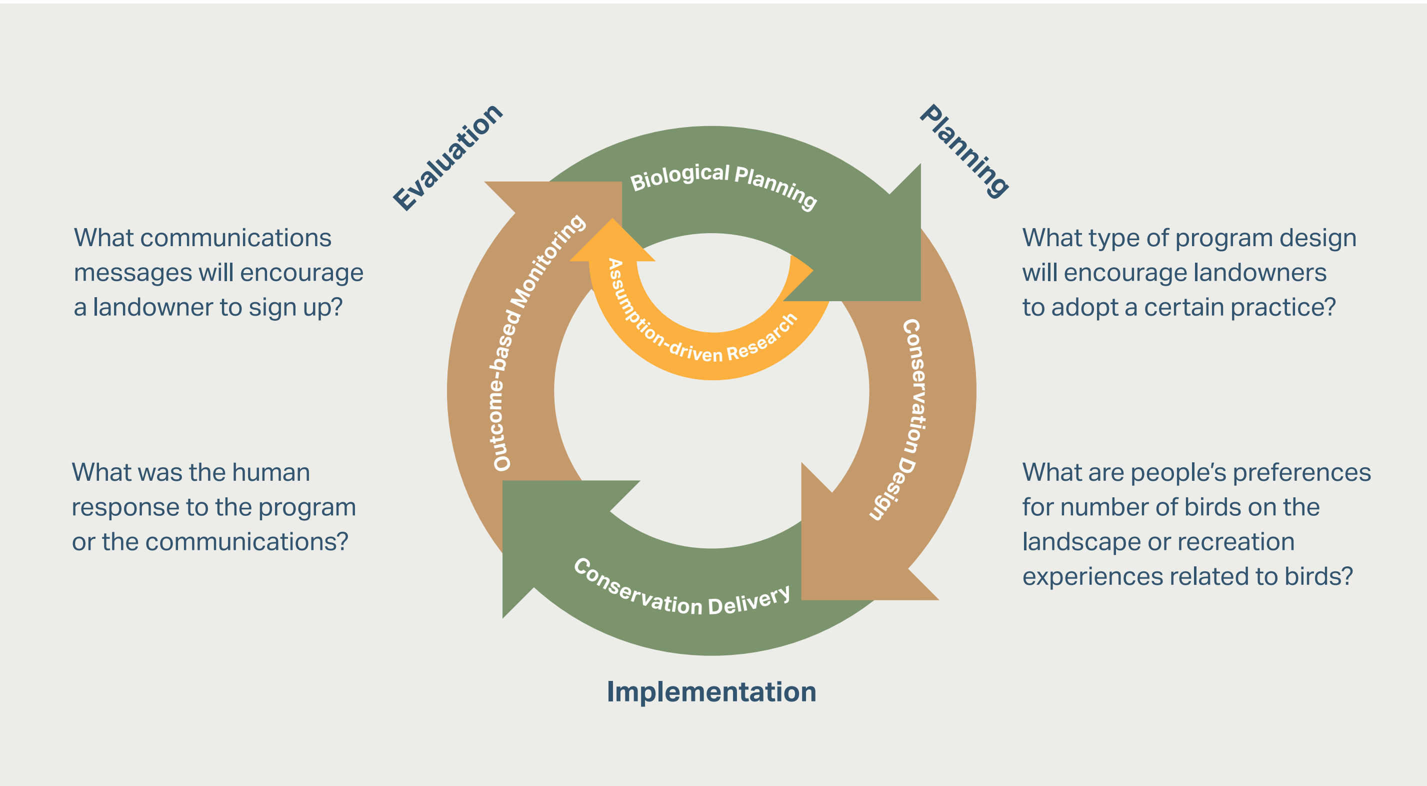


**FIGURE 5.1 Strategic Habitat Conservation (SHC) and human dimensions: Human dimensions research can help improve all aspects of the work of a Joint Venture.** For example, in the case of private lands conservation, human dimensions research questions are important to consider in every phase of a Joint Venture's work, including biological planning, conservation design, program delivery and monitoring.

# PRIORITY HUMAN DIMENSIONS TOPICS IN THE CENTRAL VALLEY

The CVJV identified seven priority human dimensions topics to address, then conducted an extensive literature review on these topics. The literature review (Dayer and Meyers 2016a) and the resulting report (Dayer and Meyers 2016b) are available online at https://www.centralvalleyjointventure.org/science/2020-implementation-plan.

The seven priority topics focus on human dimensions aspects of four key stakeholder groups: hunters, farmers, non-hunting recreationists and urban residents; and three key issues: ecosystem services, environmental justice and multiple benefits.

High-priority human dimensions research needs and management recommendations are detailed in the Dayer and Meyers (2016b) report.

# HUNTERS:

## Waterfowl hunter recruitment, retention and reactivation, and maintaining hunt club ownership of land

Waterfowl hunters on a privately-owned wetland - California Waterfowl Association

Hunters are often active conservationists, and lands owned by waterfowl hunting clubs are typically managed as high-quality wildlife habitat. Hunters also contribute toward conservation financially; for example, in 2017, California hunters and anglers generated more than $91 million through the sale of hunting and fishing licenses, tags and stamps (CDFW 2018). For these reasons, hunters are an important focus of the CVJV's conservation strategy.

The number of duck hunters in California declined 63 percent from 1971 to 2015 (CDFW 2016). This group is primarily composed of rural residents (75 percent), males (91 percent) and whites (88 percent) (USFWS 2013)– a significantly different demographic profile from the population of the region (see Environmental Justice section). Research shows that increasing urbanization is associated with a value shift away from hunting (Larson et al. 2014). Other contributing factors include hunter success, access to land and harvest regulations (Slagle and Dietsch 2018). Therefore, these declines are likely to continue unless new approaches to hunter recruitment, retention and reactivation (R3) are developed and implemented (CDFW 2019).

According to one recent study (Larson et al. 2014), hunters need quality social habitat to flourish. Three types of social habitat are needed: the micro level (the hunter, their family, hunting friends and hunting mentors); the meso level (community support networks, including extended family and peers, and local access to hunting opportunities); and the macro level (demographic changes, urban areas expansion, habitat fragmentation and agency policies).

A particularly problematic research gap for R3 and hunter support for waterfowl habitat is the dearth of information about duck hunting clubs in the Central Valley. Hunt clubs have long conserved wildlife habitat, especially for waterfowl. One study identified 351 hunt clubs in California whose management practices have significantly improved wetland protection and restoration (Brown 2008). However, little to no research has been conducted on how to best support these clubs and their members in the face of declining hunter populations and growing costs of maintaining clubs.

The 2016 NAWMP/National Flyway Council's human dimensions survey of waterfowl hunters in California (and nationally) (Slagle and Dietsch 2018) provides valuable information on waterfowl hunters' behaviors, preferences for recreational experiences, conservation behaviors and perceptions of ecosystem services of wetlands. Further analysis of this information could provide insights on how to maintain and increase hunt club ownership of land, a potentially important strategy to increase waterfowl habitat, and could guide development of the CVJV's targeted communication strategies.

# FARMERS:
## Beliefs and behavior related to wildlife habitat, and how to engage and support farmers

Farmer beliefs and attitudes related to wildlife habitat can strongly influence their habitat conservation behaviors, such as enrolling in habitat incentive programs to benefit birds. Research shows that prior farmer behavior is the strongest predictor of whether they will conduct a conservation behavior (Sheeder and Lynne 2011; Klöckner 2013; Moses 2013). Many other factors play a role in decisions to create habitat, such as farm size, perceived ability to create habitat, social norms, and length and restrictiveness of contracts (Parkhurst 2011; Sheeder and Lynne 2011; Klöckner 2013; Moses 2013; Canales et al. 2015).

The most consistent and important motivational factors for adopting conservation measures is an ethos or attitude of believing it is important to protect and conserve natural resources and to put social good above profits. Some farmers are willing to continue conservation practices without financial incentives, once they have invested time and money to start them (Dayer et al. 2017). This willingness suggests that carefully designed research and education programs to support continued farm conservation may work in the absence of financial incentives. The extent to which this is the case for farmers in CVJV areas is unknown.

*Sutter Bypass - Daniel Nylen, American Rivers*

A study that examined different management styles found that farmers may fall into one of three groups (Brodt et al. 2006). Environmental Stewards put higher priority on natural resources conservation and an ethos of social good than on higher profits. Production Maximizers prioritize producing the highest possible yields and focusing their attention and resources on the farm. For them, the economic benefits of wildlife conservation activities should be emphasized. Networking Entrepreneurs have a business-like attitude but with a broader social network. Economic and environmental benefits should also be clearly described to them, but they may be more receptive to educational programs than Production Maximizers. Recognition of these differing management styles can be valuable for developing effective, targeted approaches to working with farmers. Some farmers need larger economic incentives to adopt wildlife management practices and less information about the practices. Others need fewer economic incentives but need to know that their specific practices result in multiple benefits that could include benefits to humans as well as habitat and wildlife conservation.

Research on conservation program design suggests that the following steps would be effective to increase Central Valley farmers' bird habitat conservation actions: Identify farmers who have previously taken conservation actions and who are Environmental Stewards; provide them with shorter-term contracts that support large-scale conservation work (with opt-out options for significant commodity price declines or adverse weather conditions); show farmers how their specific practices will lead to social and environmental benefits for specific wildlife species in specific areas (especially on their lands) and to specific people; and recognize their work with their peers.

# NON-HUNTING RECREATIONISTS:
## Attitudes toward wetlands and associated wildlife, and how to foster support

Non-hunting recreationists provide significant economic value by visiting wetland habitat and by birdwatching in the Central Valley and throughout California, and they are generally willing to financially support wetland preservation. For example, a study in Merced County found that habitat management and wildlife-associated recreation contributed $53.4 million and 1,100 jobs to the economy (Weissman 2001). Visitors to the Kern River Preserve were willing to pay $77 (2001 dollars) to preserve that habitat, totaling about one-half million dollars (Colby and Smith-Incer 2005).

Boaters on the Sacramento River - Daniel Nylen, American Rivers

Research indicates that wetlands have value for wildlife viewing, and wildlife viewers will support water allocation to them. When recreational users understood that diverting water from wetlands reduced birdwatching and other wildlife viewing opportunities, support for water allocation for wetland habitat increased. One study found that water diverted to wetlands in the San Joaquin Valley was worth $78 million in waterfowl hunting, fishing and wildlife viewing (1989 dollars), while the same quantity of water sold for municipal and industrial users was worth only $19 million (Creel and Loomis 1992). Using this information with other economic data, such as the value of flood reductions gained by preserving wetlands, may increase support by the public and policymakers for water allocations for wetlands.

Research on conservation behavior of birdwatchers also illustrates the potential for this audience to be a strong constituency for conservation. A recent study in New York found that wildlife recreationists, including both hunters and birdwatchers, were four to five times more likely than non-recreationists to actively support conservation efforts (Cooper et al. 2015). Those who both hunt and birdwatch, a group that has not previously been considered in research and rarely considered in practice, had the greatest conservation behavior. Thus, hunters, birdwatchers, and especially hunter/birdwatchers could be valuable constituents for the CVJV and its partners. As for what media to use to reach these audiences, while the public has tended to want their information from television, newspapers and direct mail, wildlife watchers have wanted their information provided by conservation organizations and the parks they visit.

The 2016 NAWMP/National Flyway Council survey also studied birdwatchers in California and nationally (Slagle and Dietsch 2018). This information will be very useful to the CVJV in understanding this audience in California and their relationship to wetlands and waterfowl conservation.

## URBAN RESIDENTS:
### Attitudes toward water, wetlands, and wildlife conservation, and determinants of support for water allocations for wetland birds

As many as 95 percent of California residents live in urban areas (ICIP 2016), a higher proportion than the national average (2010 data). Water resources form the main connection between wetland conservation and urban residents in California. A majority of California voters in 2015 described the state's water shortage as extremely serious (66 percent) (DiCamillo and Field 2015); 86 percent believed that water supply issues were going to be an ongoing problem (Metz and Below 2015); and 80 percent understood that residential water use reductions were "very important" (DiCamillo and Field 2015). The strongest arguments for reducing household water usage were: 1) water shortages are here to stay (97 percent found this statement very or somewhat convincing), 2) collective responsibility (93 percent) and 3) responsibility to future generations (87 percent) (Gomberg et al. 2014).

*Winter-run Chinook salmon - Steve Martarano, USFWS*

The public is split concerning support for policies that would protect the environment versus protecting water supplies for human use. In 2014, 46 percent of California voters said we "need to protect the environment, even if it hurts the water supply," compared to 36 percent who said the opposite; 55 percent were opposed to suspending environmental regulations that protect fish and wildlife (Wu 2014). The mixed support for environmental protection suggests that the three arguments for water conservation to be adapted and used for public information campaigns are ones that show how water use reductions in the city, and allocations for wetlands, are part of a necessary collective responsibility to conserve wetlands for society and our children, to reduce flooding now and in the future, and to improve water supplies for use now and in the future.

Innovative policy initiatives also hold promise for increasing the public's political and financial support for wetlands. When water quality improvements completed by farmers and other private landowners can be measured, they are called performance-based improvements. Urban residents have been willing to pay for performance-based water quality improvements by agricultural producers. In exchange, agricultural producers are often willing to accept payment for performance-based water quality improvements (Baird et al. 2011).

The CVJV needs to evaluate this approach further to assess if it can be modified so that agricultural producers and others who conduct wetlands restoration can have contracts with urban areas to reduce downstream flooding in the CVJV region. In one study, California residents indicated they were willing to pay $35 per acre per year (1989 dollars, the equivalent of $71 in 2019 dollars) to protect wetland quality and salmon fishing in the San Joaquin Valley and strongly supported funding for wetlands protection and salmon fishing (Pate and Loomis 1997). These results indicate there may be support for funding performance-based flood reduction programs that restore wetlands.

## ECOSYSTEM SERVICES:

## Integrating the economic and cultural valuation of ecosystem services into natural resource management, and how to message about these services

Ecosystem services are the benefits that ecosystems provide to humans. These benefits can include market values, such as flood protection, crop pollination and recreation, and non-market values, such as aesthetic appreciation, existence value and option value. De Groot et al. (2006) used three general types of value (ecological, sociocultural and economic) to calculate Total Economic Value (TEV) of wetlands, finding each acre of wetlands in the world provided an average value of $1,325 per acre/year. Integrating the valuation of ecosystem services into natural resource management can highlight the economic and cultural importance of protecting land in its natural state.

Three common methods for ecosystem valuation are direct market valuation, indirect market valuation (or Avoided Cost) and contingent valuation (De Groot et al. 2006). Direct market valuation identifies the exchange value of ecosystem services in markets, as when conservation programs acquire conservation easements by paying landowners not to develop wetlands. Indirect market valuation is used when there are no explicit markets for ecosystem services. It identifies "revealed preferences" by estimating costs that would have been incurred without those services such as the value of using conservation techniques to avoid silting in a wetland, saving the cost of restoring the silted-in wetland. Contingent valuation asks respondents to state their preference for what they would be willing to pay for some ecosystem service, such as conserving a particular wetland for wildlife watching. Proponents of a fourth method argue strongly that using group decision-making is a more appropriate method to identify the ecosystem value of a service.

*Birdwatchers at a Central Valley wetland - Mike Peters*

Planners and decision-makers are frequently not fully aware of the connections between wetland conditions, the provision of wetland services and the economic and non-economic benefits for people. For example, one study calculated that the total economic impact of ecosystem services in Merced County equaled $53.4 million per year and 1,100 jobs (Weissman 2001; see also Non-Hunting Recreationists section, above). Lack of awareness can lead to ill-informed decisions to allow development on wetlands. A best practice for performing an ecosystem services valuation to inform decision-making was developed by the U.S. Fish and Wildlife Service's National Wetlands Inventory (Stelk et al. 2014). It includes these steps: 1) identify the context, 2) define the boundaries, 3) identify stakeholders, 4) develop a functional analysis, 5) perform ecosystem services valuation, 6) develop trade-off analysis and 7) communicate results.

Using non-jargon terminology is extremely important in communicating effectively with the public. The topic of ecosystem services is especially prone to dense, jargon-rich parlance (Resource Media 2012), and the term "ecosystem services" has been shown to confuse members of the public and management experts alike. A 2010 national voter survey (Metz and Weigel 2010) found that voters strongly preferred the terms "nature's value" or "nature's benefits."

# ENVIRONMENTAL JUSTICE:

## Socio-demographic differences in the Central Valley, environmental justice issues and how to communicate and engage with communities

Environmental justice involves empowering affected communities, which are generally low-income communities and communities of color to protect their communities' health and that of the local environment (CEJA 2015; Skelton and Miller 2016). The rapidly-growing human population of the Central Valley has a higher proportion of people of color compared to the rest of the state. For example, the Hispanic population in this region is approximately 10 percent to 20 percent higher than in the state overall (2010 U.S. Census data, summarized in CVAF n.d.), and has a large population of immigrant farm workers.

The environmental injustices in the Central Valley are well-documented and present an opportunity for collaboration between the CVJV and environmental justice organizations (EJOs), which work with affected communities, to address mutual interests. These organizations tend to be well organized, highly aware of environmental issues, involved with climate change activists, politically astute, and effective. Given these qualities, they may be open to working with conservation partners to decrease flooding and restore riparian zones in their communities as part of efforts to increase bird habitat.

Resources are available to support these partnerships. The Environmental Justice Grants program provides funds for recreational or other community amenities, and it could perhaps include restored riparian or wetland zones in vulnerable communities. Spatial planning tools, such as CalEnviroScreen (OEHHA 2017), can potentially identify communities and overlay those with watershed, flood zone and land use maps to identify where restoration of riparian zones might reduce flooding impacts, while providing wildlife habitat and recreational spaces.

*Egrets in a flooded field outside Sacramento - Dave Feliz, Yolo Bypass Wildlife Area*

To build collaborations, the social and political qualities of EJOs need to be considered. One approach to building effective collaboration in environmental justice contexts has been Community-Based Participatory Action Research (Bacon et al. 2013). This approach brings organizations together with communities to collaborate on a research and implementation project. The communities provide specialized, local knowledge, such as the most important flood reduction zones in their communities, based upon their knowledge of who is most vulnerable and what is most valuable in their communities. Flood control planning by restoring wetland and riparian zones, for example, could then be integrated with carefully designed flood control measures in the communities to protect their most valued areas, benefitting both groups. The communities then become partners in advocating for flood reduction efforts that benefit wetlands, riparian areas, and people.

## MULTIPLE BENEFITS:
## Effectiveness of existing methods for developing strategies to manage for multiple benefits

The terms "multi-benefit" and "multiple-benefit projects" are used by the Central Valley Flood Protection Plan to refer specifically to flood control efforts that also provide environmental benefits (CDWR 2017). This Plan defines multiple-benefit projects more broadly, as land use projects designed to meet public safety needs, enhance ecological function and improve habitat quality for fish and wildlife. Multiple-benefit projects can provide benefits such as groundwater recharge, improved water quality and enhanced access to recreation. (See also the Multiple-Benefit Projects subchapter.)

Multiple-benefit approaches to conservation and planning seek to balance two or more types of benefits. The benefits might include environmental, economic and/or human welfare benefits when addressing a water and/or habitat management challenge.

*Environmental education - David Kalb*

Involving the public in planning multiple-benefit projects will reap long-term benefits for the CVJV. The importance of meaningful public participation and collaboration has been demonstrated and discussed extensively in the human dimensions literature. For example, Integrated Resource Management conducts multiple-benefit planning through collaborative processes among localities, state, and federal resource groups. In 2010, California established the policy that the Natural Resources Agency use Integrated Resource Management for environmental assessments, mitigation planning, etc. Early, frequent and meaningful community engagement and participation in planning riparian restoration projects has been identified as absolutely critical in building community support for, and increasing the likelihood of, successful restoration projects.

Early engagement has also helped planners identify what research needs to be conducted to address community concerns. This understanding then helps shape an overall research agenda needed to identify and select proposed alternatives. When communities are meaningfully involved, they have generally advocated for additional lands and recreational opportunities (such as fishing access) to be included in riparian restoration projects and asked for larger restoration projects. This advocacy is done with the understanding that these recreational amenities would increase economic opportunities from tourism generated from multiple-benefit projects.

**These seven human dimensions topics hold great potential for enhancing the work of the CVJV over the next 10 years. Specific recommendations for acting on the information summarized here, as well as priorities for further research into these topics, are presented in the Dayer and Meyers (2016b) report, posted online at https://www.centralvalleyjointventure.org/science/2020-implementation-plan.**

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# SECTION III

# CONSERVATION OBJECTIVES BY BIRD GROUP

# 6 INTRODUCTION TO BIRD CONSERVATION OBJECTIVES

**This section of the Central Valley Joint Venture (CVJV) Implementation Plan (hereafter, "the Plan") summarizes the science used to establish the Plan's conservation objectives. The section contains a chapter about each distinct group of birds included in the Plan, defined by habitat, taxonomy, and/or season, as well as a chapter with a focus on at-risk bird species in the Central Valley. The CVJV has applied the best available science to develop conservation objectives. Experts on each bird group used existing data from the Central Valley region, employed established methods, and developed new methods when necessary, to determine the estimated number of individual birds and associated acres of habitat required in the Central Valley to support viable bird populations.**

## The Conservation Objectives

For non-breeding shorebirds, breeding shorebirds, non-breeding and breeding waterbirds, breeding riparian landbirds, and breeding grassland-oak savannah landbirds, conservation objectives have been established for two timeframes. The first set are long-term, 100-year conservation objectives that, if achieved, would indicate ultimate conservation success. These conservation objectives are highly ambitious and very long-term. They should be considered "stretch goals," that is, those that inspire creativity to accomplish what currently seems impossible (Manning et al. 2006). The second set are short-term, 10-year conservation objectives that align with the timeframe of this Plan. These short-term objectives were used to develop the overall CVJV habitat objectives, which consider overlap among the needs of different bird groups as well as social and economic factors (see the Human Dimensions of Bird Conservation chapter).

The At-Risk Bird Species chapter does not provide conservation objectives but creates the first-ever Central Valley-specific list of declining and vulnerable avian taxa (species, sub-species, and distinct populations).

Breeding and non-breeding waterfowl were treated somewhat differently. Planning for waterfowl was guided by the North American Waterfowl Management Plan (NAWMP 2012), an international agreement to conserve waterfowl populations across the continent. The NAWMP establishes continental population objectives for ducks, geese and swans. Regional Joint Ventures share the responsibility to determine the amount and type of habitat required to support the population objectives in each region.

This CVJV Plan establishes long-term habitat objectives for non-breeding waterfowl in the Central Valley, based on duck population objectives determined for this region (Fleming et al. 2017) and on current goose and swan populations. This Plan also establishes population objectives for breeding ducks in the Central Valley, using the general principles outlined in the NAWMP, albeit at a local scale. NAWMP population objectives and corresponding habitat objectives to support them are considered long-term and are subject to periodic revision as directed by the NAWMP Committee or the CVJV.

The chapters that follow are summaries of the science employed to inform the overarching CVJV conservation objectives and conservation delivery strategies (Conservation Delivery chapter). Peer-reviewed publications that form the basis for the conservation objectives described here can be found in the online journal San Francisco Estuary and Watershed Science (Volume 15, Issue 1, 2017) for all bird groups except waterfowl. For waterfowl, the science used to inform objectives is derived from several sources and peer-reviewed publications, which are identified in the respective Breeding and Non-Breeding Waterfowl chapters.


*(1) Sandhill cranes flying over wetland - Tom Grey (2) "Modesto" song sparrow - Brian Gilmore*

## Confidence Ranks

The CVJV and consulting experts assigned a qualitative confidence rank, from Low to High, to each bird group's conservation objectives (Table 6.1). These confidence ranks are intended to indicate a level of scientific certainty. It is important to note that each rank is only defined relative to the other bird groups. Hence, a High rank does not mean the CVJV has complete information, only that the state of knowledge is more advanced than for bird groups ranked as Medium or Low. Similarly, a Low rank does not mean the objectives are meaningless or derived from guesswork, but rather, that they are based on less, or less precise, existing knowledge.

Setting robust conservation objectives is a difficult endeavor. The confidence that scientists place in the final products is dependent on the type, amount and quality of the data as well as the methods available to turn that data into conservation objectives. Hence, knowing the confidence level of the conservation objectives for each bird group can be useful in interpreting the results and, more importantly, in weighting their use in conservation planning. Additionally, those bird groups with Low-ranked objectives could be raised in priority for additional research so that their objectives can be updated with better information.

| BIRD GROUP | CONFIDENCE RANK | INFORMATION NEEDED TO SET OR IMPROVE OBJECTIVES |
|---|---|---|
| **Non-breeding Waterfowl** | High | Future trends in rice farming and compatibility of postharvest rice field management with waterfowl needs; improved estimates of food availability and depletion rates in key habitats. |
| **Breeding Waterfowl** | Low | Improved knowledge of key variables that influence recruitment of young, especially nest and duckling survival; improved knowledge of the contribution of recent landscape changes to population declines. |
| **Non-Breeding Shorebirds** | Medium | Invertebrate energy density estimates by land cover type and over space and time; spatially-explicit habitat availability; impacts of shifting climate patterns on habitat availability and food energy supply. |
| **Breeding Shorebirds** | Low | Better estimates of breeding densities and distribution by habitat type and planning regions (particularly for killdeer); improved estimates of reproductive success by habitat and region. |
| **Breeding and Non-Breeding Waterbirds** | Low | Better estimates (by planning region) of population sizes, densities in key habitats, and energy or resource needs, particularly for non-breeding and solitary breeding waterbirds. |
| **Breeding Riparian Landbirds** | Medium | Better estimates of breeding densities by habitat type and geography. |
| **Breeding Grassland-Oak Savannah Landbirds** | Medium | Better estimates of breeding densities and distribution by habitat type and geography. |
| **At-Risk Bird Species** | N/A | Quantification of current population sizes; extent of key habitats; bird densities within those habitats; energy resource requirements and the amount available in a given extent of habitat by season. |

**TABLE 6.1 Relative confidence ranks of conservation objectives for each bird group, and the highest-priority information needed to improve confidence in future planning activities.**

Priority research needs for each bird group are outlined in the 2010 CVJV Monitoring and Evaluation Plan (CVJV 2010), which will be updated to improve future planning efforts. The next update of this needs assessment is slated to begin in 2020.

Additional information, from monitoring and from directed research, is needed for all bird groups as part of the adaptive management framework, to inform current understanding and plan for future periodic updates.

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1

# NON-BREEDING WATERFOWL




2


3

# CHAPTER SUMMARY

The Central Valley provides critical habitat for numerous North American waterfowl species during their winter and/or migration seasons. The Central Valley Joint Venture applies the objectives of the North American Waterfowl Management Plan to create landscape conditions that support abundant and resilient populations of these waterfowl species.

This chapter describes the conservation objectives for wetland restoration and enhancement, wetland water supplies, and acreage of rice and corn agriculture needed to support the Valley's waterfowl populations under different types and degrees of potential future changes to habitat quality and quantity. The Implementation Plan used a food energetics model (TRUEMET) to develop these objectives.

The Conservation Delivery chapter in Section I integrates the waterfowl 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.

## HABITAT TYPE

Non-breeding waterfowl in the Central Valley use a mix of managed seasonal wetlands and postharvest rice and corn fields. The quality and quantity of foods in these habitats, and the availability of water to winter-flood or summer-irrigate these habitats over the course of the year, are key factors for waterfowl survival and later reproductive success.

## SUCCESS STORY: Willow Creek Ranch – Managing Water For Multiple Uses

Water for wetlands in the Central Valley is limited and will only become more so in the future. This trend highlights the need to use the water currently available in a way that maximizes habitat benefits for wildlife. One outstanding example of this approach is the Willow Creek Ranch: 7,050 acres of privately-owned wetlands and wildlife-friendly rice fields located adjacent to two National Wildlife Refuges.

Over the years, individual landowners in the area had improved wildlife habitat on their properties. But existing topography and infrastructure limited water-use efficiency and water and habitat management capabilities. Although there had been efforts in the past to make repairs to this degraded system, a comprehensive upgrade was needed. Enter Ducks Unlimited (DU), Willow Creek Mutual Water Company, and numerous private landowners. Through a series of projects on the ranch, individual duck clubs have been refurbished by DU and California Waterfowl Association, and a landscape approach to water conveyance is underway.

Project work to date has increased water efficiency, allowing the water to be reused up to five times before leaving the ranch. The work has reduced mosquito production and greatly improved wetland management capabilities for waterfowl. This big-picture approach to wetland conservation, together with an outstanding partnership, is improving habitat on the scale needed to achieve the Central Valley Joint Venture's objectives for non-breeding waterfowl.

### LONG-TERM HABITAT OBJECTIVES: WHAT'S NEEDED?

**MAINTAIN EXISTING MANAGED WETLANDS:**
**219,000 ACRES**

**WETLAND RESTORATION:**
**69,000 ACRES**

**ANNUAL WATER SUPPLIES:**
**1,360,000 ACRE-FEET**

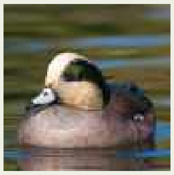
**WINTER-FLOODED RICE HABITAT:**
**341,000 ACRES**

**GRAIN CORN HABITAT:**
**34,000 ACRES**

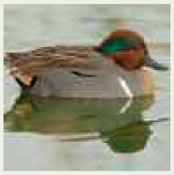
### BIRD SPECIES INCLUDE:

Representative waterfowl in the Central Valley in the non-breeding season

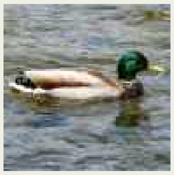
Northern pintail*



American wigeon***



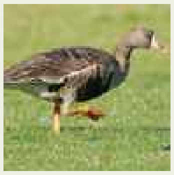
Green-winged teal**



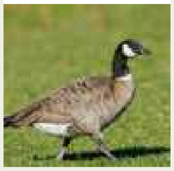
Mallard****

Canvasback**

Lesser snow goose***



Greater white-fronted goose**



Aleutian cackling goose**

** Image: Dale Garrison ** Image: Tom Grey *** Image: Mike Peters **** Image: Robert McLandress*

*(1) Northern pintail - Mike Peters (2) Snow geese - Jeff McCreary (3) Ring-necked duck - Mike Peters*

## INTRODUCTION

**The Central Valley of California supports one of the largest concentrations of non-breeding waterfowl (ducks, geese and swans) in the world despite the loss of more than 90 percent of its historical wetland acreage (Heitmeyer et al. 1989; Fleskes 2012). Approximately 60 percent of the Pacific Flyway's waterfowl winter in the Central Valley, with a third or more of North America's pintail *(Anas acuta)*, and almost all the continental population of tule white-fronted geese *(Anser albifrons elgasi)* and Aleutian cackling geese *(Branta canadensis leucopareia)* (Gilmer et al. 1982; Petrie et al. 2016). In addition to waterfowl that winter in the Central Valley, many species depend on habitats in the Valley during migration between their northern breeding grounds and wintering areas in the south, including the Salton Sea and coast of southern California, the Baja California Peninsula, and western Mexico.**

Conservation planning for waterfowl in the Central Valley has its roots in the North American Waterfowl Management Plan (NAWMP 2012). A key challenge to NAWMP implementation has been the need to develop a set of regional habitat objectives that collectively support the NAWMP's continental waterfowl population objectives. As the NAWMP approached its 20th anniversary, an international steering committee evaluated the plan's success. In doing so, the committee identified the planning actions needed to produce a consistent and cohesive set of Joint Venture habitat objectives across the North American landscape (ASC 2007). Those actions included Biological Planning, Conservation Design, and Conservation Delivery. The Central Valley Joint Venture (CVJV) adopted these planning actions to develop the waterfowl chapters for this updated Implementation Plan (hereafter, "the Plan").

- Biological Planning includes the scale at which planning regions are established; clearly defined assumptions about the limiting biological factors and waterfowl demographic parameters being addressed; and the development of population-habitat models that reflect these limiting factors and demographic parameters.

- Conservation Design addresses the fundamental questions of how much conservation, of what type, and where. CVJV waterfowl conservation design begins with habitat objectives that describe the amount of habitat needed to support waterfowl population objectives in each planning region of the Central Valley. It also includes annual targets for wetland enhancement and water supply. The objectives were informed by waterfowl ecology during the non-breeding period, an evaluation of the existing amount and composition of habitat available to waterfowl in each planning region of the Central Valley, and an assessment of future threats to that habitat.

- Conservation Delivery identifies the primary approaches to meet both habitat and bird population objectives. The Conservation Delivery chapter of this Plan identifies potential future scenarios and a process that allows for adaptability in identifying and implementing priority conservation strategies and actions.

For this Plan, the CVJV considered all NAWMP waterfowl species that winter in or migrate through the Central Valley in numbers sufficient enough that conservation actions would have a population- or sub-population-level impact. The CVJV focuses its conservation objectives on ducks because species like northern pintail remain well below NAWMP population objective. In contrast, goose populations have exceeded their population objectives (Olson 2018).

## CONSERVATION GOAL

**The Central Valley Joint Venture's long-term goal for waterfowl is to guide regional efforts to create landscape conditions necessary to support abundant and resilient breeding and non-breeding duck populations in the Central Valley, at levels that support hunting and other uses, consistent with the North American Waterfowl Management Plan.**

# BIOLOGICAL PLANNING:
## The Science Behind CVJV Conservation Objectives

### Planning Regions

Planning units represented the geographic scale at which the CVJV originally established habitat and conservation objectives for migrating and wintering waterfowl. The Central Valley's nine drainage basins served as the planning units in both the 1990 and 2006 Implementation Plans (CVHJV 1990; CVJV 2006). Historically, these drainage basins produced distinct wetland complexes within the Central Valley. They range in size from 170 square miles to 5,600 square miles (Figure 7.1). However, the 2020 Implementation Plan combines some drainage basins into larger planning regions. The American, Butte, Colusa, and Sutter basins were combined into the Sacramento planning region, while the Yolo and Delta drainage basins were combined into the Yolo-Delta planning region. The Suisun, San Joaquin, and Tulare planning regions are consistent with previous CVJV plans (Figure 1). The decision to combine drainage basins reflects the belief that conservation opportunities vary widely among some adjacent basins, and that consolidating these basins provided greater flexibility for meeting waterfowl needs.

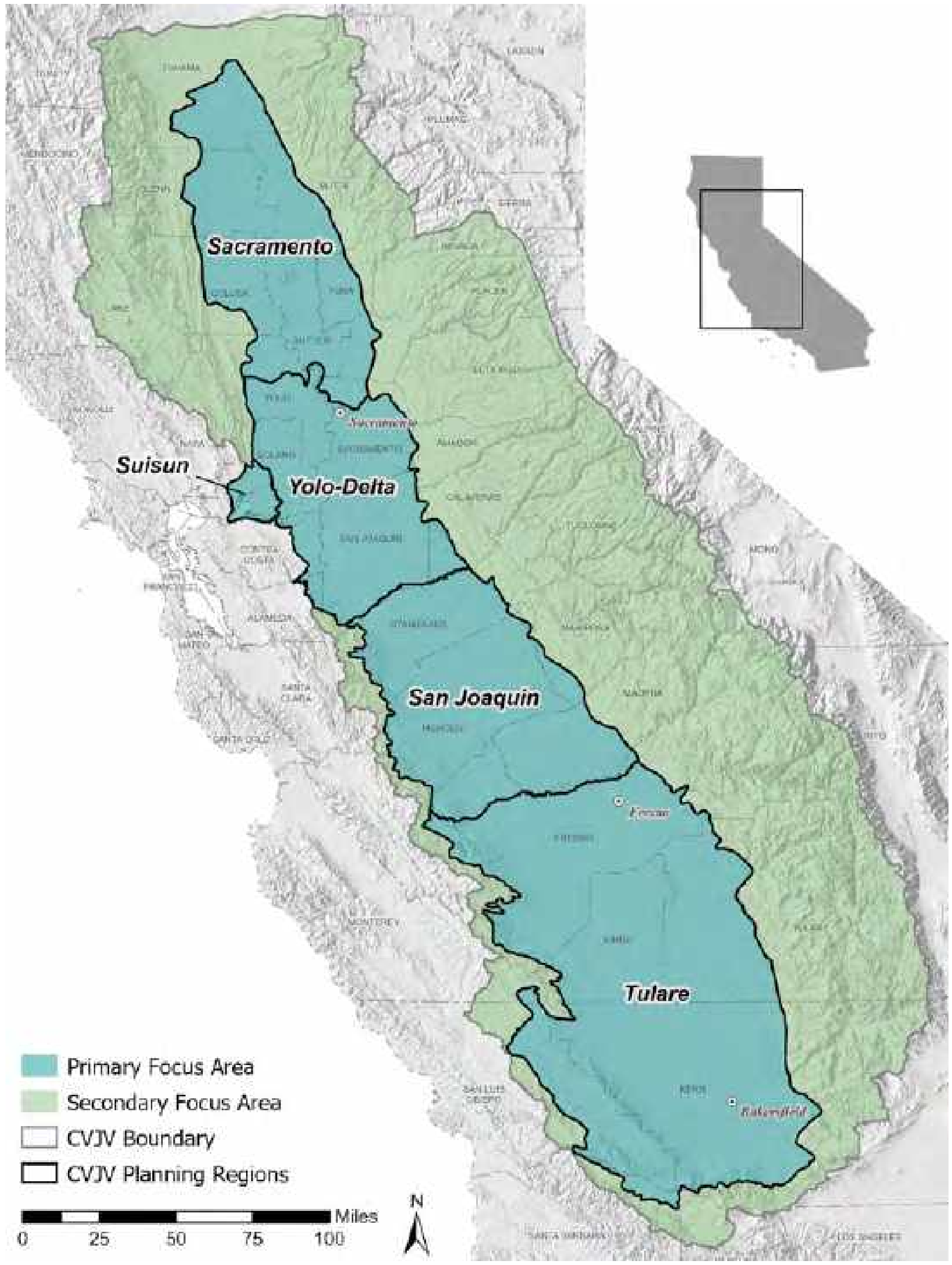



**FIGURE 7.1 Central Valley Joint Venture perimeter and Primary Focus Area, divided into five planning regions.**

### Limiting Biological Factors

Conservation planning for migrating and wintering waterfowl in the Central Valley is largely driven by the food limitation hypothesis, which states that food availability during the non-breeding period influences survival and reproductive success through its effects on body condition (Brasher 2010; Williams et al. 2014). The fundamental assumption is that ensuring adequate food is available and reducing energetic costs of securing food during fall and winter allows birds to maintain good body condition and thus, their overwinter survival will be improved (Delnicki and Reinecke 1986; Bergan and Smith 1993; Thomas 2004; Heitmeyer 2006;

Moon and Haukos 2006; Fleskes and Yee 2007; Moon et al. 2007). Moreover, it appears that habitat conditions during winter and spring benefit breeding productivity (Heitmeyer and Fredrickson 1981; Kaminski and Gluesing 1987; Raveling and Heitmeyer 1989; Guillemain et al. 2007; Devries et al. 2008; Anteau and Afton 2009).

## Population – Habitat Model

Most Joint Ventures use a food energy approach to establish conservation objectives for migrating and wintering waterfowl (Williams et al. 2014). Waterfowl scientists developed the TRUEMET bioenergetics model (Petrie et al. 2016) to estimate waterfowl habitat requirements by comparing food energy needs to food energy supplies. Consistent with the 2006 CVJV Implementation Plan, the CVJV adopted the TRUEMET model for the 2019 Implementation Plan. The model calculates population-level energy needs from the daily energy requirements of a single bird multiplied by time-specific population size objectives. Food energy supplies are dependent on the availability and amount of waterfowl habitat, as well as the quantity and quality of foods contained in these habitats. The model accounts for the combined effects of waterfowl consumption, decomposition of foods over time, and changes in habitat availability that result from wetland flooding schedules or other events such as the timing of agricultural harvest. The CVJV used the TRUEMET model to evaluate the current habitat conditions for waterfowl relative to population food energy needs, identify any habitat shortfalls, and evaluate future threats to waterfowl habitat in the Central Valley. The model was also used to help establish the habitat and conservation objectives for waterfowl in each planning region. Key inputs used in the TRUEMET model are described below.

### Waterfowl Population Objectives and Daily Energy Needs

Waterfowl can be divided into foraging guilds to reflect differences in the foods eaten (Petrie et al. 2016). For this Plan, the CVJV focused on two waterfowl foraging guilds: ducks and geese. More than 90 percent of all ducks in the Central Valley are dabbling ducks, with the remainder being diving ducks. The Plan treats diving ducks and dabbling ducks as a single foraging guild to account for their potential competition for food resources, especially wetland plant seeds in managed seasonal wetlands. The goose guild contains three species of "dark" geese, including greater white-fronted geese (*Anser albifrons*), western Canada geese (*Branta canadensis moffitti*), and Aleutian cackling geese (*Branta hutchinsii leucopareia*), and two species of "white" geese, including lesser snow geese (*Anser caerulescens caerulescens*), and Ross's geese (*A. rossii*). Although the 2006 Plan separated white and dark geese into different foraging guilds, recent work on the diets of dark geese in the Central Valley indicates they should not be separated based on food consumption (Skalos 2012). As a result, the current Plan treats all goose species as a single foraging guild. Tundra swans (*Cygnus columbianus*) are also included in the goose guild. They have similar dietary needs and are present in the Central Valley in much smaller numbers compared to geese.

### Ducks

The CVJV derived duck population objectives for the entire Central Valley from the NAWMP as described by Fleming et al. (2017) (Table 7.1). To partition the Central Valley duck population objectives among planning regions, a percentage of this total objective was assigned to each region based on an understanding of duck distribution and the desire to maintain traditional hunting opportunities throughout the Central Valley (Table 7.2; CVJV 2006). The population abundance objectives established by Fleming et al. (2017) correspond to a single mid-winter period in early January. However, ducks are present in the Central Valley from mid-August through the end of March and their overall numbers vary considerably over this six-month period. To account for this temporal variation in bird abundance, the CVJV established 15-day interval population objectives from August 15 to March 28 by combining the population objectives from Fleming et al. (2017) with information on duck migration chronology for the Central Valley and for each planning region (Petrie et al. 2011).

The estimate of the daily food energy needs of an "average duck" in the Central Valley was drawn from Miller and Newton (1999).

### Geese

Many North American goose populations have exceeded their population objectives (USFWS 2014). As a result, Joint Ventures have been advised to use recent goose counts as the population objectives when developing implementation

Greater white-fronted geese in postharvest-flooded rice field - California Rice Commission

| SPECIES | MID-WINTER OBJECTIVE |
|---|---|
| **Wood duck** (*Aix sponsa*) | 144,672 |
| **Cinnamon teal** (*Spatula cyanoptera*) | 2,490 |
| **Northern shoveler** (*Spatula clypeata*) | 596,917 |
| **Gadwall** (*Mareca strepera*) | 146,676 |
| **American wigeon** (*Mareca americana*) | 844,473 |
| **Mallard** (*Anas platyrhynchos*) | 737,894 |
| **Northern pintail** (*Anas acuta*) | 1,613,310 |
| **Green-winged teal** (*Anas crecca*) | 805,690 |
| **Total Dabbling Ducks** | **4,892,122** |
| | |
| **Canvasback** (*Aythya valisineria*) | 109,651 |
| **Redhead** (*Aythya americana*) | 40,158 |
| **Ring-necked duck** (*Aythya collaris*) | 79,517 |
| **Scaup** (greater, *Aythya marila,* and lesser, *Aythya affinis,* combined) | 184,450 |
| **Ruddy duck** (*Oxyura jamaicensis*) | 130,609 |
| **Total Diving Ducks** | **544,385** |
| **Total Ducks** | **5,436,507** |

**TABLE 7.1 Mid-winter duck population objectives for the Central Valley, "stepped down" from the NAWMP** (Fleming et al. 2017). These mid-winter population objectives were combined with information on duck migration chronology to establish population objectives by 15-day period annually between August 15 and March 28.

plans (Koneff 2003). To estimate the number of geese in the Central Valley, the CVJV calculated three-year averages for each goose species based on the most recent surveys of each (Table 7.3). These surveys are generally timed to coincide with peak goose numbers. To estimate the number of geese in the Central Valley for each 15-day interval between August 15 and March 28, the CVJV averaged the peak population estimate for each species over the most recent three years of surveys and combined this peak value with information on migration chronology (Petrie et al. 2011), then distributed the total population size in each interval among the five planning regions, based on survey data (Fleskes et al. 2005). More than 80 percent of all geese found in the Central Valley occurred in the Sacramento Valley (i.e., Sacramento and Yolo-Delta planning regions).

The estimate of the daily food energy needs of geese was determined using the methodology established in Miller and Eadie (2006).

| PLANNING REGION | PERCENT OF TOTAL CVJV DUCK POPULATION OBJECTIVE | PERCENT OF TOTAL CURRENT CVJV GOOSE POPULATION |
|---|---|---|
| **Sacramento** | 47% | 79% |
| **Yolo-Delta** | 15% | 10% |
| **Suisun** | 5% | <1% |
| **San Joaquin** | 25% | 10% |
| **Tulare** | 8% | <1% |

**TABLE 7.2** Percent of the total CVJV duck population objective, and current goose population numbers, assigned to each planning region.

| SPECIES | PEAK NUMBER |
|---|---|
| **White geese** (lesser snow geese, *Anser caerulescens caerulescens,* and Ross's geese, *Anser rossii*). | 1,375,300 |
| **Greater white-fronted geese** (*Anser albifrons*) | 675,051 |
| **Aleutian cackling geese** (*Branta hutchinsii leucopareia*) | 164,250 |
| **Western Canada geese** (*Branta canadensis moffitti*) | 5,914 |
| **Tundra swans** (*Cygnus columbianus*) | 62,102 |
| **Total Geese and Swans** | **2,282,617** |

**TABLE 7.3** Peak numbers of geese and tundra swans in the Central Valley, based on the average of the last three survey years.

## Area and Availability of Waterfowl Foraging Habitats

The CVJV assumed ducks in the Central Valley rely on three major foraging habitats: managed seasonal wetlands, harvested rice fields that are winter-flooded, and harvested grain corn fields whether flooded or not. It was assumed that ducks consume seed resources and macro-invertebrates in seasonally managed wetlands, waste grain in winter-flooded rice fields, and waste grain in harvested cornfields. Geese were assumed to forage in both harvested rice fields and harvested grain corn fields whether flooded or not. Geese are believed to use wetlands mostly for roosting (Skalos 2012).

### Managed Seasonal Wetlands

To determine the area of managed seasonal wetlands now present in the Central Valley, as a whole and by planning region, the CVJV used estimates produced from 2009 satellite imagery (Petrik et al. 2014) supplemented by the area of wetlands restored between 2009 and 2015 (D. Fehringer, unpublished data, 2016, see "Notes"; Table 7.4). Consistent with the 2006 Plan, this 2020 Plan uses the flooding schedules estimated for public and privately managed seasonal wetlands in the Central Valley provided by wetland managers. These flooding schedules were used for modelling the temporal availability of managed seasonal wetlands in the Central Valley as a whole and in each of the five planning regions.

| PLANNING REGION | MANAGED SEASONAL WETLANDS |
|---|---|
| **Sacramento** | 68,495 |
| **Yolo-Delta** | 21,954 |
| **Suisun** | 28,752 |
| **San Joaquin** | 58,375 |
| **Tulare** | 18,834 |
| **Total** | **196,410** |

**TABLE 7.4** Managed seasonal wetland estimates (acres) for the Central Valley, identified by planning region.

### Rice

Between 2007 and 2014, on average, 541,362 acres of rice were harvested in the Central Valley (USDA 2015). The Plan relies on that average figure, even though drought conditions after 2014 reduced the amount of planted rice (Petrie et al. 2016). Rice harvest in the Central Valley generally begins in early September, with nearly all fields harvested by early November. The model excluded 4,536 acres of rice grown in the San Joaquin planning region because nearly all these acres are tilled and left dry after harvest, providing little foraging value to waterfowl (CVJV 2006). Approximately 95 percent of all rice occurs in the Sacramento planning region, with approximately 63 percent of all harvested rice fields being winter-flooded (Table 7.5). To determine the area of winter-flooded rice by 15-day time period in each planning region, the CVJV relied on estimates based on satellite imagery of winter-flooded rice from late September through the end of March (Dybala et al. 2017). For harvested rice fields that are not winter-flooded, 25 percent of these fields were assumed to be "deep-plowed" and provide no waterfowl food resources (CVJV 2006).

| PLANNING REGION | PLANTED | WINTER-FLOODED | UNFLOODED | DEEP-PLOWED |
|---|---|---|---|---|
| **Sacramento** | 509,873 | 324,847 | 138,763 | 46,263 |
| **Yolo-Delta** | 26,953 | 15,823 | 8,346 | 2,784 |
| **Suisun** | 0 | 0 | 0 | 0 |
| **San Joaquin** | 4,536 | 0 | 0 | 4,536 |
| **Tulare** | 0 | 0 | 0 | 0 |
| **Total** | **541,362** | **340,670** | **147,109** | **53,583** |

**TABLE 7.5** Rice habitat estimates (in acres) for the Central Valley, identified by planning region.

### Grain Corn

Between 2011 and 2013, an average of 137,634 acres of grain corn was harvested in the Central Valley, mostly in the Yolo-Delta planning region (USDA 2014). The model relies on this average figure. The CVJV assumed that only 25 percent of all harvested grain corn fields provide waterfowl food resources and that postharvest practices in the remaining fields make most or all unharvested corn unavailable to waterfowl (Table 7.6; Matthews 2019). The timing of grain corn harvest was assumed to be similar to that for rice (CVJV 2006).

| PLANNING REGION | PLANTED | PROVIDE FOOD | PROVIDE NO FOOD |
|---|---|---|---|
| **Sacramento** | 29,624 | 7,406 | 22,218 |
| **Yolo-Delta** | 108,008 | 27,002 | 81,006 |
| **Suisun** | 0 | 0 | 0 |
| **San Joaquin** | 0 | 0 | 0 |
| **Tulare** | 0 | 0 | 0 |
| **Total** | **137,634** | **34,408** | **103,224** |

**TABLE 7.6** Grain corn habitat estimates (in acres) for the Central Valley, identified by planning region.

## Habitat Foraging Values

### Managed Seasonal Wetlands

The CVJV obtained moist-soil seed production estimates for managed seasonal wetlands in the Central Valley from Naylor (2002) (Table 7.7). However, consistent with the 2006 Plan, it was assumed that seed production in managed seasonal wetlands within the Suisun and Tulare planning regions is lower than elsewhere in the Central Valley (CVJV 2006). The CVJV assumed seed production in the Suisun region was 50 percent lower due to water quality (salinity) and plant species composition, and that seed production in the Tulare region was 25 percent lower because of a lack of water for summer irrigation. In addition, waterfowl do not consume all the food energy available in wetlands because foraging efficiency declines with decreasing food biomass (Reinecke and Loesch 1996). As a result, the CVJV adopted a "foraging threshold" of 13 kg/acre, below which waterfowl give up trying to feed and move on to a different field. This threshold value represents the minimum amount of food remaining in managed seasonal wetlands at the end of March (Naylor 2002; CVJV 2006). This foraging threshold was applied to all seasonal wetland and agricultural habitats.

### Rice

The amount of waste rice remaining in Central Valley rice fields for use by waterfowl varies by harvest method. Conventionally harvested fields averaged 157 kg/acre of waste rice, while stripper-headed fields averaged 99 kg/acre (Fleskes et al. 2012). Because an estimated 18 percent of all rice fields in the Central Valley are now stripper-head harvested (Fleskes et al. 2012), a weighted average of 147 kg/acre waste rice was used. Consistent with the 2006 Plan, the CVJV assumed that 15 percent of the available waste rice is consumed by non-waterfowl species (CVJV 2006), reducing the average amount available to waterfowl to 125 kg/acre. However, harvested rice fields were also assumed to provide an additional 11 kg/acre of moist soil seeds (CVJV 2006), resulting in a total seed biomass of 136 kg/acre. To account for the waterfowl foraging threshold of 13 kg/acre, the total available seed biomass was estimated to be 123 kg/acre (Table 7.7).

### Grain Corn

Recent sampling of grain corn fields within the Central Valley indicate that these habitats only provide about 66 kg/acre of waste corn after accounting for the waterfowl foraging threshold of 13 kg/acre (Table 7.7; pooled data from Shaskey 2016 and Raquel 2017). This equates to about one percent of the average corn yield for the Central Valley and is consistent with other studies that have estimated the amount of corn remaining after harvest (Krapu et al. 2004).

### Invertebrates

Seasonal shifts in diet suggest that invertebrate consumption by most Central Valley ducks is minimal prior to January; however, invertebrates can be more than 50 percent of the diet from January through March (Euliss and Harris 1987; Miller 1987). Consistent with the 2006 Plan, the CVJV assumed that managed seasonal wetlands provide 13 kg/acre of invertebrate biomass beginning January 1 (Table 7.7; CVJV 2006). Although winter-flooded rice undoubtedly provides some invertebrate resources, these foods were not included in the TRUEMET model because rice fields are quickly drained in late January after the close of the hunting season, and the invertebrate food resources they provide are uncertain (Petrie et al. 2016).

### True Metabolizable Energy

Although waterfowl carrying capacity of a given habitat is strongly dependent on food biomass, it is also a function of the energy or calories provided by these foods. Therefore, true metabolizable energy estimates (TME values) for moist-soil seeds, rice, corn, and invertebrates were obtained from published sources for use in the TRUEMET model (Table 7.7).

| FOOD TYPE | FOOD DENSITY (KG/ACRE) | TRUE METABOLIZABLE ENERGY (TME) (KCAL/G) |
|---|---|---|
| **Moist-Soil Seeds** | 225[a, b] | 2.5 |
| **Rice** | 123[b] | 3.0 |
| **Corn** | 66[b] | 3.9 |
| **Invertebrates** | 13 | 2.39 |

*[a] Food density estimate of moist soil seeds reduced by 25 percent and 50 percent respectively for managed seasonal wetlands in the Tulare and Suisun planning regions. Weighted moist soil seed density for entire Central Valley equals 203 kg/acre.*

*[b] Estimates reduced by 13 kg/acre, because waterfowl stop feeding when seed densities are that low.*

**TABLE 7.7 Food types, density and true metabolizable energy of important waterfowl foods in the Central Valley.**

# CONSERVATION DESIGN:
## How much conservation, of what type, and where?

### Methods for Establishing Conservation Objectives

Several types of conservation objectives were defined for ducks in each planning region: (1) habitat objectives, which represent the total area (acres) of each type of habitat needed to support the region's duck population objectives; (2) water supply objectives, which represent the amount of water needed to provide duck habitat on those acres; and (3) wetland enhancement objectives, which include both ongoing management efforts to enhance food supply, and maintenance of and improvements to infrastructure required to manage the water supply. In addition, the CVJV Lands Committee used information from this chapter to (4) define objectives for the protection of agricultural habitats in the Sacramento planning region, through conservation easements.

The CVJV defined habitat objectives for managed seasonal wetlands, winter-flooded rice fields, and harvested grain corn fields, which provide nearly all the foraging habitat available to ducks in the Central Valley. Objectives for these habitats were partly determined by the relative importance of each based on an understanding of non-breeding waterfowl ecology, the existing habitat available relative to duck population objectives, and future threats to that habitat (described below). For example, agricultural habitats play little to no role in supporting duck populations in some planning regions and a critical role in others.

For each planning region, the CVJV defined the habitat objectives by first determining the proportion of the duck population objectives each habitat type should support, and then using TRUEMET to model the total area of each habitat type required. For managed seasonal wetlands, a restoration objective is defined as the difference between the total habitat objective and the current area of managed seasonal wetlands. Water supply objectives were also defined for managed seasonal wetlands in each planning region with the assumption that the wetland restoration objectives will be met. These water supply objectives are based on the Central Valley Wetlands Water Supply Investigations (USFWS 2000), which provides estimates of the amount of reliable and affordable water required for optimal management of seasonal wetlands in the Central Valley. These requirements differ by both time period and planning region; this information was used when estimating water needs.

The CVJV also defined two types of wetland enhancement objectives. The first, Type I, is the acres of wetlands each year for which wetland and water conveyance infrastructure is repaired or enhanced. Based on interviews with resource managers, it was determined that this infrastructure will require some form of enhancement, on average, every twelve years. Therefore, the annual wetland enhancement objective is defined as one-twelfth of the total wetland area in a planning region. Wetland enhancement objectives are expressed on a yearly basis and are perpetual. However, the acreage needing enhancement each year will increase over time in regions where the CVJV is restoring additional wetland acres. This is because, when total wetland acreage increases year over year, the acres needing infrastructure enhancement will also increase over time. The increases in Type I enhancement objective acreage are calculated based on restoration in 2,000-acre increments, to show progress toward meeting the wetland restoration objective.

The second type of wetland enhancement objective, Type II, addresses annual management activities that increase food production (e.g., disking of wetlands to set back wetland plant succession). For each planning region, these Type II objectives were established by estimating the percent increase in food production on existing wetlands that would reduce, by a given percentage, the number of additional acres needed of wetland restoration. Reductions in wetland restoration acreage were modeled at 25 percent intervals. The CVJV assumes that increases in food production will mostly come from these annual enhancement efforts but recognizes that Type I enhancement can also contribute to increases in average food production for wetlands in a planning region. It is worth noting that Naylor (2002) documented wide variation in food production among managed wetlands (100 kg/acre – 600 kg/acre), much of it due to management practices. This wide range suggests that there is considerable opportunity to optimize food production in Central Valley wetlands through implementing best practices.

Finally, because rice provides most of the agricultural habitat in the Central Valley (Table 7.8), the CVJV Lands Committee established an objective of protecting 10 percent of the existing rice base in the Sacramento and Yolo-Delta planning regions over the next ten years using conservation easements. Easements will be prioritized in the Sacramento planning region as most rice is grown there and rice provides most of the nutritional needs of non-breeding waterfowl in this region (Table 7.8). Agricultural easements can also serve to buffer existing wetlands from disturbance and development, so rice habitat that is adjacent to wetlands should be a priority for protection. Other factors such as the risk of conversion, reliability of surface water supplies, and size and cost of parcels under consideration for protection would also be important in determining easement priorities.

| PLANNING REGION | MANAGED WETLANDS | *WINTER-FLOODED RICE* | | *HARVESTED GRAIN CORN* | | AGRICULTURAL LANDS: RICE AND CORN |
|---|---|---|---|---|---|---|
| **Sacramento** | 25% | 74% | + | 1% | = | 75% |
| **Yolo-Delta** | 50% | 23% | + | 27% | = | 50% |
| **Suisun** | 100% | 0% | | 0% | | 0% |
| **San Joaquin** | 100% | 0% | | 0% | | 0% |
| **Tulare** | 100% | 0% | | 0% | | 0% |
| **Central Valley Overall** | **44%** | **52%** | + | **4%** | = | **56%** |

**TABLE 7.8 Relative contribution (%) of wetlands and agriculture (rice and corn) to total duck food energy in the Central Valley.**

*Green-winged teal - Tom Grey*

## Informing the Conservation Objectives

### Non-Breeding Waterfowl Ecology

Although conservation planning for waterfowl in the Central Valley is based on the food limitation hypothesis, this hypothesis does not address how food energy should be provided to waterfowl. Agricultural grains such as rice and corn are high in digestible energy content (Table 7.7); however, they are nutritionally incomplete because they lack some of the amino acids required by non-breeding waterfowl (Sherfy 1999). Therefore, in the 2006 Plan, the CVJV stipulated that seeds from wetland plants in managed seasonal wetlands must meet 50 percent or more of duck food energy needs in a given planning region. With this "wetland stipulation" (called a "wetland constraint" in the 2006 Plan), the CVJV assumes that meeting at least half of duck food energy from wetland food sources will allow birds to access a nutritionally complete diet.

### The Existing Conservation Landscape for Waterfowl

To evaluate the existing conservation landscape for waterfowl, the first step was to determine the contribution of each habitat type to total food energy for ducks and geese. For ducks, 56 percent of the total food energy in the Central Valley is provided by agricultural habitats, mostly winter-flooded rice, with the rest provided by managed seasonal wetlands (Table 7.8). However, these proportions vary among planning regions. Agricultural habitats provide 75 percent of the food energy available to ducks in the Sacramento planning region, while there is an even split between agricultural and wetland sources in the Yolo-Delta region. In the Suisun, San Joaquin and Tulare planning regions, managed seasonal wetlands are assumed to provide 100 percent of the food resources available to ducks (Table 7.8).

For geese, the CVJV assumed that agricultural habitats provide nearly all the food consumed in the Central Valley, with 95 percent of this total provided by rice (winter-flooded rice and unflooded rice). Although rice dominates the diet of white-fronted geese in the Sacramento planning region from October through January, birds also consume the rhizomes of alkali bulrush. During February and March, white-fronted geese shift to a diet comprised mostly of green forage (Skalos 2012). Because the availability of bulrush tubers or green forage is unknown, the estimate of food availability for geese in the Central Valley is incomplete. This lack of data is especially pronounced for the February and March time periods when green forage increasingly dominates goose diets (Skalos 2012).

Waterfowl foraging habitats are also categorized by ownership and protection status. An estimated 66 percent of all managed seasonal wetlands in the Central Valley are privately owned and maintained as duck hunting clubs, with the remainder (34 percent) being public (Table 7.9; CVJV 2006). Similar proportions are found in the Sacramento and Yolo-Delta planning regions, but privately managed wetlands account for nearly 80 percent of all wetlands in the Suisun and San Joaquin planning regions and only a third of all wetlands in the Tulare planning region. For this analysis, all agricultural habitats are assumed to be privately owned, although a small amount (up to 3,500 acres) of rice is grown under contract by local farmers on state wildlife areas (B. Olson, personal communication, 2019, see "Notes").

The protection status of waterfowl habitat in the Central Valley varies by habitat type. All state- and federally-owned wetlands are permanently protected, while approximately 90 percent of all privately owned wetlands are protected through conservation easements that prevent their conversion to

| PLANNING REGION | PRIVATE WETLANDS[a,b] | *PUBLIC WETLANDS*[a,b] | *TOTAL WETLANDS*[a] |
|---|---|---|---|
| **Sacramento** | 41,097 (60%) | 27,399 (40%) | 68,496 |
| **Yolo-Delta** | 14,051 (64%) | 7,903 (36%) | 21,954 |
| **Suisun** | 22,720 (79%) | 6,032 (21%) | 28,752 |
| **San Joaquin** | 44,949 (77%) | 13,426 (23%) | 58,375 |
| **Tulare** | 6,215 (33%) | 12,619 (67%) | 18,834 |
| **Central Valley Total** | **129,032 (66%)** | **67,379 (34%)** | **196,411** |

*[a] Estimated wetland area: from D. Fehringer, personal communication, 2016, see "Notes."*
*[b] Percentage of private vs. public wetlands: from CVJV 2006.*

**TABLE 7.9 Ownership and extent (in acres) of Central Valley managed seasonal wetlands, by planning region.** (Sums may not be exact, due to rounding in original data.)

other land uses (CVJV 2006). Only about 6,000 acres (one percent) of private rice habitat is protected, all of it through conservation easements in the Sacramento planning region (V. Getz, personal communication, 2019, see "Notes"). For each planning region, the level of habitat protection was evaluated in terms of the area of duck foraging habitat protected and the percent of total duck food energy (in an average year) that occurs in protected habitats. For the Suisun, San Joaquin and Tulare planning regions, more than 90 percent of all habitat and duck food energy is protected. In contrast, only 25 percent of all duck food energy and 18 percent of all habitats are protected in the Sacramento planning region. In the Yolo-Delta planning region, about half of duck food energy and approximately one third of the total area of habitat are protected (Table 7.10). It is important to note that while the land is protected, food energy provided by these habitats is not, and maintaining current levels relies on active management and water availability.

TRUEMET and the model inputs described in the Biological Planning section were used to evaluate the carrying capacity of the Central Valley and each planning region relative to their duck population objectives. Food energy supplies for ducks in the Central Valley overall appear sufficient to support the population objectives from late August until March (Figure 7.2). Large food surpluses in fall and early winter are the result of traditional flooding schedules of managed seasonal wetlands that provide habitat well before most ducks have arrived in the Central Valley (Petrie et al. 2016). In the Sacramento and Suisun planning regions, food energy supplies for ducks appear sufficient in all time periods. In contrast, in the Yolo-Delta planning region, although early season flooding of managed wetlands produces an initial food surplus for ducks, food supplies are projected to be exhausted by mid-February. Similarly, both the San Joaquin and Tulare planning regions appear unable to support their duck population objectives as food resources are estimated to be exhausted by February (Figure 7.2).

| PLANNING REGION | % HABITAT ACRES PROTECTED | % TOTAL FOOD ENERGY PROTECTED |
|---|---|---|
| **Sacramento** | 18% | 25% |
| **Yolo-Delta** | 32% | 47% |
| **Suisun** | 92% | 92% |
| **San Joaquin** | 92% | 92% |
| **Tulare** | 97% | 97% |

**TABLE 7.10 Relative portion of duck foraging habitat and total food energy protected in each planning region.**

Although the CVJV's conservation objectives are focused on ducks, the carrying capacity of geese in the Central Valley overall was also evaluated. Most geese occur in the Sacramento and Yolo-Delta planning regions. Unlike for ducks, the carrying capacity analyses for geese were based on current goose estimates, which are mostly above population objectives (with the exception of tule greater white-fronted geese). Food energy supplies for geese in the Central Valley as a whole are projected to be exhausted by mid-February, while goose food supplies in the Sacramento and Yolo-Delta planning regions were exhausted by early March and early February, respectively (Figure 7.3). However, it is important to note that the model does not include green forage as a food source. Geese in the Central Valley rely heavily on green forage in February and March (Skalos 2012), so it is likely that geese have more food energy available than is reflected in the model.

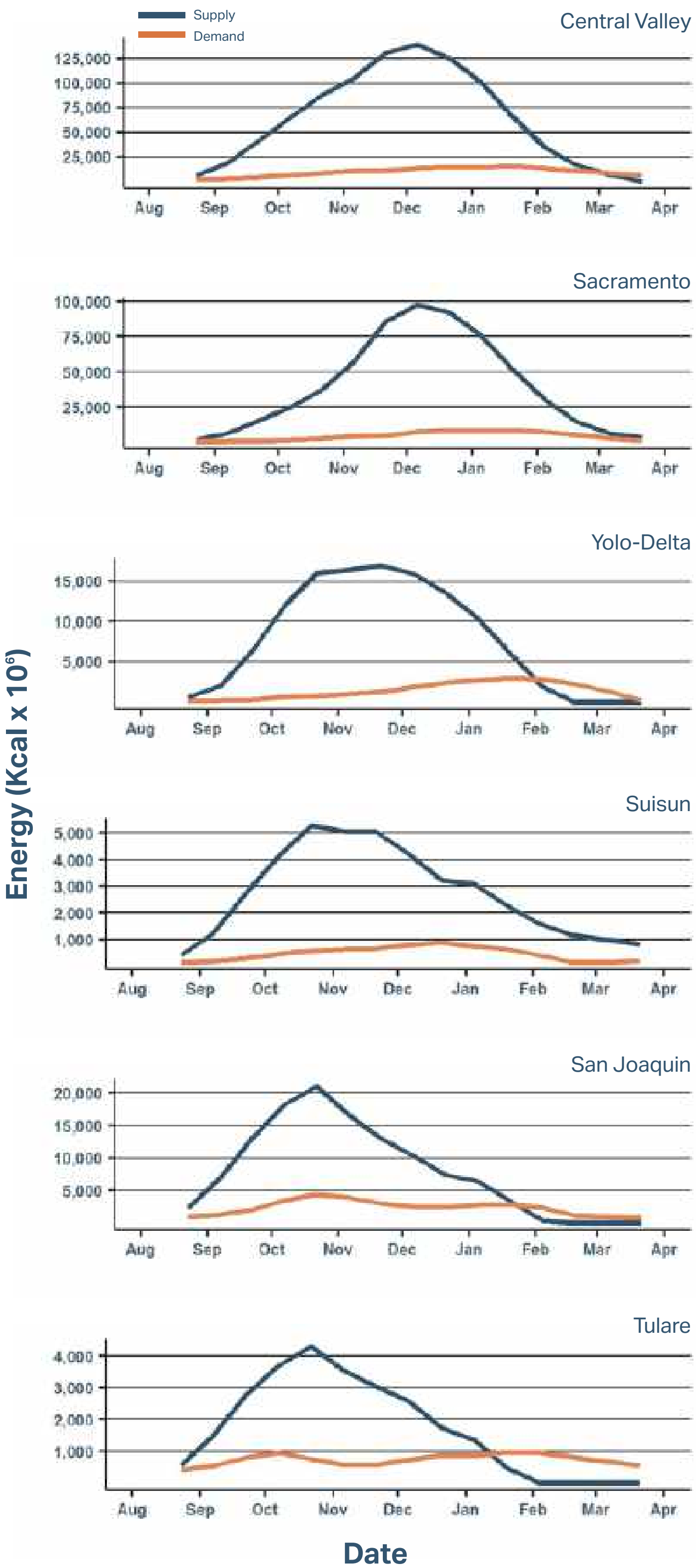



**FIGURE 7.2 Duck population energy supply (blue) vs. food energy demand (orange) (in kcal x $10^6$) for the Central Valley as a whole and for each planning region.**

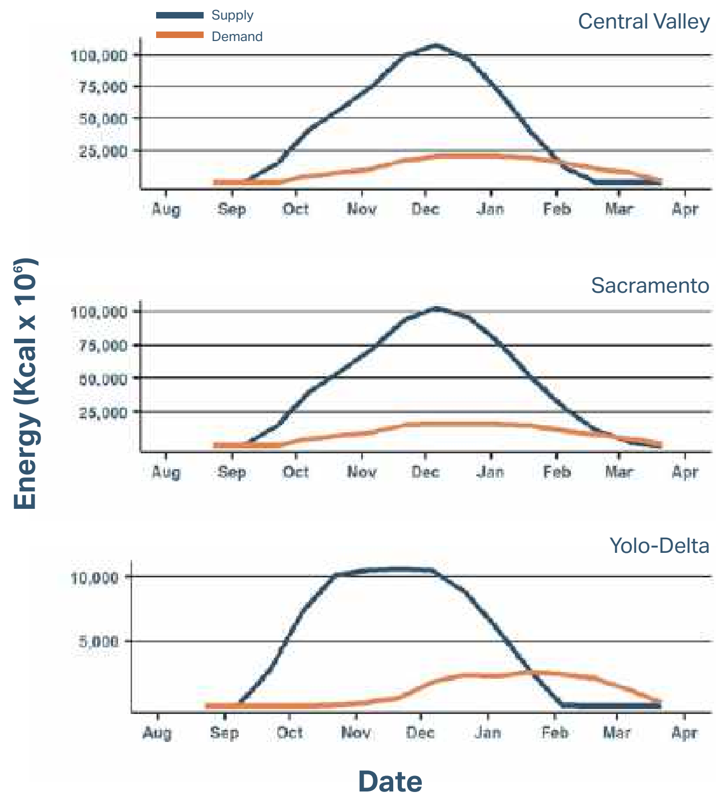



**FIGURE 7.3 Goose population energy supply (blue) vs. food energy demand (orange) (in kcal x $10^6$) for the Central Valley as a whole and for each planning region.**

## Future Threats – Scenario Descriptions

Although the CVJV's conservation objectives are primarily informed by the existing amount and composition of habitat available to waterfowl, the objectives also incorporate future threats to that habitat. Four broad threats to waterfowl habitats in the Central Valley are: 1) insufficient water supplies for managed seasonal wetlands, 2) changing postharvest practices that reduce the food resources provided by agricultural habitats, 3) reduced investments in private wetland management, and 4) increasing numbers of geese. The TRUEMET modeling explores the possible effects of each future threat on waterfowl carrying capacity represented by nine scenarios (Table 7.11). While these model simulations were conducted for the Central Valley as a whole, they are intended to provide inference at the scale of the planning regions as well. Understanding how these threats move the Central Valley landscape away from the desired condition for waterfowl also informed the CVJV's discussion about Conservation Delivery and the programs and policies needed to address these threats.

Water supplies are managed on seasonal wetlands for three general purposes: flood-up from late summer through fall, maintaining water levels from fall through spring, and summer irrigating in June and July (CVPIA IRP 2009). Approximately 56 percent of all managed seasonal wetlands in the Central Valley are summer irrigated during a typical year, according to CVJV surveys of land managers. Seed biomass in these irrigated wetlands is nearly 60 percent greater than in non-irrigated wetlands (Naylor 2002), making them important habitats for waterfowl. During the recent drought, however, wetland managers estimated that only 10 percent of all wetlands were summer irrigated, while 75 percent of all wetlands were still flooded at a normal level during fall and winter (Petrie et al. 2016). Water demand in the Central Valley is highest in mid-summer for both agricultural and urban users, so obtaining surface water supplies for summer irrigation of managed wetlands in low water years may be difficult.

The first scenario in the Future Threats exercise modeled the way in which a reduction in summer irrigation would impact duck carrying capacity. In this scenario, summer irrigation of all managed wetlands in the Central Valley was eliminated, except for wetlands in the Suisun planning region, where irrigation water supplies are not likely to be limited even in drought years (S. Chappell, personal communication, 2019, see "Notes"; Scenario #1). This scenario would have the estimated effect of reducing the average seed biomass in managed wetlands by 20 percent, from 203 kg/acre to 161 kg/acre. Scenario #2 re-runs this no-summer-irrigation scenario assuming that only 75 percent of existing wetlands were flooded during the traditional fall flooding period, because of a lack of surface water supplies.

More than half of all food available to ducks in the Central Valley is provided by agricultural habitats (Table 7.8). These agricultural food sources can be subject to economic drivers that are beyond the influence of the waterfowl management community and are virtually unprotected. These food resources may decline due to changing crop types, increased harvest efficiency, or postharvest practices that reduce the availability of waste grains. Because rice provides nearly all the agricultural foods available to ducks, modeling was focused on this habitat type. Although the recent California drought reduced the amount of rice planted in the Central Valley, rice production had been stable prior to the drought (Petrie et al. 2014). Similarly, the amount of rice remaining after harvest does not appear to have changed since the mid-1980s (Fleskes et al. 2012). As a result, the CVJV believes that the greatest threat to agricultural food sources for ducks is a decline in winter-flooded rice. To model this potential threat, Scenarios #4 and #5 reduce the food resources now provided by winter-flooded rice by 50 percent and 100 percent, respectively.

Approximately two-thirds of all managed seasonal wetlands in the Central Valley are privately owned and maintained as duck hunting clubs, most of which are permanently protected through conservation easements (CVJV 2006). Although this ownership pattern makes the outright loss of these habitats unlikely, private wetland owners are not obligated to maintain these wetlands in a highly managed way. Well-managed duck clubs require a substantial investment of time and money. If new club members cannot be recruited because of an overall decline in hunter numbers, or a decrease in hunting opportunity discourages future investment in these properties, the contribution of these privately managed wetlands to waterfowl carrying capacity may decline. To explore how changes in private wetland management may affect waterfowl carrying capacity in the Central Valley, the food resources now provided by these habitats was reduced by 50 percent in the TRUEMET model (note that total wetland food biomass was only reduced to 66 percent of current levels because the CVJV assumed there would be no change for publicly managed habitats). This decline in food resources could result from some duck clubs being idled, fewer food resources being produced on some clubs because of a lack of financial resources, or a combination of both (Scenario #5).

The 2006 Plan assumed a peak number of 1.08 million geese in the Central Valley (CVJV 2006). However, peak counts of geese in the Central Valley now average nearly 2.3 million birds (Table 7.3). Increasing numbers of geese may reduce the food energy available to ducks through exploitive competition of shared food resources. Most of this competition presumably involves winter-flooded rice, based on foraging habitats typically used by both ducks and geese in the Central Valley. The CVJV included geese as a threat because most are already above population objectives; future population increases may reduce duck food resources, similar to postharvest practices that reduce waste grains for ducks.

To explore the possible effects of geese on duck food resources within the limitations of the TRUEMET model, the CVJV examined the rate at which geese consume agricultural food resources in the Central Valley under current and projected population estimates. The first simulation used current estimates of goose and swan numbers (because swan numbers are folded into goose population estimates) and assumed that these birds had access to current levels of winter-flooded rice, unflooded rice, and grain corn (Scenario #6). Then, the goose number was increased by 50 percent and 100 percent while keeping agricultural habitats unchanged (Scenario #7 and Scenario #8, respectively). Ducks were not included in any simulation in order to isolate the effects of growing goose populations on agricultural foods.

Although each of these possible future threats to waterfowl habitat was evaluated in separate modeling scenarios, some of these threats are related and could occur simultaneously. For example, the same water shortages that curtail the summer irrigation or fall flooding of managed wetlands would probably reduce the amount of winter-flooded rice as well. To address that, one additional model scenario was developed where multiple future threats occur simultaneously. This scenario included conditions where only 75 percent of all managed seasonal wetlands were flooded, no summer irrigation of any wetland habitats occurred outside of Suisun Marsh, winter-flooded rice was reduced to 50 percent of current levels, and goose and swan numbers were 50 percent higher than they are today (Scenario #9).

## Future Threats – Scenario Highlights

- When no managed wetlands (outside of the Suisun planning region) were summer irrigated (Scenario #1; Figure 7.4), all available duck food resources were consumed by mid-February. When only 75 percent of all wetlands were flooded (Scenario #2; Figure 7.4), food deficits occurred by early February.
- When 50 percent of all winter-flooded rice was eliminated (Scenario #3; Figure 7.4), duck food resources were unable to meet population needs by mid-February, or by mid-January when all winter-flooded rice was removed from the model (Scenario #4; Figure 7.4).
- Reducing the food resources from privately managed wetlands produced a food deficit by early February (Scenario #5; Figure 7.4).
- Geese and swans are currently capable of consuming all the agricultural food resources now available to waterfowl in the Central Valley, without any consumption by ducks, by late March (Scenario #6; Figure 7.5).
- Agricultural food resources were completely exhausted by early February when the current number of geese and swans was increased by 50 percent in the TRUEMET model (Scenario #7; Figure 7.5) and by early January when these populations were doubled (Scenario #8; Figure 7.5).
- Results for Scenario #6 (current consumption by geese and swans) may help explain the results for Scenarios #3 and #4, where declines in winter-flooded rice did not reduce the duck supply curve to the degree expected, given that winter-flooded rice supplies half of all duck food resources (Table 7.8). Geese are currently exerting considerable foraging pressure on winter-flooded rice, and this exploitive competition may be significantly diminishing the value of this habitat for ducks compared to its value in the absence of geese. As a result, reducing winter-flooded rice within the model may have a limited effect on duck food energy supplies.
- Finally, the scenario that considered multiple threats acting simultaneously on duck foraging habitats would result in a food energy deficit by early January (Scenario #9; Figure 7.6).

| SCENARIO | DUCK POPULATION[a] | GOOSE POPULATION[a] | MANAGED WETLANDS[a] | WINTER-FLOODED RICE[a] | WETLAND FOOD BIOMASS[a] |
|---|---|---|---|---|---|
| #1 | 100% | 100% | 100% | 100% | 80% |
| #2 | 100% | 100% | 75% | 100% | 80% |
| #3 | 100% | 100% | 100% | 50% | 100% |
| #4 | 100% | 100% | 100% | 0% | 100% |
| #5 | 100% | 100% | 100% | 100% | 66% |
| #6 | 0% | 100% | NA | 100% | NA |
| #7 | 0% | 150% | NA | 100% | NA |
| #8 | 0% | 200% | NA | 100% | NA |
| #9 | 100% | 150% | 75% | 50% | 80% |

*[a] Percentages indicate the value of the model parameter relative to its currently assumed value. For example, the 80% Wetland Food Biomass value in Scenario #1 reflects the estimate that eliminating summer irrigation would reduce the average seed biomass in managed wetlands in the Central Valley by 20%.*
*NA: Not applicable to scenario.*

**TABLE 7.11 Summary of scenarios included in the TRUEMET model to examine future threats to duck foraging habitats and food energy supplies in the Central Valley.**

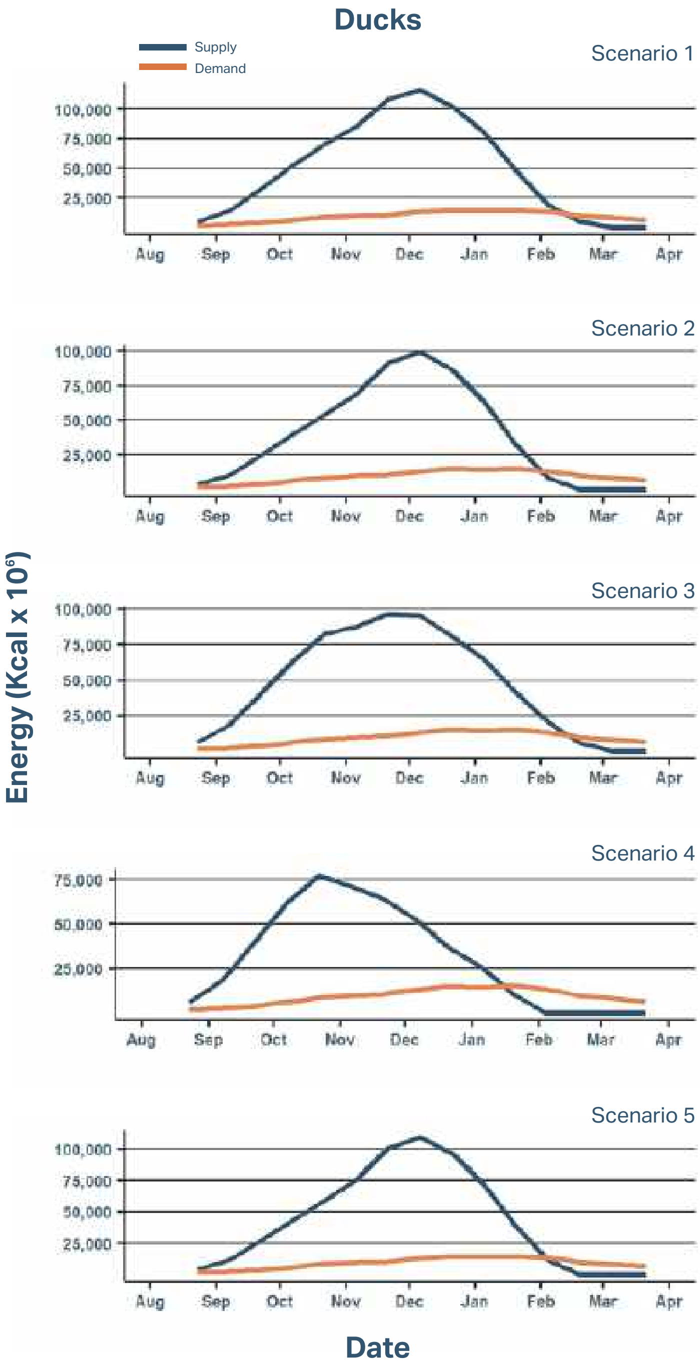



**FIGURE 7.4 Duck population energy supply (blue) vs. food energy demand (orange) (in kcal x 10⁶) for the Central Valley under different model scenarios.**

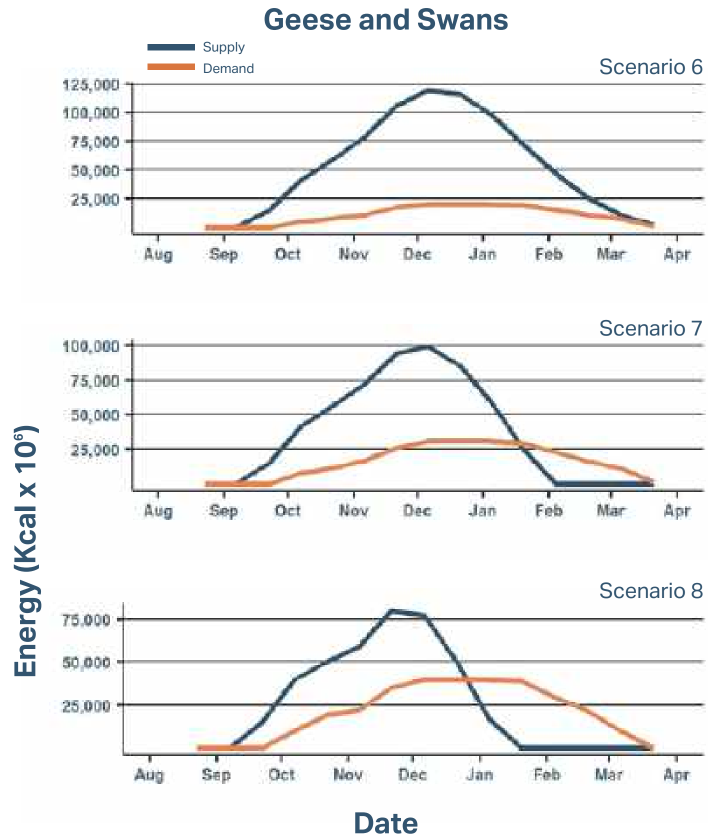



**FIGURE 7.5 Goose population energy supply (blue) vs food energy demand (orange) (in kcal x 10⁶) under different model scenarios.**


**FIGURE 7.6 Duck population energy supply (blue) vs. food energy demand (orange) (in kcal x 10⁶) for the Central Valley when multiple threats are considered in the TRUEMET model (Scenario #9).**

## Types of Conservation Objectives for Ducks in the Central Valley

**Habitat objectives**

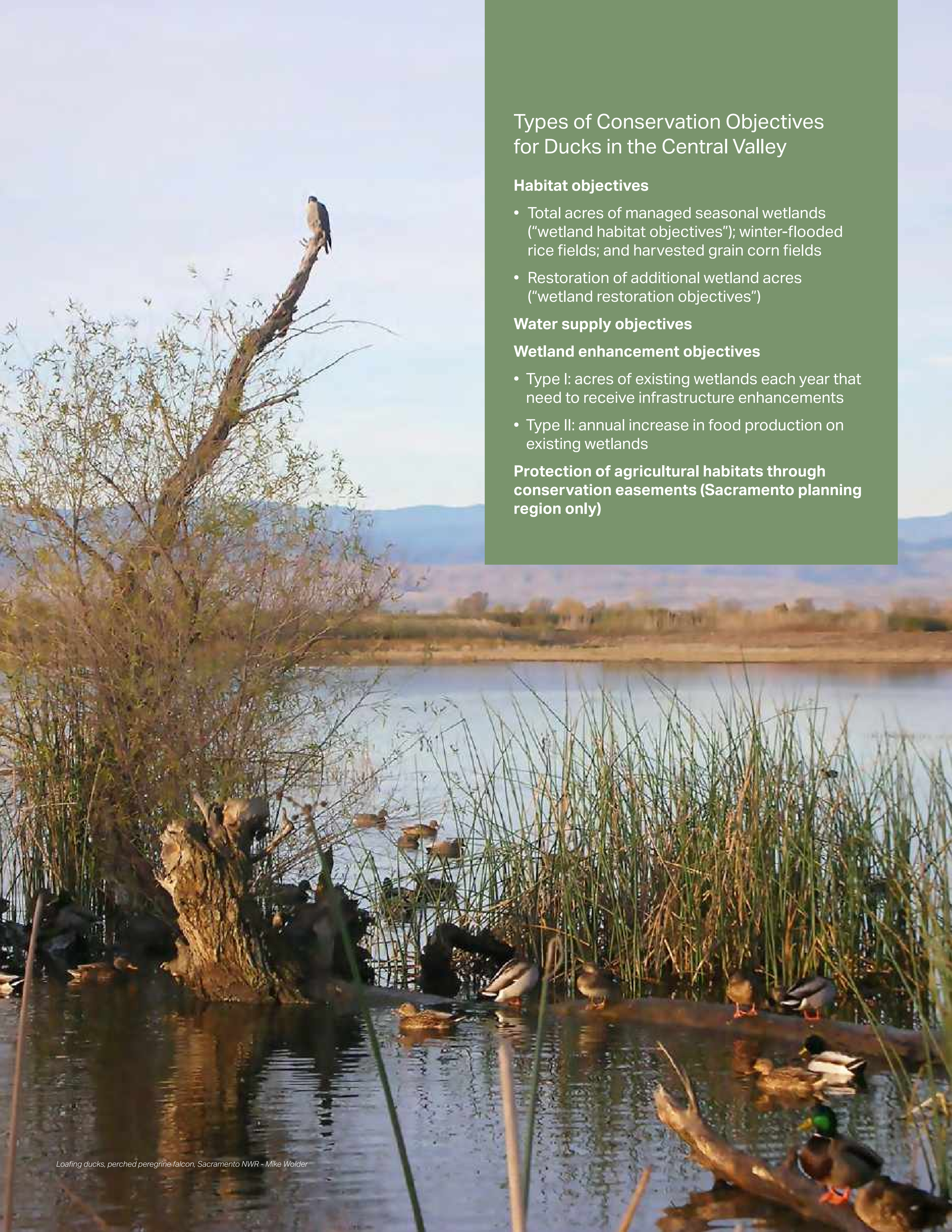
- Total acres of managed seasonal wetlands ("wetland habitat objectives"); winter-flooded rice fields; and harvested grain corn fields
- Restoration of additional wetland acres ("wetland restoration objectives")

**Water supply objectives**

**Wetland enhancement objectives**

- Type I: acres of existing wetlands each year that need to receive infrastructure enhancements
- Type II: annual increase in food production on existing wetlands

**Protection of agricultural habitats through conservation easements (Sacramento planning region only)**



*Loafing ducks, perched peregrine falcon, Sacramento NWR - Mike Wolder*

## Conservation Objectives by Planning Region

The CVJV applied the modeling results showing non-breeding waterfowl energy needs, current food energy supply, and possible future threats, to establish a set of conservation objectives for each planning region.

### Sacramento Planning Region

Most of the duck food resources in the Sacramento planning region are provided by winter-flooded rice (Table 7.8). Although rice is of overwhelming importance to waterfowl in the Central Valley, there is considerable risk in relying too heavily on a single, unprotected habitat type, as shown in the review of Future Threats. As much as 25 percent of existing agricultural food resources in the Sacramento planning region could be lost over the next 10 years. The CVJV recommends that this potential loss be offset by creating additional managed seasonal wetlands.

In addition, meeting the "wetland stipulation" requirements would reduce the risk of habitat loss, since most of the wetlands now being restored in the Central Valley receive permanent protection. It would also help ensure that ducks are provided with a nutritionally complete diet (Sherfy 1999).

The Plan's modeling results indicate that existing food supplies in the Sacramento planning region currently support its assigned proportion of the total duck population objectives, though there appears to be little or no food surplus in late winter and early spring (Figure 7.2). Despite these adequate food supplies under current conditions, the region will need 27,500 acres of new managed seasonal wetlands to offset the threat of losing 25 percent of agricultural food resources in this planning region. This acreage is the Plan's wetland restoration objective. There are currently an estimated 68,500 acres of managed wetlands in the Sacramento planning region. The Plan therefore defines a total habitat objective for managed wetlands in the Sacramento planning region as 96,000 acres (Table 7.12). Meeting this objective would also meet the 50 percent wetlands stipulation.

| AGRICULTURAL FOOD RESOURCES LOST | EXISTING MANAGED SEASONAL WETLANDS | ADDITIONAL WETLAND RESTORATION NEEDED | TOTAL WETLAND AREA NEEDED |
|---|---|---|---|
| **25%** (current 10-year projection) | 68,500 | **27,500**[a] | **96,000**[a] |
| **50%** | 68,500 | 52,500 | 121,000 |
| **75%** | 68,500 | 64,500 | 133,000 |
| **100%** | 68,500 | 71,500 | 140,000 |

[a] *Current restoration objectives for managed seasonal wetlands in the Sacramento planning region.*

**TABLE 7.12 Managed seasonal wetlands (in acres) needed to support wintering waterfowl populations at varying levels of agricultural food resource decline in the Sacramento planning region.**

Although the wetland habitat objective is based on a 25 percent loss of agricultural foods, modeling also showed how this objective would change under different rates of loss, including the elimination of all agricultural foods (Table 7.12). Note that the wetland objectives do not increase in a linear manner with greater levels of agricultural loss. Because geese do not forage in wetlands but do compete with ducks for food in winter-flooded rice, managed wetlands are insulated from the effects of goose foraging.

Type I wetland enhancement objectives (acres of wetlands each year receiving infrastructure enhancements) and wetland water supply objectives are based on the wetland habitat objective of 96,000 acres (Tables 7.13 and 7.14). Type II wetland enhancement objectives (Table 7.15) reflect the increase in average food production needed to reduce the acreage of wetland restoration needed. For example, reducing the Sacramento planning region's wetland restoration objective by 25 percent (from 27,500 to 20,625 acres) would require an eight percent increase in average food production on existing wetlands to meet the food energy needs of ducks within that planning region (Table 7.15).

There are nearly 325,000 acres of winter-flooded rice and 7,400 acres of harvested grain corn currently in the Sacramento planning region (Tables 7.5 and 7.6). Because there is no meaningful food surplus in this region, the conservation objectives for these two habitat types are to maintain existing acreages. These objectives may be difficult to accomplish, however, because food resources provided to ducks by these agricultural habitats are expected to decline due to increasing goose numbers, less water for winter flooding, and changing postharvest practices. To help offset this projected decline, the CVJV Lands Committee established an agricultural protection objective of 54,000 acres for the Sacramento planning region. This objective is focused exclusively on rice fields and is to be achieved using permanent conservation easements.

| WETLAND ACRES[a] | ANNUAL ENHANCEMENT OBJECTIVE[b] (ACRES) |
|---|---|
| **68,500**[c] | 5,686 |
| **70,500** | 5,852 |
| **72,500** | 6,018 |
| **74,500** | 6,184 |
| **76,500** | 6,350 |
| **78,500** | 6,516 |
| **80,500** | 6,682 |
| **82,500** | 6,848 |
| **84,500** | 7,014 |
| **86,500** | 7,180 |
| **88,500** | 7,346 |
| **90,500** | 7,512 |
| **92,500** | 7,678 |
| **94,500** | 7,844 |
| **96,000**[d] | 7,968 |

*[a] In 2000-acre increments, to show progress toward the meeting the wetland restoration objective.*
*[b] Acres needing Type I enhancements increase as progress is made in meeting the total wetland restoration objective.*
*[c] Current acres of wetlands.*
*[d] Wetland restoration objective.*

**TABLE 7.13 Annual Type I wetland enhancement objectives for the Sacramento planning region.**

| MONTH | WATER NEED (ACRE-FEET) |
|---|---|
| **January** | 19,200 |
| **February** | 19,200 |
| **March** | 19,200 |
| **April** | 0 |
| **May** | 67,200 |
| **June** | 0 |
| **July** | 0 |
| **August** | 86,400 |
| **September** | 172,800 |
| **October** | 38,400 |
| **November** | 38,400 |
| **December** | 19,200 |
| Annual Need | **480,000** |

**TABLE 7.14 Water needs per month for managed seasonal wetlands in the Sacramento planning region when the total wetland habitat objective of 96,000 acres is met.**

| WETLAND RESTORATION OBJECTIVE[a] (ACRES) | TOTAL WETLANDS NEEDED[b] (ACRES) | AVERAGE FOOD PRODUCTION (KG/ACRE) |
|---|---|---|
| **27,500** (current objective) | 96,000 | 225[c] |
| **20,625** | 89,125 | 242 (8% increase)[d] |
| **13,750** | 82,250 | 263 (17% increase)[d] |
| **6,875** | 75,375 | 287 (28% increase)[d] |
| **0** | 68,500 | 315 (40% increase)[d] |

*[a] Wetland restoration objectives under varying levels of average wetland food production needed to meet duck energy requirements.*
*[b] Existing wetlands (68,500 acres) + wetland restoration objective.*
*[c] Current average food production estimated for managed wetlands in the Sacramento planning region.*
*[d] Increases in average food production needed to reduce wetland restoration objectives and still meet duck energy requirements. These increases reflect the Type II wetland enhancement objectives.*

**TABLE 7.15 Type II wetland enhancement objectives for the Sacramento planning region. Enhancing existing acres for increased food production would reduce the acreage of additional restored wetlands needed.**

## Yolo-Delta Planning Region

The food resources available to ducks in the Yolo-Delta planning region are equally split between wetland and agricultural sources, with grain corn the most abundant agricultural food (Table 7.8). Model results indicate that this planning region cannot currently support its duck population objective because food resources are exhausted by late winter (Figure 7.2). It is unlikely this food shortage can be eliminated by providing more agricultural habitats, since the amount of rice planted in Yolo-Delta is small compared to the Sacramento region (<30,000 acres), and much of this rice is already winter-flooded (nearly 60 percent; Table 7.5). The existing food deficit in Yolo-Delta should therefore be addressed by restoring managed seasonal wetlands, which would also address concerns about nutritional quality of available food for ducks in this planning region (Sherfy 1999).

As in the Sacramento planning region, the CVJV assumed a 25 percent loss of food resources from agricultural habitats in the Yolo-Delta region over the next 10 years due to increasing goose numbers, less available water for winter flooding, and evolving postharvest practices and cropping patterns. Offsetting these losses and eliminating the Yolo-Delta region food deficit using only wetlands requires a restoration objective of 18,000 acres and a total habitat objective for managed seasonal wetlands of 40,000 acres. Modeling was also used to determine how this restoration objective changed under different rates of loss, including the loss of all agricultural foods (Table 7.16). The objectives for wetland enhancement and wetland water supplies (Tables 7.17, 7.18 and 7.19) were calculated based on this habitat objective.

| PERCENT OF AGRICULTURAL FOOD RESOURCES LOST | EXISTING MANAGED SEASONAL WETLANDS | ADDITIONAL WETLAND RESTORATION NEEDED | TOTAL WETLAND AREA NEEDED |
|---|---|---|---|
| **25%** (current 10-year projection) | 22,000 | 18,000[a] | 40,000[a] |
| **50%** | 22,000 | 20,500 | 42,500 |
| **75%** | 22,000 | 22,500 | 44,500 |
| **100%** | 22,000 | 23,500 | 45,500 |

[a] *Current restoration objectives for managed seasonal wetlands in the Yolo-Delta planning region.*

**TABLE 7.16 Managed seasonal wetlands (in acres) needed to support wintering waterfowl populations at varying levels of agricultural food resource decline in the Yolo-Delta planning region.**

Opportunities to increase grain corn or winter-flooded rice habitats in the Yolo-Delta region are uncertain. Rice is considered a possible solution to subsidence of peat soils in the Yolo-Delta planning region (Deverel et al. 2016), but local climate and water management present challenging growing conditions and adoption is not widespread. As such, the Plan sets conservation objectives for these two habitat types to maintain current acreages.

| WETLAND ACRES[a] | ANNUAL ENHANCEMENT OBJECTIVE[b] (ACRES) |
|---|---|
| **22,000[c]** | 1,826 |
| **24,000** | 1,992 |
| **26,000** | 2,158 |
| **28,000** | 2,324 |
| **30,000** | 2,490 |
| **32,000** | 2,656 |
| **34,000** | 2,822 |
| **36,000** | 2,988 |
| **38,000** | 3,154 |
| **40,000[d]** | 3,320 |

[a] *In 2000-acre increments, to show progress toward the meeting the wetland restoration objective.*
[b] *Acres needing Type I enhancements increase as progress is made in meeting the total wetland restoration objective.*
[c] *Current acres of wetlands.*
[d] *Acres of wetlands when restoration objectives are met.*

**TABLE 7.17 Annual Type I wetland enhancement objectives for the Yolo-Delta planning region.**

| MONTH | WATER NEED (ACRE-FEET) |
|---|---|
| **January** | 8,000 |
| **February** | 8,000 |
| **March** | 8,000 |
| **April** | 0 |
| **May** | 28,000 |
| **June** | 0 |
| **July** | 0 |
| **August** | 36,000 |
| **September** | 72,000 |
| **October** | 16,000 |
| **November** | 16,000 |
| **December** | 8,000 |
| Annual Need | 200,000 |

**TABLE 7.18 Water needs per month for managed seasonal wetlands in the Yolo-Delta planning region when the total wetland habitat objective of 39,954 acres is met.**

*Canvasbacks - Mike Peters*

| WETLAND RESTORATION OBJECTIVE[a] (ACRES) | TOTAL WETLANDS NEEDED[b] (ACRES) | AVERAGE FOOD PRODUCTION (KG/ACRE) |
|---|---|---|
| **18,000** (current objective) | 39,954 | 225[c] |
| **13,500** | 35,454 | 254 (13% increase)[d] |
| **9,000** | 30,954 | 290 (29% increase)[d] |
| **4,500** | 26,454 | 340 (51% increase)[d] |
| **0** | 21,954 | 409 (82% increase)[d] |

[a] *Wetland restoration objectives under varying levels of average wetland food production needed to meet duck energy requirements.*
[b] *Total wetlands equal existing wetlands (21,954 acres) + wetland restoration objective.*
[c] *Current average food production estimated for managed wetlands in the Yolo-Delta planning region.*
[d] *Increases in average food production needed to reduce wetland restoration objectives and still meet duck energy requirements. These increases reflect the Type II wetland enhancement objectives.*

**TABLE 7.19 Type II wetland enhancement objectives for the Yolo-Delta planning region.** Enhancing existing acres for increased food production would reduce the acreage of additional restored wetlands needed.

## Suisun Planning Region

All of the food resources available to ducks in the Suisun planning region are provided by managed seasonal wetlands, so the nutritional quality of foods available to ducks in this region is considered adequate (Table 7.8). Although seed production in managed seasonal wetlands in Suisun is assumed to be only one-half that of seed production elsewhere in the Central Valley, food supplies still appear to be adequate to support the Plan's duck population objective (Figure 7.2). Therefore, the CVJV did not define a managed wetland habitat objective for this region. Although the CVJV adopted a conservative estimate of food production for this region, the spread of invasive plant species and salinity challenges may lead to levels of food production below those assumed here (D. Skalos, personal communication, 2019, see "Notes"). As a result, updated estimates of food production in Suisun Marsh managed seasonal wetlands are needed before a more reliable evaluation of waterfowl carrying capacity can be conducted.

The lack of agriculture in the Suisun planning region eliminates any concerns over changes in agricultural practices or growing numbers of geese. Although outright loss of wetlands is unlikely, The Suisun Marsh Habitat Management, Preservation, and Restoration Plan (USBR et al. 2013) calls for up to 7,000 acres of managed wetlands to be converted to tidal habitat by 2042. This conversion will reduce the available wetland foraging habitat for ducks, because tidal wetlands in Suisun are not a preferred habitat for ducks (Coates et al. 2012) and don't contribute appreciably to food energy needs of waterfowl. These planned conversions to tidal habitat increase the importance of enhancing the remaining wetlands to maintain or even increase wetland food production to offset these losses.

The Plan's annual wetland enhancement objective for the Suisun planning region is 2,386 acres per year. This objective remains constant through time, since there is no objective to restore additional wetlands in this planning region that would then need enhancements. Considerably more detail on the enhancement needs of managed wetlands in the Suisun Marsh can be found in the 2013 Suisun Marsh plan.

Table 7.20 shows the Plan's wetland water supply objective for the Suisun planning region. Because the water needs are primarily met with gravity fed water from tidal sloughs adjacent to managed wetland habitats, the salinity of the water supply varies seasonally. This variability can affect the managed wetland plant species composition as well as the amount of seed produced. The CVJV will need to monitor this situation and potentially account for it in setting conservation objectives in the future.

| MONTH | WATER NEED (ACRE-FEET) |
|---|---|
| January | 5,750 |
| February | 5,750 |
| March | 5.750 |
| April | 7,188 |
| May | 0 |
| June | 0 |
| July | 0 |
| August | 25,877 |
| September | 57,504 |
| October | 11,501 |
| November | 11,501 |
| December | 5,750 |
| Annual Need | 136,571 |

**TABLE 7.20** Water needs per month for managed seasonal wetlands in the Suisun planning region.

## San Joaquin Planning Region

All of the food resources available to ducks in the San Joaquin planning region are provided by managed seasonal wetlands, so the nutritional quality of these foods are considered adequate (Table 7.8). However, existing food supplies cannot currently support the San Joaquin region's duck population objective (Figure 7.2). Since suitable agricultural habitats are lacking within this region, the foraging habitat deficit can only be addressed by restoring additional seasonal wetlands.

The lack of agricultural habitats in this region eliminates any concern over long-term changes in agricultural practices, as well as concerns over competition with geese. Similarly, there is little concern over the outright loss of wetland habitats in the San Joaquin planning region as nearly all of these habitats are afforded permanent protection (CVJV 2006). However, a long-term decline in the willingness or ability of private wetland owners to invest in wetland management is a future threat, given that nearly 80 percent of all wetlands in this region are privately held (i.e., duck clubs) and these habitats provide the majority of duck food resources (Table 7.9).

Finally, insufficient affordable water supplies for wetland management may pose the greatest long-term threat to waterfowl habitat in the San Joaquin region. Shortages in water supplies for both fall flooding of seasonal wetlands and summer irrigation of these habitats are both likely.

The TRUEMET analysis indicated that a total of 70,875 acres of managed seasonal wetlands are needed to meet the food energy needs of the San Joaquin planning region's duck population objective. Given an estimated 58,375 acres of existing wetlands, the Plan set a wetland restoration objective of 12,500

| TOTAL WETLAND HABITAT OBJECTIVE | EXISTING WETLANDS | WETLAND RESTORATION OBJECTIVE |
|---|---|---|
| 70,875 | 58,375 | 12, 500 |

**TABLE 7.21 Managed seasonal wetland restoration objective (acres) for the San Joaquin planning region.**

| WETLAND ACRES[a] | ANNUAL ENHANCEMENT OBJECTIVE[b] (ACRES) |
|---|---|
| **58,375**[c] | 4,845 |
| **60,375** | 5,011 |
| **62,375** | 5,177 |
| **64,375** | 5,343 |
| **66,375** | 5,509 |
| **68,375** | 5,675 |
| **70,375** | 5,871 |
| **70,875**[d] | 5,883 |

[a] *In 2000-acre increments, to show progress toward the meeting the wetland restoration objective.*
[b] *Acres needing Type I enhancements increase as progress is made in meeting the total wetland restoration objective.*
[c] *Current acres of wetlands.*
[d] *Acres of wetlands when restoration objective is met.*

**TABLE 7.22 Annual Type I wetland enhancement objectives for the San Joaquin planning region.**

| MONTH | WATER NEED (ACRE-FEET) |
|---|---|
| **January** | 14,157 |
| **February** | 14,157 |
| **March** | 14,157 |
| **April** | 0 |
| **May** | 56,628 |
| **June** | 17,696 |
| **July** | 0 |
| **August** | 56,628 |
| **September** | 141,570 |
| **October** | 28,314 |
| **November** | 28,314 |
| **December** | 14,157 |
| Annual Need | **385,778** |

**TABLE 7.23 Water needs per month for managed seasonal wetlands in the San Joaquin planning region when the total wetland habitat objective of 70,785 acres is met.**

| WETLAND RESTORATION OBJECTIVE[a] (ACRES) | TOTAL WETLANDS NEEDED[b] (ACRES) | AVERAGE FOOD PRODUCTION (KG/ACRE) |
|---|---|---|
| **12,500** (current objective) | 70,785 | 225[c] |
| **9,375** | 67,750 | 236 (5% increase)[d] |
| **6,250** | 64,625 | 247 (10% increase)[d] |
| **3,125** | 61,500 | 260 (16% increase)[d] |
| **0** | 58,375 | 274 (22% increase)[d] |

[a] *Wetland restoration objectives under varying levels of average wetland food production needed to meet duck energy requirements.*
[b] *Total Wetlands equals existing wetlands (58,375 acres) + wetland restoration objective.*
[c] *Current average food production estimated for managed wetlands in the San Joaquin planning region.*
[d] *Increases in average food production needed to reduce wetland restoration objectives and still meet duck energy requirements. These increases reflect the Type II wetland enhancement objectives.*

**TABLE 7.24 Type II wetland enhancement objectives for the San Joaquin planning region.** Enhancing existing acres for increased food production would reduce the acreage of additional restored wetlands needed.

acres to reach the total wetland habitat objective (Table 7.21). Tables 7.22 and 7.23 show the conservation objectives for Type I wetland enhancement and wetland water supplies, respectively. Table 7.24 shows objectives for Type II wetland enhancement.

*Northern shoveler - Tom Grey*

## Tulare Planning Region

The food resources available to ducks in the Tulare planning region are provided exclusively by managed wetlands. Though this means there are no nutritional concerns, the current amount of food resources is insufficient to support the Tulare planning region's duck population objectives (Table 7.8; Figure 7.2). The TRUEMET analysis indicated that just over 30,000 acres of managed seasonal wetlands are needed to meet nutritional objectives for ducks in this region. Given the current estimated 18,834 acres of wetlands in this region, the Plan set a wetland restoration objective of 11,166 acres to reach the total wetland habitat objective (Table 7.25). This assumes existing wetlands are flooded each year, which may not be the case when water is limited or used for other purposes. Tables 7.26 and 7.27 show the conservation objectives for Type I wetland enhancement and wetland water supplies, respectively. Table 7.28 shows the objectives for Type II wetland enhancement.

No other planning region in the Central Valley faces the conservation challenges found in the Tulare region. Finding affordable and reliable water supplies for existing wetlands, let alone those yet to be restored, remains a formidable obstacle within the Tulare planning region.

| TOTAL WETLAND HABITAT OBJECTIVE | EXISTING WETLANDS | WETLAND RESTORATION OBJECTIVE |
|---|---|---|
| 30,000 | 18,834 | 11,166 |

**TABLE 7.25 Managed seasonal wetland restoration objective (acres) for the Tulare planning region.**

| WETLAND ACRES[a] | ANNUAL ENHANCEMENT OBJECTIVE[b] (ACRES) |
|---|---|
| **18,834**[b] | 1,563 |
| **20,834** | 1,729 |
| **22,834** | 1,895 |
| **24,834** | 2,061 |
| **26,834** | 2,227 |
| **28,834** | 2,393 |
| **30,000**[d] | 2,490 |

*[a] In 2000-acre increments, to show progress toward the meeting the wetland restoration objective.*
*[b] Acres needing Type I enhancements increase as progress is made in meeting the total wetland restoration objective.*
*[c] Current acres of wetlands.*
*[d] Acres of wetlands when restoration objectives met.*

**TABLE 7.26 Annual Type I wetland enhancement objectives for the Tulare planning region.**

| MONTH | WATER NEED (ACRE-FEET) |
|---|---|
| **January** | 5,999 |
| **February** | 5,999 |
| **March** | 0 |
| **April** | 23,998 |
| **May** | 0 |
| **June** | 16,499 |
| **July** | 0 |
| **August** | 14,999 |
| **September** | 59,994 |
| **October** | 11,998 |
| **November** | 11,998 |
| **December** | 5,999 |
| Annual Need | **157,484** |

**TABLE 7.27 Water needs per month for managed seasonal wetlands in the Tulare planning region when the total wetland habitat objective of 30,000 acres is met.**

| WETLAND RESTORATION OBJECTIVE[a] (ACRES) | TOTAL WETLANDS NEEDED[b] (ACRES) | AVERAGE FOOD PRODUCTION (KG/ACRE) |
|---|---|---|
| **11,166** (current objective) | 30,000 | 169 |
| **8,375** | 27,209 | 186 (10% increase) |
| **5,583** | 24,417 | 208 (23% increase) |
| **2,792** | 21,626 | 234 (38% increase) |
| **0** | 18,834 | 269 (59% increase) |

*[a] Wetland restoration objectives under varying levels of average wetland food production needed to meet duck energy requirements.*
*[b] Total wetlands equals existing wetlands (21,954 acres) + wetland restoration objective.*

**TABLE 7.28 Type II wetland enhancement objectives for the Tulare planning region.** Enhancing existing acres for increased food production would reduce the acreage of additional restored wetlands needed.

## Summary

Table 7.29 shows the conservation objectives for each planning region and for the Central Valley as a whole.

| PLANNING REGION | WETLAND RESTORATION (ACRES) | WETLAND ENHANCEMENT: TYPE I[a] (ACRES) | WETLAND ENHANCEMENT: TYPE II[b] (ACRES) | WATER SUPPLIES (ACRE-FEET) | AGRICULTURAL HABITAT[c] (ACRES) | AGRICULTURAL HABITAT PROTECTION (ACRES) |
|---|---|---|---|---|---|---|
| Sacramento | 27,500 | 7,968 | 17% | 480,000 | 325,000 WFR<br>7,400 GC | 54,000<br>(rice) |
| Yolo-Delta | 18,000 | 3,320 | 29% | 200,000 | 16,000 WFR<br>27,000 GC | 0 |
| Suisun | NA | 2,386 | NA | 136,571 | NA | NA |
| San Joaquin | 12,500 | 5,883 | 10% | 385,778 | NA | NA |
| Tulare | 11,166 | 2,490 | 23% | 157,484 | NA | NA |
| **Central Valley** | **69,166** | **22,047** | **NA** | **1,359,833** | **341,000 WFR**<br>**34,400 GC** | **54,000**<br>(rice) |

*[a] Annual wetland enhancement objective when wetland restoration objectives are met for a planning region. This objective assumes that the infrastructure of managed wetlands requires some form of maintenance on average every 12 years.*
*[b] Percent increase in average food production in existing managed wetlands needed to reduce wetland restoration objectives by 50%. For other levels of reduced wetland restoration that correspond to increased levels of food production see earlier tables for each planning region.*
*[c] WFR: Acres of winter-flooded rice. GC: Acres of grain corn.*
*NA: Not Applicable*

**TABLE 7.29 Conservation objectives for migrating and wintering waterfowl in the Central Valley of California.**

*Ducks in flight - USFWS*

# CONSERVATION DELIVERY:
## Accomplishing the Habitat Objectives

The Conservation Delivery chapter of this Plan describes the process needed to identify and implement the CVJV's priority conservation strategies to meet both habitat and bird population objectives for waterfowl. Because conservation objectives associated with agricultural easements and water needs are addressed elsewhere, the habitat objectives in this chapter were restricted to wetlands.

The CVJV partnership identified four primary mechanisms to accomplish the habitat objectives for each of the bird groups considered in this Plan. These actions include habitat protection, restoration, enhancement and management. The type of habitat protected or restored, as well as the appropriate strategies to enhance habitat, are specific to the biological needs of the focal species in each of the bird groups. For non-breeding waterfowl, wetland habitat restoration remains a high priority. Several thousand acres have been restored since the 2006 Plan, allowing the CVJV to set a smaller objective of just under 70,000 acres for this Plan. This is still a formidable goal, because the amount of wetland restoration now occurring annually in the Central Valley is only about 40 percent of what it was in the decade before the 2006 plan. This decrease is largely due to the increased demand for and cost of land with water rights sufficient for wetland development.

Though restoration has been the main mechanism for improving wetland habitat in the Central Valley, a long-term commitment to maintaining or improving the quality of existing managed wetlands is equally important. This work can be accomplished through annual management activities using prescribed techniques such as vegetation disturbance (e.g., disking or burning) or summer irrigation to directly increase food production and carrying capacity (Type II Enhancement). The success of annual wetland management is dependent on periodic efforts to maintain well-functioning management infrastructure (Type I Enhancement). Infrastructure includes maintenance levees, water conveyance components (control structures, pumps and wells), and wetland bottom slope and topography that allows for desired hydrology and habitat values.

The costs associated with habitat protection, restoration and varying levels of enhancement and management continue to increase. Additionally, the surface and ground water required for wetlands to function is increasingly expensive to secure. Having well-funded programs that support all wetland conservation priority actions on both private and public wetlands will be critical to these efforts.

*American wigeon - Dale Garrison*

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1

# BREEDING WATERFOWL

8

2

3

# CHAPTER SUMMARY

The Central Valley hosts hundreds of thousands of breeding ducks in the spring and summer. The Central Valley Joint Venture applies the goals of the North American Waterfowl Management Plan to create landscape conditions that support abundant and resilient populations of these duck species.

This chapter describes the current status and declining population trends of the three most common nesting duck species in the Valley (mallard, gadwall and cinnamon teal); the landscape changes and limiting factors these species face; and the conservation objectives for the restoration and management of wetlands flooded during the spring and summer breeding season and adjacent upland nesting habitat needed by these species.

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

## HABITAT TYPE

Breeding ducks in the Central Valley require upland and wetland habitats, in proximity to each other. Upland habitats, which are used for nesting, include natural or planted uplands, pasture and certain annual crops (growing or idle). Wetland ponds and planted rice fields that are used for brood rearing contain water in the spring and summer. Post-breeding adults also need wetlands that remain flooded until late summer, during their flightless wing-molt period. Semi-permanent wetlands provide the needed spring and summer habitat and are the most practical option for most land managers.

## SUCCESS STORY: Partnerships Enhancing Nesting Habitat on the Conaway Ranch

The importance of upland nesting and brood rearing habitats for California's resident mallard, gadwall and cinnamon teal populations has been well documented and has served as the basis for the California Waterfowl Association's Conservation Programs for the past several decades. In the Yolo Basin, for example, California Waterfowl partnered with federal and state agencies to acquire several thousand acres of wildlife-friendly farming conservation easements and to restore hundreds of acres of wetlands and uplands on the Conaway Ranch.

Upland habitats on the Conaway Ranch are also critically important to tricolored blackbirds, giant garter snakes and a suite of other wildlife species. The Conaway Ranch, owned by a private preservation group, is managed for a mixture of uses including cattle ranching, wildlife friendly-farming, conservation, resource management, flood control and integrated water management.

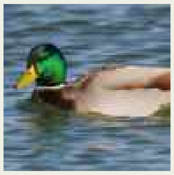
### LONG-TERM HABITAT OBJECTIVES: WHAT'S NEEDED?

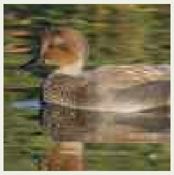
**SEMI-PERMANENT WETLANDS:**
**44,000 ACRES TOTAL**
**= 21,000 ADDITIONAL ACRES**

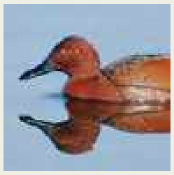
**UPLAND NESTING HABITAT:**
**177,000 ACRES TOTAL**
(Current acreage is not known)

**INCLUDES 54,000 ACRES IN THE RICE-GROWING REGION OF THE SACRAMENTO VALLEY**

### BIRD SPECIES INCLUDE:


Mallard*


Gadwall*


Cinnamon teal*

*Images: Tom Grey

(1) Cinnamon teal - Jennifer Barton (2) Breeding duck habitat - Dan Skalos (3) Mallards - Mike Peters

# INTRODUCTION

**Conservation planning for waterfowl and wetland management in the Central Valley has its origins in the North American Waterfowl Management Plan (NAWMP 2012) and has largely focused on meeting the habitat needs of wintering and migrating waterfowl (ducks, geese and swans). Since its formation in 1988, the Central Valley Joint Venture (CVJV) and its partners have restored thousands of acres of managed wetlands in an effort to meet those needs. While wintering ducks, geese and swans have benefitted under this management paradigm, locally nesting duck species have declined substantially, and their populations are at or near all-time lows (Skalos and Weaver 2019). This chapter addresses the CVJV's objectives for protecting and restoring habitat to support populations of breeding ducks in the Central Valley. Breeding goose populations are robust, and no native swans breed in the Central Valley.**

More than 90 percent of restored wetlands in the Central Valley are managed seasonally for waterfowl, along with shorebirds and other waterbirds, during the fall and winter (Petrik et al. 2014). Improved wetland habitat, combined with current agricultural practices (predominantly winter-flooded rice), has benefitted migrating and wintering duck populations in several ways, particularly increased body condition, increased survival and shorter observed flight distances (Ackerman et al. 2006; Fleskes et al. 2007; Thomas 2009; Fleskes et al. 2016; McDuie et al. 2019).

Hundreds of thousands of wintering ducks remain in the Central Valley during the spring and summer to breed. The three most common nesting species are mallards (*Anas platyrhynchos*), gadwall (*Mareca strepera*) and cinnamon teal (*Spatula cyanoptera*). Ducks have additional habitat requirements during the breeding season to what they require in winter or during migration. These requirements include seasonal and semi-permanent wetlands that are flooded during the spring and summer, to serve as foraging habitat for hens and their broods, and adjacent or nearby upland habitats with suitable vegetation for nesting (Baldassarre and Bolen 2006). Post-breeding and resident non-breeding ducks also have specific habitat requirements. During wing molt, when they are flightless for three to four weeks in late summer, ducks rely on semi-permanent or permanent wetlands: these types of wetlands are not prone to drying up in the summer and contain emergent (above-water) perennial herbaceous plants that provide protective cover (Yarris et al. 1994; Kohl 2019).

These additional habitat needs for breeding ducks pose challenges for managers of public and private wetlands in the Central Valley and sometimes require creative conservation strategies that benefit both breeding and non-breeding waterfowl. Providing upland and spring- and summer-flooded wetland habitats in addition to traditional wintering habitat is paramount for sustaining local duck populations. Unfortunately, negative trends in Central Valley breeding duck populations indicate these habitats are not currently available in sufficient quantity and quality to maintain populations. Mallards, the most abundant nesting duck in the Central Valley, are 28 percent below their long-term average (LTA) statewide (Skalos and Weaver 2019) and 44 percent below their LTA in the Central Valley.

Duck hunters play an important role in protecting wetland habitat (see the Human Dimensions chapter in this Implementation Plan). The contribution of locally breeding ducks to hunter harvest in California is significant. Reversing the negative population trend for ducks is therefore important for maintaining engagement from duck hunters, engaging the next generation of hunters, and, in turn, maintaining the habitat in which duck hunters continue to invest. Importantly, 60 percent of the hunter-harvested mallards, 53 percent of the harvested cinnamon teal and 49 percent of the harvested gadwall in California are resident and are hatched and raised locally (de Sobrino et al. 2017). Mallards (20 percent), gadwall (five percent) and cinnamon teal (three percent) combined make up a considerable portion of hunter-harvested ducks in California (mean percent from 1965-2018; Olson 2019; Trost and Drut 2003). These data indicate that local duck production and resident duck populations have a direct impact on hunter success, as well as on the non-hunting public who enjoy waterfowl viewing.

In 2008, the U.S. Fish and Wildlife Service (USFWS) recognized three separate stocks of breeding mallards: eastern, mid-continent and western, each with its own adaptive harvest management (AHM) strategy (USFWS 2008; Yparraguirre et al. 2014). California mallards are now recognized and managed as a component of the western mallard population. Mallards produced within the CVJV's planning regions contribute significantly to and comprise about 17 percent (2010-2017) of the western mallard stock. The western mallard AHM strategy is an important element of Pacific Flyway management, as the status of mallards in western states and provinces collectively determines the hunting regulations and opportunities there. Improving habitat conditions for locally nesting mallards and other ducks to reverse the population declines contributes to this obligation.

The North American Waterfowl Management Plan Assessment Steering Committee (ASC 2007) reviewed past Joint Venture planning efforts nationwide and identified the actions needed to produce a consistent and cohesive set of habitat objectives across the North American landscape. Those actions, which are consistent with Strategic Habitat Conservation, include Biological Planning, Conservation Design and Conservation Delivery. The CVJV adopted these planning actions to develop the current Implementation Plan ("the Plan"). Strategic Habitat Conservation and these planning actions are explained in more detail in the Non-Breeding Waterfowl chapter and the Planning for Conservation Success chapter.

## CONSERVATION GOAL

**The Central Valley Joint Venture's long-term goal for waterfowl is to guide regional efforts to create landscape conditions necessary to support abundant and resilient breeding and non-breeding duck populations in the Central Valley at levels that support hunting and other uses, consistent with the North American Waterfowl Management Plan.**

*Gadwall breeding pair - Mike Peters*

# BIOLOGICAL PLANNING:
## The Science Behind CVJV Conservation Objectives

### Planning Regions

Planning regions represent the geographic scale at which the CVJV establishes conservation objectives for breeding waterfowl. The CVJV has two distinct focus areas, the Primary Focus Area (the Valley floor, including the Carrizo Plain) and the Secondary Focus Area (the surrounding foothills/mountains; Figure 8.1). The Central Valley's nine drainage basins within the Primary Focus Area served as the planning units in the 2006 CVJV Implementation Plan (CVJV 2006) (see individual basins in Figure 4.1.1, in the Environmental, Social and Political Landscape: Background subchapter). However, this 2020 Plan combines some adjacent drainage basins into larger planning areas, resulting in five planning regions. The larger extent of planning regions (versus drainage basins) allows increased flexibility for placement of wetland restoration and agricultural easements.

The Primary Focus Area of the Central Valley is the emphasis of planning for breeding waterfowl for several reasons. Most importantly, annual population surveys indicate the Valley floor supports the majority of the breeding ducks within the CVJV boundary. The majority of natural and managed wetlands and agriculture that is complementary to breeding ducks (e.g., winter wheat and rice) occur on the Valley floor. In addition, most of the existing wetlands in this area are actively managed, thus, strategies expected to improve breeding and post-breeding success can be developed and implemented there. In this chapter, unless otherwise indicated, "the Valley" refers to the CVJV's Primary Focus Area.

The CVJV did not develop population and habitat objectives for breeding waterfowl in the CVJV Secondary Focus Area. The mountain ranges and foothills included in the Secondary Focus Area are expansive and include considerable, but dispersed, habitat for nesting ducks. The main habitats in these areas include lakes, rivers and their tributaries, isolated emergent and forested wetlands and human-made stock ponds. The number of ducks and geese inhabiting these areas is unknown, as breeding population surveys are not conducted there. Habitat quality and breeding densities of dabbling ducks are expected to be lower, but perhaps with less variability, than in the Primary Focus Area. Many of the same disturbances and activities seen in the Primary Focus Area have altered these landscapes, but human population

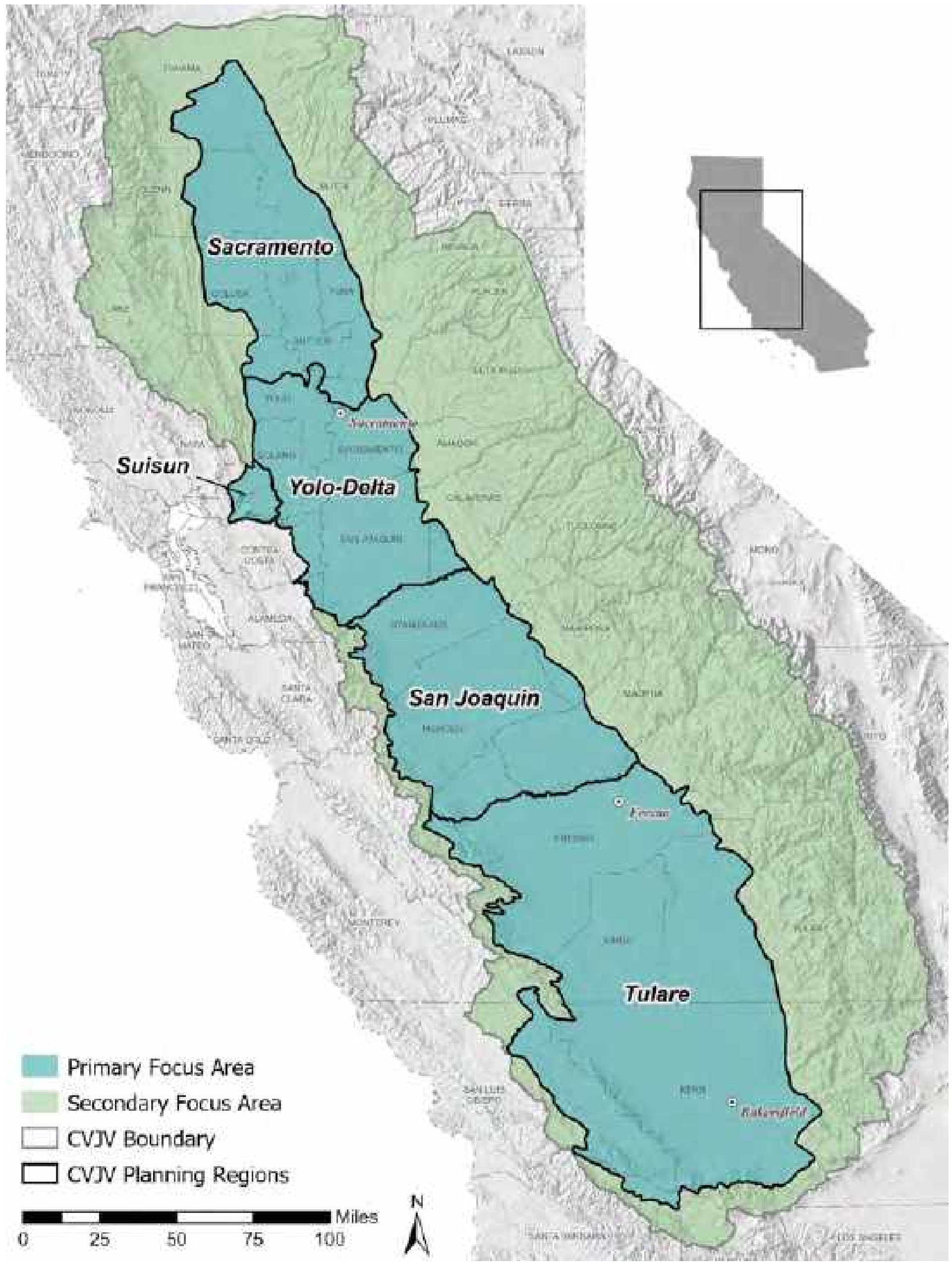



**FIGURE 8.1 Central Valley Joint Venture perimeter and Primary Focus Area, divided into five planning regions.**

densities are lower and modifications to the habitat are less severe. However, the human population continues to grow, and the extent of urban development and perennial crops continue to expand and to degrade habitats (Cameron et al. 2014; Sleeter et al. 2017; Pandolfino and Handel 2018).

## Focal Species

At least 10 species of waterfowl breed in the Central Valley (Skalos and Weaver 2019). Guidelines for selecting CVJV focal species were based on the following criteria:

- The population exists at relatively high abundance in the Primary Focus Area.
- Regional abundance is of high importance to statewide population size and hunter harvest.
- Factors limiting reproduction are relatively well understood, at least at the local scale.
- Population surveys using accepted protocol are conducted to monitor status.

Based on these criteria, the CVJV selected mallards, gadwall and cinnamon teal to use as focal species to direct conservation planning. The combined populations of these three species account for about 85 percent of the breeding ducks in the Primary Focus Area (Skalos and Weaver 2019) and likely represent the habitat needs of the entire dabbling duck guild. Additionally, harvest information indicates that 60 percent of mallards, 49 percent of gadwall and 53 percent of cinnamon teal originate from California breeding stock (de Sobrino et al. 2017). Therefore, maintaining healthy breeding populations of these species for ecological and recreational purposes is a key priority for the CVJV.

Seven other breeding duck species did not meet the focal species criteria. Among dabbling ducks, northern pintails (*Anas acuta*) and northern shovelers (*Spatula clypeata*) were excluded because their breeding populations are small and contributions to the large regional winter population are minor. Wood ducks (*Aix sponsa*) are common local nesters but were excluded because breeding duck surveys do not adequately assess their population size or trends (due to poor detection in their preferred riparian habitat).

Four species of diving ducks also breed in the Central Valley but were not considered because their breeding populations are small relative to wintering populations. They include ruddy ducks (*Oxyura jamaicensis*), redheads (*Aythya americana*), hooded mergansers (*Lophodytes cucullatus*) and common mergansers (*Mergus merganser*). The breeding habitat needs of these species are partially addressed by the objectives in this and other chapters of the Plan where riparian, wetland and upland habitat conservation is prescribed. Breeding redheads are considered a California Bird Species of Special Concern (Beedy and Deuel 2008) and their habitat needs and distribution are given further consideration in the At-Risk Bird Species chapter.

Canada geese (*Branta canadensis*) were excluded from the CVJV's breeding waterfowl conservation objectives because their breeding population index is already well above the long-term average (Skalos and Weaver 2019) and they do not appear to be habitat-limited. In fact, they are considered a nuisance in many areas of California, including parts of the Central Valley (California Code of Regulations, Title 14, Subdivision 2, Chapter 7, 503). Canada geese breeding in the Central Valley are managed using a harvest strategy approved by the Pacific Flyway Council's subcommittee on Pacific Population of Western Canada Geese (Pacific Flyway Council 2000). No other species of goose, and no native swans, breed in the Valley.

*Ruddy duck - Mike Peters*

## Current Population Status and Trends

The Primary Focus Area of the CVJV is the major breeding area for waterfowl in California and it accounts for about 70 percent of all breeding ducks in the state. Northeastern California, which is part of the Intermountain West Joint Venture, also contributes markedly to populations of breeding ducks statewide (Skalos and Weaver 2019). Other areas (e.g., coastal regions and southern California) are thought to support minor populations and are not surveyed at this time (Sauer et al. 2017). The CVJV Secondary Focus Area (especially the foothills region) may contribute a significant share of habitat during wet years; however, no assessment of the overall contribution of this region has been conducted.

The California Department of Fish and Wildlife (CDFW) estimates waterfowl breeding populations in the Valley in April based on results from the annual breeding waterfowl survey (Skalos and Weaver 2019). The annual survey has been conducted in the state since 1948, but the methodology was redesigned and updated in 1991 to be more consistent with continental surveys (Zezulak et al. 1991; Skalos and Weaver 2019). This survey has been ongoing using the new design since 1992 and is part of the regulation guidance under the USFWS adaptive harvest management (AHM) plan for western mallards (USFWS 2019b). Consolidating the nine basins into five planning regions made it possible to derive regional population estimates (D. Skalos, unpublished data, 2019, see "Notes"). Survey data were extrapolated to suitable habitat in un-surveyed areas and to estimate the breeding duck population for the Primary Focus Area as a whole and for each planning region. Changes in breeding duck population abundance and other trends were assessed for the Primary Focus Area and for each of the planning regions using data from the revised surveys.

Current duck populations were calculated using survey data from the past three years (2017-2019). The average of these three years' results was used to reflect the "current" population, rather than just one year, to account for yearly fluctuations inherent to duck populations. Long-term average (LTA) populations represent the average of survey data between 1992, when the survey methodology was updated, and 2019, the latest data available.

### Focal species distribution

The Sacramento planning region is historically the major breeding region for mallards in the Valley, comprising an LTA of 38 percent of the Valley's total population of breeding mallards (Table 8.1). In recent years, the proportion of mallards in this region has declined to about 25 percent; the region now ranks third in importance for mallards behind the Yolo-Delta and San Joaquin planning regions (Table 8.1).

Gadwall and cinnamon teal population estimates are more variable. Compared to mallards, these species tend to use areas with less agriculture, more natural habitat and more arid conditions. For gadwall, habitat in the Tulare region supports the greatest portion of the population, with an LTA of

| PLANNING REGION | MALLARD | | GADWALL | | CINNAMON TEAL | | TOTAL[a] | |
|---|---|---|---|---|---|---|---|---|
| | CURRENT[b] | LTA[c] | CURRENT[b] | LTA[c] | CURRENT[b] | LTA[c] | CURRENT[b] | LTA[c] |
| **Sacramento** | 25.1% | 38.3% | 14.5% | 16.8% | 14.3% | 19.0% | 22.7% | 34.5% |
| **Suisun** | 9.9% | 6.8% | 23.2% | 21.1% | 16.9% | 7.9% | 12.4% | 8.4% |
| **Yolo-Delta** | 26.3% | 22.4% | 16.0% | 10.7% | 11.6% | 12.2% | 23.7% | 20.4% |
| **San Joaquin** | 25.3% | 20.2% | 18.8% | 24.4% | 26.4% | 31.1% | 24.4% | 21.5% |
| **Tulare** | 13.4% | 12.3% | 27.5% | 27.0% | 30.8% | 29.8% | 16.8% | 15.2% |
| | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |

[a] *Total of the three focal species.*
[b] *Current population is defined as the mean of the latest three years of breeding population surveys, 2017-2019.*
[c] *LTA (long-term average) is defined as the mean of the 1992-2019 breeding population surveys.*

**TABLE 8.1 Current and long-term average (LTA) distribution of duck focal species' breeding populations in the Primary Focus Area of the Central Valley.** (Sums may not be exact, due to rounding in original data.)

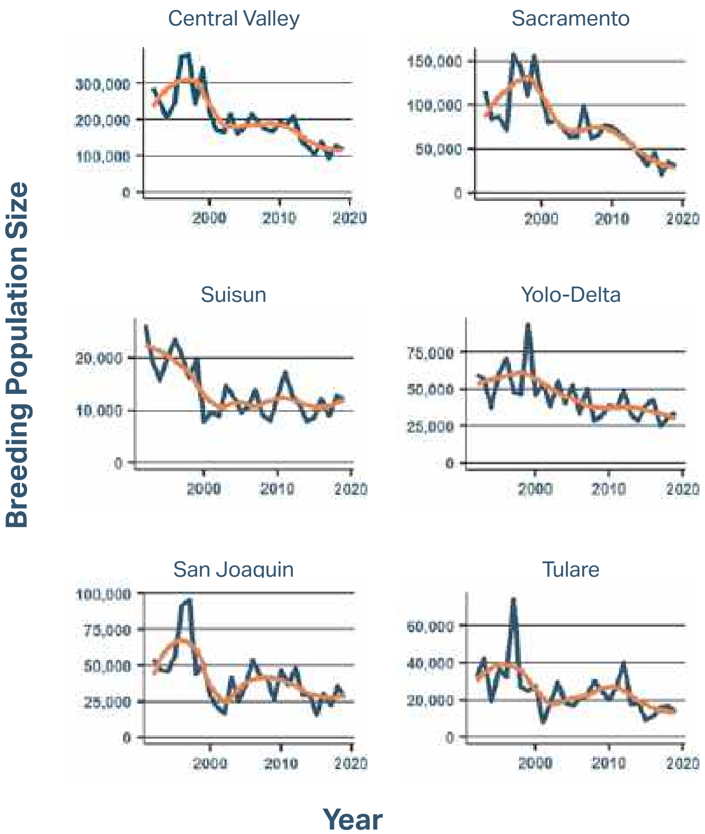



**FIGURE 8.2 Breeding mallard population estimates for the CVJV Primary Focus Area and five planning regions, 1992-2019 (orange trend line smoothed using Loess regression with span of 0.50).**

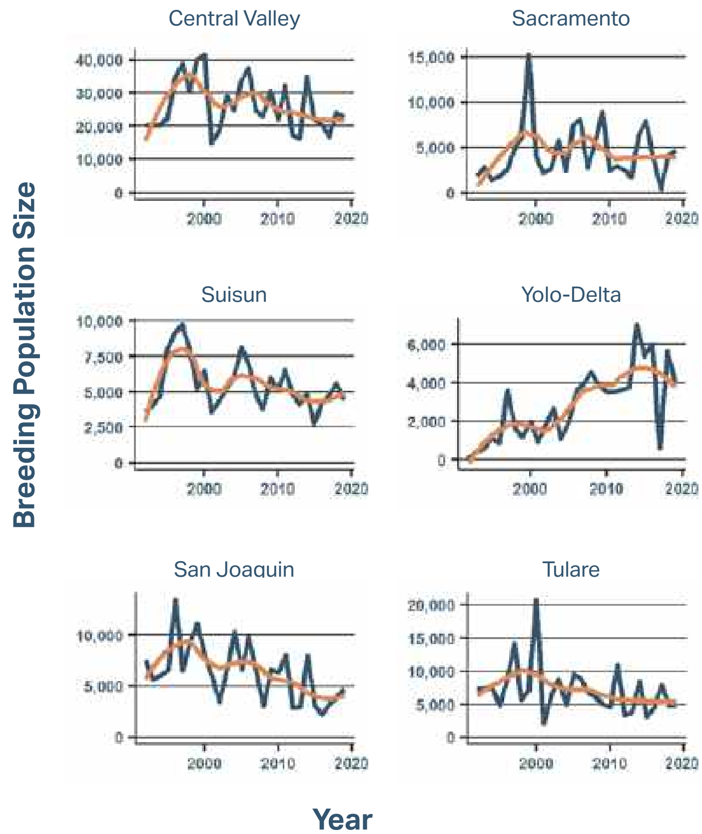



**FIGURE 8.3 Breeding gadwall population estimates for the CVJV Primary Focus Area and five planning regions, 1992-2019 (orange trend line smoothed using Loess regression with span of 0.50).**

about 27 percent of the Valley's total population (Table 8.1). Breeding gadwall are found in slightly lower numbers in the San Joaquin and Suisun planning regions. The Sacramento and Yolo-Delta planning regions typically contain a smaller portion of breeding gadwall. Cinnamon teal tend to be distributed mostly in the southern portion of the Central Valley, including the San Joaquin region with an LTA of 31 percent and the Tulare region with an LTA of 30 percent (Table 8.1).

Note that planning regions are not the same size, so the proportion of a population does not necessarily reflect a region's importance or the quality of available habitat in a region. For example, when standardized by planning region area, Suisun represents the highest densities of mallards, with a long-term average of 84 ducks per square mile, followed by Sacramento at 20 per square mile. Likewise, in the late 1980s, Suisun had the highest pair and nest densities (McLandress et al. 1996).

## Current status of focal species

Table 8.2 shows population numbers, objectives and trends for the three focal species, in the Central Valley as a whole and in each planning region. Figures 8.2, 8.3 and 8.4 depict the population survey data for the three species graphically, showing high and low years and long-term trends.

The current population of breeding mallards within the CVJV boundary is about 113,000 individuals, compared to a maximum population of 386,000 individuals observed in 1997 and a minimum of 104,000 individuals observed in 2015 (Figure 8.2). Overall, mallards are currently 44 percent below the LTA. The most significant disparity occurs in the Sacramento Valley, where the current three-year average is 63 percent below the LTA. Breeding mallard abundance is 34 percent below the LTA in Yolo-Delta region, 30 percent below in the San Joaquin region, and 39 percent below the LTA in Tulare. The mallard population decline in Suisun is less severe than for other planning regions. Although mallard populations are still 18 percent below the LTA in Suisun Marsh, the trends in this region have improved in recent years (Figure 8.2).

The current population of gadwall within the CVJV is 21,000 individuals, compared to a maximum of 41,000 observed in

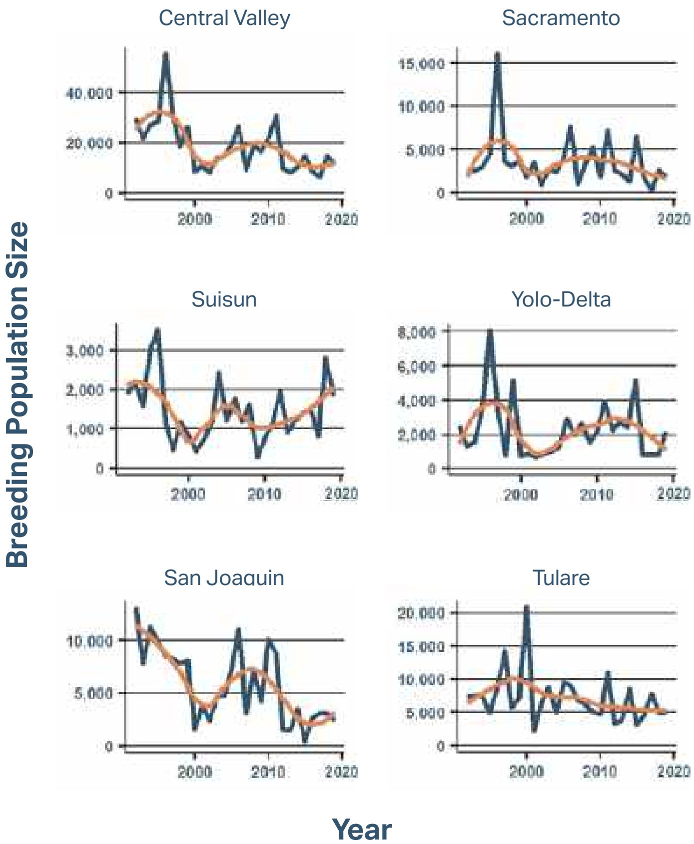



**FIGURE 8.4 Breeding cinnamon teal population estimates for the CVJV Primary Focus Area and five planning regions, 1992-2019 (orange trend line smoothed using Loess regression with span of 0.50).**

2000 and a minimum of 14,700 observed in 2001 (Figure 8.3). Overall, breeding gadwall have not declined as precipitously as mallards in the Valley but remain 19 percent below their LTA. Gadwall populations were once on the increase in the Sacramento region but began to decline in 2006 and are now 30 percent below the LTA in this region. In the Yolo-Delta region, gadwall populations have continually increased since breeding surveys began in 1992 and are currently 21 percent above the LTA in this area. In the Suisun planning region, gadwall are 11 percent below the LTA and, similar to mallards, are trending upwards. Because mallard populations are declining faster than gadwall populations, the percentage of gadwall nests in Suisun Marsh has increased in recent years from, 17 percent of monitored nests historically (Ackerman et al. 2014) to 48 percent of nests recently (J. Ackerman, unpublished data, 2019a, see "Notes"). Gadwall population estimates are 37 percent and 18 percent below the LTA in the San Joaquin and Tulare planning regions, respectively.

The current population estimate for cinnamon teal is about 10,800 individuals, which is 42 percent below the LTA.

The cinnamon teal breeding population has ranged from a minimum of 6,400 observed in 2017 and a maximum of about 55,500 observed in 1996 (Figure 8.4). By region, population levels are 56 percent below the LTA in the Sacramento, 45 percent below in Yolo-Delta, 51 percent below in San Joaquin, and 40 percent below in Tulare. Cinnamon teal in Suisun have been increasing in recent years and are currently 24 percent above the LTA, although the overall population size of cinnamon teal in Suisun is relatively small.

## Population objectives

### Background and NAWMP Revision

When the NAWMP was revised in 2012, it provided guidance to Joint Ventures that allowed differing approaches to developing population objectives for their respective regions. Considering the dynamic nature of duck populations, the waterfowl conservation community recommended using a two-part objective to account for the natural variation when establishing population abundance objectives: 1) As the baseline, maintain LTA population levels (50th percentile) for mallards, the primary duck species, and 2) recognizing that populations will be well above the LTA in some years, periodically achieve an 80th percentile abundance level (highest 20 percent of years) for total ducks (NAWMP 2014).

The dual objectives were intended to be complimentary and represent the dynamic nature of waterfowl habitats and populations. Yet NAWMP provided little guidance on the appropriate application or interpretation of these objectives. Furthermore, breeding duck population objectives from the NAWMP cannot be applied directly to the CVJV region because it falls outside the traditional survey area covered by the Waterfowl Breeding Population and Habitat Survey (USFWS 2019a). However, a similar objective-setting process, with slight modifications, was applied to the Central Valley using breeding duck survey information from California.

### Revising the Population Objectives

The annual CDFW waterfowl breeding population survey uses fixed and repeated survey transect lines to sample the Central Valley and provide an index of duck abundance. Survey transect data were extrapolated to suitable habitat in areas not surveyed, to estimate the total breeding duck population for the CVJV Primary Focus Area and for each planning region. Using these data, the CVJV calculated the current population abundance, the LTA abundance, the 90th percentile of the LTA abundance (meaning that 90 percent of the years are at or below this population size), and the difference between the current population, the LTA, and 90th percentile of the LTA (Table 8.2).

| SPECIES | POPULATION MEASURES | | | | POPULATION TREND | |
|---|---|---|---|---|---|---|
| PLANNING REGION | CURRENT[a] | MINIMUM[b] | OBJECTIVE[c] | DEFICIT[d] | vs. MINIMUM[b] | vs. OBJECTIVE[c] |
| **Mallard** (*Anas platyrhynchos*) | | | | | | |
| Sacramento | 28,309 | 77,148 | 117,042 | 88,733 | -63% | -76% |
| Suisun | 11,223 | 13,618 | 20,660 | 9,437 | -18% | -46% |
| Yolo-Delta | 29,675 | 45,048 | 68,343 | 38,668 | -34% | -57% |
| San Joaquin | 28,568 | 40,778 | 61,865 | 33,297 | -30% | -54% |
| Tulare | 15,200 | 24,776 | 37,587 | 22,387 | -39% | -60% |
| **CVJV Total** | **112,975** | **201,369** | **305,497** | **192,522** | **-44%** | **-63%** |
| **Gadwall** (*Mareca strepera*) | | | | | | |
| Sacramento | 3,088 | 4,388 | 6,335 | 3,248 | -30% | -51% |
| Suisun | 4,919 | 5,542 | 8,000 | 3,081 | -11% | -39% |
| Yolo-Delta | 3,404 | 2,807 | 4,052 | 649 | +21% | -16% |
| San Joaquin | 3,989 | 6,379 | 9,208 | 5,219 | -37% | -57% |
| Tulare | 5,837 | 7,083 | 10,226 | 4,388 | -18% | -43% |
| **CVJV Total** | **21,237** | **26,199** | **37,822** | **16,585** | **-19%** | **-33%** |
| **Cinnamon teal** (*Spatula cyanoptera*) | | | | | | |
| Sacramento | 1,545 | 3,521 | 5,669 | 4,124 | -56% | -73% |
| Suisun | 1,817 | 1,460 | 2,351 | 535 | +24% | -23% |
| Yolo-Delta | 1,252 | 2,268 | 3,652 | 2,399 | -45% | -66% |
| San Joaquin | 2,852 | 5,775 | 9,299 | 6,447 | -51% | -69% |
| Tulare | 3,324 | 5,532 | 8,907 | 5,583 | -40% | -63% |
| **CVJV Total** | **10,790** | **18,556** | **29,878** | **19,088** | **-42%** | **-64%** |
| **Total** (focal species) | | | | | | |
| Sacramento | 32,942 | 85,058 | 129,046 | 96,105 | -61% | -74% |
| Suisun | 17,959 | 20,620 | 31,012 | 13,053 | -13% | -42% |
| Yolo-Delta | 34,331 | 50,123 | 76,047 | 41,716 | -32% | -55% |
| San Joaquin | 35,409 | 52,932 | 80,372 | 44,963 | -33% | -56% |
| Tulare | 24,361 | 37,391 | 56,720 | 32,359 | -35% | -57% |
| **CVJV Total** | **145,002** | **246,124** | **373,197** | **228,195** | **-41%** | **-61%** |

[a] *Current population is defined as the mean of the latest three years of population surveys, 2017-2019.*
[b] *Minimum CVJV population objective, defined as the long-term average (LTA) of the 1992-2019 breeding population surveys.*
[c] *CVJV population objective, defined as the 90th percentile of the LTA of the 1992-2019 breeding population surveys.*
[d] *Population deficit, the difference between the population objective and the current population.*

**TABLE 8.2 Population abundance, population objectives and population trends for breeding duck focal species, in the Valley as a whole and by planning region.** (Sums may not be exact, due to rounding in original data.)

*Gadwall brood - Mike Peters*

The CVJV used guidance from NAWMP (2014) to establish dual population objectives, but interpreted the guidance using available information for local waterfowl populations and habitat conditions. NAWMP objectives are based on the traditional survey area in the mid-continental United States and Canada, where estimates of total breeding ducks in recent years were above the LTA (USFWS 2019a). In contrast, the breeding duck populations in the Central Valley are well below their LTA and have been for several years (Table 8.2). Additionally, the LTA for mid-continent duck populations is based on surveys since 1955, so these data represent a wide range of breeding habitat conditions from a longer time period. Breeding duck surveys in the Central Valley have only been conducted since 1992, a period less than half as long as surveys in the traditional survey area. The CVJV considered these differences and other regional factors when applying NAWMP guidance to population objectives.

The CVJV did not consider the LTA of a rapidly declining population as an acceptable population objective for planning or even as a baseline population level. Rather, the CVJV interpreted the LTA as an absolute minimum acceptable level. The population dropping below this level will accelerate conservation efforts for breeding ducks. Further, the CVJV interpreted the 90th percentile of the LTA as the population objective to strive for every year, rather than the population level that would occasionally be achieved due to fluctuations when conditions are optimal. The California duck breeding population has exceeded the 90th percentile of the LTA during 10 percent of the years since 1992 (almost 30 years). This information indicates that landscape conditions capable of periodically providing breeding habitat above the 90th percentile level are achievable. For example, during the five-year period from 1995-1999, the mean population size for mallards was 317,685 birds, which is greater than the 90 percent of the LTA (305,497). Moreover, breeding duck populations historically far exceeded objectives proposed here; they declined as a result of the tremendous (more than 90 percent) wetland loss in the Central Valley in modern times (Frayer et al. 1989).

Breeding population objectives for each focal species for the CVJV and within each planning region were established using the above criteria (Table 8.2).

- The LTA of the breeding population for each species is considered the **minimum population objective.**

- The 90th percentile of the LTA is set as the **long-term population objective.**

*Mallard pair - Mike Peters*

## Current Status Relative to Population Objectives

Current population estimates and 90th percentile abundance values were used to calculate abundance deficits for the three focal species across the CVJV Primary Focus Area and in each of the five planning regions. Abundance deficits are the long-term population objective minus the current population estimate. Based on abundance estimates for the CVJV Primary Focus Area as a whole, current populations for the three focal species total about 145,000 breeding ducks. Achieving the 90th percentile population abundance objectives for these three species requires an increase of 228,000 breeding ducks. This increase will require a 61 percent increase in the combined abundance of these three species. Furthermore, the combined population of the focal species is 41 percent below the minimum population objective (Table 8.2).

All three focal species currently have significant population deficits relative to their long-term objectives and all are below their minimum population objectives. Numerically, mallards have the largest population deficit: they are about 193,000 ducks (63 percent) below the Valley-wide objective. Mallards are well below their objectives in all planning regions, but the largest deficit is in the Sacramento planning region. Achieving the long-term population objective there (approximately 117,000 individuals) would require more than a fourfold increase in the current population (Table 8.2).

The population deficit for gadwall is less than for the other focal species, but still well below (33 percent) the Valley-wide long-term population objective of about 38,000 breeding ducks. The population deficit for gadwall is more than 3,000 ducks below regional objectives in the Sacramento, Suisun, San Joaquin and Tulare planning regions (Table 8.2). In the Yolo-Delta planning region, breeding gadwall are closer to, but still below, population objectives.

Cinnamon teal have the largest deficit relative to their population objective; their current population of about 10,800 is 66 percent below the Valley-wide long-term objective of about 30,000 individuals. In all planning regions except Suisun, cinnamon teal are at least 60 percent below their population objective (Table 8.2). The largest population deficits for cinnamon teal are in the southern planning regions (San Joaquin and Tulare), which historically supported more than half the breeding ducks for this species. In the Suisun planning region, the cinnamon teal population is 24 percent above the minimum population level (the LTA), but still 23 percent below the long-term objective.

## Life-Cycle Modeling and Limiting Factors

Biological models provide a means for effective conservation planning by translating population objectives into habitat objectives. The CVJV translated population objectives for non-breeding waterfowl into habitat objectives (as acres of foraging habitat), based on estimates of how much food energy will be needed by duck populations that have reached the population objectives (see the Non-Breeding Waterfowl chapter). Developing models for the breeding season is more complex, because waterfowl behavior and habitat requirements change depending on the stage of the life cycle (Johnson et al. 1992). Currently, there is no clear link between population objectives for breeding waterfowl and the amount and types of habitat needed in the Central Valley to support them.

Identifying population-limiting factors and understanding these factors' ecological relationships to habitat are essential when developing habitat objectives and conservation strategies. Vital rates (factors affecting population growth, such as nesting success and duckling survival rates) are available for breeding mallards in the Central Valley from several published and unpublished sources (CVJV 2006, Table 5-2; Feldheim et al. 2018). This information has improved researchers' knowledge of locally breeding ducks and simple demographic models have been developed (Oldenburger 2008). However, the understanding of factors influencing the population growth of locally nesting species in the Central Valley remains incomplete. Thus, the CVJV relied on both local data and published information from other regions to explore possible limiting factors and to develop habitat objectives.

There is convincing evidence that dabbling duck population growth is primarily influenced by habitat quality and quantity during the breeding season, and that it is most responsive to vital rate changes during this period.

Demographic models for mallards indicate that mortality outside of the breeding season (such as hen survival) can inhibit population growth in some areas (Hoekman et al. 2006), including California, but that various factors during the breeding season are more significant (Hoekman et al. 2002; Oldenburger 2008; Dugger et al. 2016). The breeding season vital rates most important to population growth include breeding propensity (the likelihood a hen will nest), nest success and duckling survival.

However, the non-breeding season also includes the annual wing molt, a potentially vulnerable period for adult ducks because they are flightless, have increased energetic demands, and have specific habitat needs that are limited in the Central Valley (Yarris et al. 1994; Fleskes at al. 2010; Kohl 2019).

The focal species included in this chapter are residents of California for most or all of the year and thus, they require habitat to fulfill their needs during their entire annual lifecycle. Habitat conditions during the non-breeding period have improved considerably since the formation of the CVJV. However, to increase the populations of focal species, it will be most effective to focus on habitats required during the breeding season, and to target the vital rates most likely to increase the production and survival of ducklings. In doing so, it is still important to recognize the cross-seasonal relationships in ducks between wintering habitats and survival and breeding success (Devries et al. 2008; Sedinger and Alisauskas 2014).

# CONSERVATION DESIGN:
# How Much Conservation, of What Type, and Where?

## Characterization of the Landscape

Breeding populations of all three focal species have declined throughout the Central Valley, indicating that factors acting at a landscape-level are likely involved. However, differing rates of decline among planning regions and among duck species indicate certain factors may be unique to each area. Nesting ducks rely on a wide variety of upland habitats, ranging from undisturbed grassland habitat to intensively farmed cropland. Some spatial and tabular data are available to evaluate upland trends, but a thorough analysis of changes in land cover types important to nesting ducks is currently lacking.

Spatial data and crop statistics are available to assess trends in agriculture, and some preliminary evaluations relative to breeding duck populations have been completed (D. Skalos, unpublished data, 2020; M. Cassazza, unpublished data, 2019, see "Notes"). Changes in the extent of managed wetlands in the Valley is well-documented by agencies and organizations involved in wetland protection and restoration (e.g., Petrik et al. 2014). However, wetland type and management (specifically, hydroperiod – the timing and duration of flooding – and the depth of flooding) is difficult to determine, so it is uncertain how much of each wetland habitat type is available during the breeding season in any given year.

The rural landscape in the Central Valley has changed dramatically since breeding waterfowl surveys were revised in 1992. Many changes, some of which are permanent, are having detrimental impacts on breeding waterfowl habitat. Urban development is expanding into rural areas in the Valley due to the lack of affordable housing in coastal areas, improving local economies and an increasing human population. The urban footprint in the CVJV Primary Focus Area has increased by 42 percent since 1992, from 680,000 acres to 970,000 acres (CDOC 2019).

Changes in cropping patterns have also been significant. Most noticeable has been the shift from annual crops to perennial crops, especially almonds (and other tree nuts), olives and vineyards (Coates et al. 2017). In 1992 there were about 650,000 acres of tree nuts planted in the CVJV planning area; today there are more than 2 million acres, an increase of more than 200 percent (USDA 2019b). Loss of annual crops and pasture is significant because annual crops are generally compatible with breeding ducks, whereas orchards and other perennial crops are not. For nesting ducks, the increases in orchards have come at the expense of annual crops such small grains (wheat and barley, reduced by almost 70 percent) and field crops (alfalfa and other hay/seed crops, reduced by more than 20 percent). Other beneficial breeding habitats such as rangeland and pasture have decreased by about 15 percent.

Mallards will readily nest in wheat and oats when planted near wetlands or rice (Loughman et al. 1991; Matchett et al. 2006). Furthermore, fields with annual crops can be fallowed as part of a crop rotation, or during periods of drought when irrigation water is not available or is designated for other uses (e.g., water transfers), whereas orchards remain in production every year. Fallow fields, especially when planted with a cover crop, are used by nesting hens of all three focal duck species (Yarris and Loughman 1990; Loughman et al. 1991, CWA 2013).

## Landscape Changes and Breeding Duck Populations

### Habitat changes on survey transects

A recent analysis of data comparing land use in 1998 versus 2016 along the CDFW breeding duck survey transects indicates that the amount of breeding habitat has declined by 17 percent in that time period (Figure 8.5; M. Cassazza, unpublished data, 2019, see "Notes"). This analysis shows that land uses that provide habitat for breeding ducks, which include wetlands, rice, pasture and other annual crops, have declined substantially, while incompatible land uses such as orchards, vineyards and urban development are increasing. Overall, potential breeding duck habitat within the transects in the CVJV area declined by about 70,280 acres (17 percent) due to conversion to incompatible land uses.

Conversion to orchards accounted for 64,450 fewer acres (16 percent) of duck habitat across transects. Relative to the respective total area of each type of habitat, conversion to orchards represents a six percent loss of rice, 13 percent loss of pasture and 22 percent loss of other annual crops. Relative to the respective area of each habitat, conversion to urban uses represented 0.24 percent loss of wetland, two percent loss of pasture and two percent loss of other annual crops. Wetland was the only habitat to increase during the 18-year period (14 percent more wetland in 2016 than 1998), the result of restoration of wetlands on former rice fields, pasture and other annual crops. Impacts on habitat area varied among regions, with greater loss occurring in the southern Central Valley, where greater than 25% habitat loss occurred on portions of survey transects (San Joaquin and Tulare planning regions; Figure 8.5).

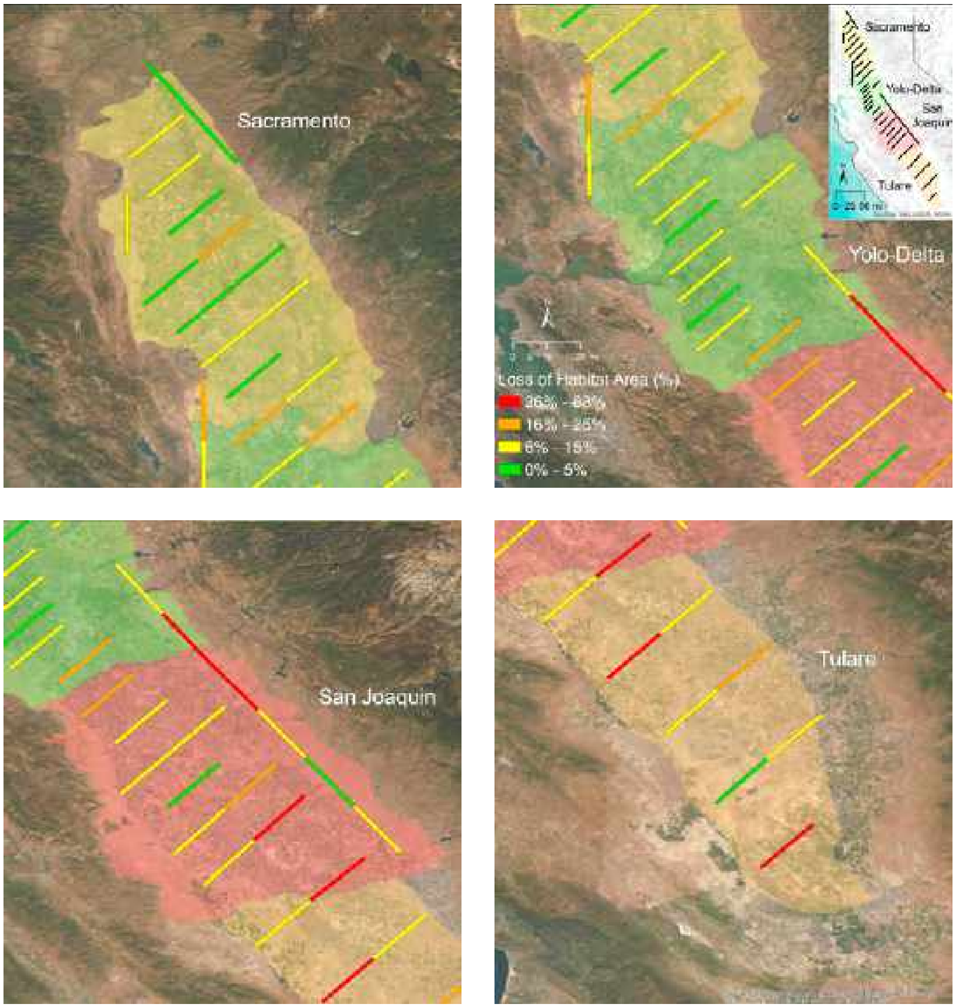



**FIGURE 8.5 Change in available potential waterfowl breeding habitat from 1998 to 2016 in waterfowl breeding population transects surveyed in the Central Valley.** Habitat includes managed wetlands, annual cropland and pasture. Non-habitat includes orchards and vineyards, forests and urban areas. Inset shows survey transects within four Central Valley planning regions (Sacramento, Yolo-Delta, San Joaquin and Tulare). Four panels, one for each region, indicate the percentage change in area of potential breeding habitat between the years 1998 and 2016.

## Trends in agriculture

The relationship between the annual number of breeding mallards and the extent of various crops in each planning region (excluding Suisun, because of limited agriculture in that region) were recently examined using simple linear regression models to explore what might be affecting the long-term decline of mallards and to direct conservation priorities (D. Skalos, unpublished data, 2020, see "Notes"). These relationships are not causal, yet they do provide insight when considered together with other factors (e.g., weather and wetland availability) and expert opinion. The relationship between changes in dominant agriculture classes and decline of mallard breeding populations was similar in all planning regions, namely, there was a negative correlation between acres of tree crops and urban development and the number of breeding mallards. Conversely, there was often a positive correlation between crops that provide upland nesting habitat (e.g., row crops, field crops and pasture) and the number of breeding mallards.

Mallard population and land use change relationships appeared strongest in the Sacramento planning region (D. Skalos, unpublished data, 2020, see "Notes"). Mallards are more reliant on agricultural lands for breeding in this region, which could explain the trend. Mallards readily use flooded rice field habitat during the spring because the timing of planting and flooding of the fields coincides with the nesting season. Small grain crops, especially winter wheat, as well as hay and other irrigated annual crops compatible with nesting mallards, are often grown in association with rice, providing an attractive mix of upland and aquatic habitats (Earl 1950; Loughman et al. 1991; Matchett et al. 2006). However, small grain crops are also the crop types most likely to be converted to perennial crops (e.g., orchards) because of suitable soils, existing irrigation infrastructure and water rights and the relatively low profitability of wheat, hay and other annual crops. Thus, conversion of these annual crop types in proximity to flooded rice fields and natural wetlands is likely contributing to the decline of mallards in the Sacramento Valley.

## Other contributing factors

Trends in potential nesting habitat in agricultural areas are well-documented, but changes in status or condition of other upland areas have not been examined. A considerable amount of natural upland area exists in association with private and public wetlands; changes to these habitats could influence use by or success of nesting ducks. For example, changes in plant species composition or vegetation structure related to various factors can influence use of potential nesting habitats. Invasive plants (e.g., Himalayan blackberry [*Rubus armeniacus*], star thistle [*Centaurea solstitialis*], pepperweed [*Lepidium* sp.] and the *Phragmites* reed [*Phragmites australis*]) can reduce habitat suitability for nesting hens. Increased woody vegetation, either through natural succession or by planting trees and hedgerows, is known to negatively influence use of habitat by grassland-nesting birds (Bakker 2003).

Additionally, changes to nesting densities (Ackerman et al. 2004), to predator populations (Croston et al. 2018) and to the populations of other prey species that duck predators also target (Ackerman 2002) can all have substantial effects on duck nest survival. Increases in certain predators (e.g., common ravens [*Corvus corax*], American crows [*Corvus brachyrhynchos*] and various raptors) have also been documented in areas of the Central Valley (Coates et al. 2017). Expansion of existing wetlands into adjacent uplands, although beneficial to non-breeding waterfowl and other waterbirds, can be detrimental to nesting ducks in areas where the lack of suitable upland habitat is limiting reproduction. Shifts in climate may also be contributing to recent declines in mallards and other nesting birds (Ackerman et al. 2011), as these declines coincide with record high temperatures and below-normal precipitation. Breeding duck populations were especially suppressed during the recent drought from 2011 to 2017 (Skalos and Weaver 2019). The influence of these climate-related changes is largely unknown and more subtle than widespread changes in agriculture or complete habitat loss from urbanization. However, they should not be ignored, especially in areas where ducks are less dependent on agriculture but still in decline.

## Wetland Trends

Changes in wetland habitat available during spring and summer for breeding ducks and their broods are more difficult to track than changes in agricultural lands, and thus have not been documented (nor have trends in natural uplands for nesting habitat). The total extent of managed wetlands has increased since the formation of the CVJV in 1988 (see the Conservation Delivery chapter). However, most of these restored wetlands are managed seasonally for migrating and wintering birds and are typically dry during the summer. A small fraction of these wetlands is managed as permanent or semi-permanent wetlands and thus are available during the breeding season. However, the wetland acreage available in any given season is highly variable and dependent on a number of factors, such as management goals and priorities, water availability and/or cost, and the annual maintenance budget.

The historical long-term loss of permanent and semi-permanent wetlands is well-documented and is proportionately greater than the loss of seasonal wetlands (Frayer et al. 1989; Heitmeyer et al. 1989; California State University Chico 2003). The amount of permanent and semi-permanent wetlands available annually since breeding waterfowl surveys were initiated in 1992 is not well understood, so any correlation to the decline of locally breeding ducks is uncertain. (Also note that these two types of wetlands are often grouped together) Importantly, the documented declines in California breeding duck populations occurred after most of these large-scale wetland losses, meaning that the loss of wetlands alone cannot explain the decline in breeding ducks over the past two decades.

The overall acreage of all types of wetlands available within the breeding duck survey transects has increased by 14 percent since 1998, based on a recent analysis of land cover changes (M. Cassazza, unpublished data, 2019, see "Notes"). However, the management goal and hydroperiod of these wetlands – for example, whether a particular wetland is flooded year-round or only during some part of the year – is unknown. Consistent with management of most wetlands in the Valley, more recently restored wetlands are likely dry during the spring and summer.

An analysis of satellite imagery from 2009 quantified the extent of wetlands in the CVJV planning area and determined the proportions managed as either seasonal or as permanent/semi-permanent (Petrik et al. 2014). The results of this study indicated a total of 201,200 acres of managed wetlands in the Valley. Approximately 10 percent (21,000 acres) were still flooded in June and were likely managed as permanent or semi-permanent wetlands (this study referred to both types of wetlands collectively as semi-permanent). There were geographic differences in the proportion of wetlands managed as semi-permanent, ranging from four percent in the San Joaquin planning region to about 16 percent in the Suisun and Yolo-Delta planning regions. The Sacramento planning region and Tulare planning region had about seven percent and 11 percent classified as semi-permanent wetlands (planning regions adapted from planning basins in Petrik et al. 2014).

*Mallard nest - Mike Peters, USFWS*

From 2009 to 2015, an additional 17,300 acres of wetlands were restored, bringing the total amount of managed wetlands to 218,500 acres (D. Fehringer, unpublished data, 2016, see "Notes"). The CVJV assumed 10 percent (1,730 acres) of recently restored wetlands were managed as permanent/semi-permanent, consistent with the 2009 mapping results. The analysis of 2009 imagery also considered ownership (private or public) when delineating wetland habitat and showed that private wetlands had a slightly greater proportion managed as permanent/semi-permanent compared to public wetlands. Roughly two-thirds of the total wetland area in the Valley is under private ownership.

Because the last evaluation was conducted in 2009 and only considered a single year (Petrik 2014), it is unknown if the amount of spring- and summer-flooded wetlands from that study represents the current situation. The recent drought in California (2011-2017) gave rise to several water policy changes (e.g., the Sustainable Groundwater Management Act). These changes, combined with increasing competition for water, changing water prices and other factors, may have changed the distribution and amount of wetlands flooded during the spring and summer.

Rice fields are an important surrogate "wetland" in the Sacramento Valley, providing important habitat for breeding ducks and their broods (Earl 1950; McLandress et al. 1996; Yarris 2008). The amount of rice planted annually during the last three years (average of 482,300 acres; 2017-2019) is similar to the 10-year period when mallards were most abundant (average of 480,300 acres; 1992-2001) and only slightly lower than the average planted annually since breeding duck surveys were initiated in 1992 (average of 508,600 acres; 1992-2019) (USDA 2019a).

## Developing the Habitat Objectives

A key assumption in waterfowl habitat conservation is that habitat conservation programs can have a positive impact on the vital rates limiting the population during specific life cycle events (Reynolds et al. 2001). The habitat improvements most likely to increase breeding duck populations in the Central Valley include increasing the amount of wetlands available in spring and summer for breeding ducks, and increasing the amount of, and enhancing the quality of, upland habitat used for nesting.

### Wetland habitat

Most wetlands in the Central Valley are managed. The hydroperiod and depth of flooding is artificially manipulated depending on the management goal and the availability of water. There are four basic wetland management strategies in the Central Valley: seasonal; reverse-cycle; semi-permanent; and permanent (these last two types are often grouped together).

Seasonal wetlands are generally flooded October through March (and are commonly drained and irrigated in spring and summer to promote wetland plant seed production). Reverse-cycle wetlands are flooded approximately March through July. Semi-permanent wetlands are generally flooded October through July. Permanent wetlands are flooded year-round. All provide benefits to locally nesting ducks, albeit at different stages of the breeding or post-breeding cycle. At a minimum, wetland habitats of some type should be flooded and available for breeding and post-breeding ducks in the spring and summer period from April 1 to August 1.

For many wetland managers, the primary goal of managing seasonal wetlands is to provide energetic resources (food) for waterfowl during the fall and winter. Water levels in seasonal wetlands are typically drawn down in spring to stimulate new growth of desired forage (moist-soil) plants (Heitmeyer et al. 1989). Seasonal wetlands provide important habitat for breeding duck pairs just prior to nesting, especially if water is not drawn off until April or May. However, this wetland type does not benefit duck broods, except temporarily for early-hatched broods or in situations where swales or perimeter “borrow” ditches are left flooded through summer (Chouinard and Arnold 2007). Seasonal wetlands can provide “upland” nesting habitat if water is removed before the nesting season and new growth or residual wetland vegetation provides enough cover to conceal nests. (Note, however, that the effectiveness of this type of vegetation as nesting habitat has not been thoroughly evaluated; it is thought to be less used than more traditional upland habitat.)

Reverse-cycle wetlands are a less common type of seasonal wetlands. They are only flooded during the spring and summer (March to August) and are dry during the fall and winter. The dry period during the fall and winter allows annual grasses and other herbaceous plants to become established. When flooded during the spring, the decomposing vegetation provides optimal conditions for invertebrate production beneficial to breeding ducks and ducklings. Reverse-cycle wetlands have been documented to have approximately four times the duckling survival of semi-permanent wetlands (Chouinard and Arnold 2007). This increased survival rate over the more-continuous flood period of permanent and semi-permanent wetlands is likely because of improved invertebrate food resources resulting from their long drying period and lower vulnerability to predators (de Szalay et al. 2003; Chouinard and Arnold 2007).

Semi-permanent wetlands are flooded for most of the year, but water is removed for a short period (typically six to eight weeks) in late summer or early fall. When managed for breeding ducks, the water level is usually maintained continuously until late July or early August. The presence of summer water encourages tules, cattails and other emergent plants that provide cover for duck broods and molting adults. Wetland maintenance and nutrient cycling includes vegetation manipulation (disking, burning, etc.) during the dry period prior to flooding in the fall. In many cases, semi-permanent wetlands that reach an ecological steady state are left dry during the summer to control invasive plants that become established under the extended hydroperiod.

Permanent wetlands remain flooded throughout the year and, depending on the water depth and clarity, provide a mixture of emergent vegetation and open water with submergent aquatic vegetation (most or all of the plant structure is submerged). Permanent wetlands typically support a diverse but relatively small invertebrate population, due to low primary productivity associated with stable water levels and vegetation associated with a steady-state ecosystem. Permanent wetlands provide habitat for breeding adults and broods and are especially valuable to post-breeding molting adults in mid- to late summer (Kohl 2019). Redheads, ruddy ducks and mallards will nest in robust emergent vegetation in both semi-permanent and permanent wetlands (Maxson and Riggs 1996).

### Upland habitat

Characteristics of uplands attractive to nesting dabbling ducks include the presence of vegetation (residual or new growth) that is tall (greater than 12 inches) and dense enough to conceal incubating hens and their nests (Ackerman et al. 2009); locations reasonably close (less than half a mile) to wetlands or other water sources (e.g., rice fields, waterways); and the presence of relatively few trees or other potential roost sites for avian predators. When upland vegetation is not suitable to provide nesting cover but the other two conditions are met, planted cover crops or grasses can increase use by and success of nesting ducks (Loughman et al. 1991).

Mallards, gadwall and cinnamon teal use a diversity of upland and wetland habitats for nesting (Baldassare 2014). Mallards are especially adaptable and use a variety of agricultural and natural habitats for nesting. Mallards in the Central Valley nest in predictable cover types, such as annual and perennial grasses, but also in fields of herbaceous plants and shrubs, growing crops (especially oats and winter wheat), cover crops, fallow or idle farmland, and over water in emergent wetland vegetation (McLandress et al. 1996). Upland cover types used by nesting gadwall are similar to mallards, but in the Valley gadwall do not commonly nest in growing crops such as winter wheat or over water in wetland vegetation (although these habitats are used by nesting gadwall elsewhere; Maxson and Riggs 1996, Skone et al. 2016). Cinnamon teal also use a variety of cover types for nesting but generally prefer sites closer to water than mallards or gadwall, and they typically require shorter vegetation for nest concealment.

The amount of existing nesting habitat available to breeding ducks in the Valley is unknown. There is considerable spatial land cover data for the CVJV planning area, but it has not been analyzed recently, nor has it been analyzed relative to the ecological requirements of the three focal breeding species. Because of the importance of agriculture to nesting ducks (especially mallards), only an analysis using relatively current data would be meaningful, given the significant land use changes that have occurred since the last Implementation Plan in 2006. An inventory of nesting habitat suitable for mallards, gadwall and cinnamon teal in each of the planning regions remains a priority for the CVJV.

Using the abundant nesting information available for mallards, the CVJV determined the amount of nesting habitat needed to support the population at the level of the minimum objective (the LTA) and at the long-term objective (the 90th percentile of the LTA). Because mallards are the most numerous focal duck species for the CVJV, providing enough nesting habitat to meet the needs of the mallard population when it has reached the long-term objective should also meet the needs of gadwall and cinnamon teal populations. The CVJV's long-term objective for breeding mallards is 305,500 individuals and the minimum objective is 201,400 (Table 8.2).

In order to estimate the amount of upland nesting habitat needed to maintain this breeding population, a series of assumptions were made using historical nesting data. Nesting uplands would need to be located within five miles of final brood wetlands and no more than 0.5 miles from the nearest wetland that the ducks can use as transit water from the upland nesting field to the final brood wetland. Assuming half of the breeding mallards are female, then nesting habitat for 152,750 mallard hens is needed to meet the needs of the long-term population objective. Using this target breeding population of hens and dividing this number by their expected nest density allows the CVJV to estimate the required amount of nesting habitat.

The expected density of nesting hens was estimated as the observed nest density of 1.42 nests per acre (arithmetic average of Grizzly Island Wildlife Area nest studies from 1985 to 2004 and 2008 to 2009; J. Ackerman, unpublished summary data, 2019b, see "Notes"). An estimated 57 percent of hens will re-nest after a failed nest attempt, that is, after losing a nest to egg predation or other factors (Arnold 2009). When adjusting the nest density to account for the estimated number of nests that are from re-nesting hens, the estimated nest density of 1.42 nests per acre is reduced to 0.86 nests per acre. (Nest density and success were estimated using the method of Mayfield; see Miller and Johnson 1978).

Dividing the 152,750 mallard hens needed to reach the Plan's objectives by the expected density of 0.86 nests per acre results in an estimated upland nesting habitat requirement of 176,900 acres, located near suitable brood rearing wetlands that are flooded in the spring and summer from April 1 to August 1. Similarly, for the minimum population objective of 201,400 mallards, or 100,700 hens, an estimated upland nesting habitat requirement of 116,600 acres would be needed.

This upland habitat requirement estimate should be used with caution. It is based simply on the amount of upland nesting habitat needed to provide hens with enough space to continue to nest at their long-term average nest density. The current assumptions are that the available nest densities and nest success used are typical for most nesting areas in the Valley, and that nest densities, nest survival and re-nesting potential do not vary with the number of breeding hens. These assumptions are likely to be incorrect. Grizzly Island Wildlife Area nesting densities are generally higher than those in other areas of California (McLandress et al. 1996), so estimated acres of habitat suggested here likely underestimate what would be needed to adequately support the breeding populations at objectives. However, this estimate provides an approximation based on current data and information, and on the limited modeling resources available.

### Upland nesting habitat needed to meet the population objective for mallards

### Number of Acres=

(target number of breeding hens) x
{(Nest Density per Acre x Nest Success) +
(Nest Density per Acre x [1- Nest Success]) –
([Nest Density per Acre x [1- Nest Success] x 0.57)}

# CONSERVATION DELIVERY:
## Defining the Habitat Objectives

### Wetland Habitat

The specific long-term habitat objective is to increase the area of wetlands currently managed as semi-permanent in the Central Valley to 20 percent of the current wetland base (Table 8.3). Generally, managers designate five to 15 percent of the wetland habitat as summer water for resident wildlife. The most recent assessment (in 2009) indicated that about 10 percent of the total wetland area (of all types) is managed as semi-permanent (Petrik et al. 2014). Another analysis, of a smaller number of recent wetland restoration projects from 2009-2015, indicated less than five percent were managed as semi-permanent (C.M. Brady, unpublished data, 2019, see "Notes"). Increasing the acreage from 10 percent to 20 percent of the current wetland base (2015 data) would add an additional 21,000 acres of semi-permanent wetlands (Table 8.3). The CVJV recommends increasing semi-permanent wetlands to meet habitat objectives, primarily by restoring additional wetlands, but also by altering the management of seasonal wetlands if impacts to non-breeding waterfowl are minimal.

Increasing the amount of semi-permanent wetlands will boost the dabbling duck population in several ways. It will increase breeding propensity and effort by providing additional food resources and territories for breeding pairs (Newbold and Eadie 2004; Howerter et al. 2014). Furthermore, increasing wetland habitat available at the time of hatch and continuing until fledging will likely improve duckling survival (Oldenburger 2008). More wetlands in summer will also provide much-needed habitat for post-breeding ducks and will likely improve adult survival during wing molt (Fleskes et al. 2010; Kohl 2019).

The CVJV is only recommending a wetland habitat objective for semi-permanent wetlands at this time. These wetlands provide much-needed summer habitat and the water management and maintenance schedule is the most realistic option for most wetland managers. There is evidence that reverse-cycle wetlands provide superior foraging habitat for duck broods, as described previously, but few studies have been conducted (de Szalay et al. 2003). Moreover, reverse-cycle wetlands are dry during the fall and winter. This status further reduces habitat needed by migratory waterbirds and eliminates the option to hunt waterfowl, which is a primary purpose of many private and public managed wetlands. Semi-permanent wetlands provide suitable habitat for breeding ducks, while still maintaining value during the remainder of the year. Ideally, a portion of the semi-permanent wetlands included in this habitat objective would be substituted with reverse-cycle wetlands, especially in areas known to support high densities of breeding ducks, or in wetland units that would benefit from an extended dry period due to their steady-state vegetation.

The acreage of additional wetlands in each region needed to meet the 20 percent objective is variable (Table 8.3). Based on the most recent assessment (Petrik et al. 2014), the largest deficits to achieving the 20 percent criteria are in the Sacramento and San Joaquin planning regions. There is evidence that the extent of semi-permanent wetlands in certain planning regions is overestimated and need revising (e.g., Tulare does not have a surplus; C.M. Brady, unpublished data, 2019, see "Notes"). As such, semi-permanent wetland objectives for each planning region will be updated periodically as more recent data on current wetland status become available.

### Upland Habitat

The total amount of suitable upland nesting habitat required to meet the CVJV long-term population objective is estimated to be almost 177,000 acres, as detailed in the previous section. The total amount of upland nesting habitat required to meet the minimum population objective is approximately 117,000 acres. This upland habitat would need to be located within 5 miles of final brood wetlands and no more than 0.5 miles from the nearest wetland that ducks can use as transit water to the final brood wetland. Because the current amount of suitable nesting habitat is unknown, it is not currently possible to determine how much additional acreage is needed to meet the population objectives. The CVJV considers determining the amount of existing suitable upland nesting habitat a high priority, in order to then establish objectives for additional acres of upland nesting habitat.

Most of the planning regions have areas with suitable nesting habitat. Increasing the extent of semi-permanent wetlands near those areas would likely improve duck breeding success. An exception is the Sacramento planning region, where rice agriculture provides summer aquatic habitat, but uplands are lacking. The decline in the mallard population in that planning region is greater than in other areas of the Central Valley, likely due to land use changes (Figure 8.2). The amount of rice grown there annually has remained relatively stable during the past 30 years; however, the complementary agriculture (annual crops such as winter wheat or pasture) and fallow rice fields that provide nesting habitat near growing rice fields has drastically declined.

To improve breeding success of ducks nesting near rice fields, the CVJV developed a habitat objective to provide suitable upland nesting cover equal to 10 percent of the recent rice crop base (based on the minimum acreage previously set aside by rice farmers as part of a price support program, before changes to the Farm Bill in 1996; that landscape supported a more robust breeding duck population than currently exists).

Actions that could meet this objective would include planting nesting cover or a suitable cover crop on fallow farm fields and leaving the cover undisturbed during the breeding season. The CVJV used the average amount of rice grown annually during 2007 to 2014 to determine the rice base and thus to set the conservation objective. During that period, an average of 541,000 acres of rice were grown annually. Therefore, the objective for planted nesting cover is 54,100 acres. Meeting this objective will likely require programs that offer economic incentives that are competitive with commodity markets and Farm Bill Programs.

## SUMMARY

Conservation planning for waterfowl and wetland management in the Central Valley has largely focused on meeting the needs of wintering and migrating waterfowl. Meanwhile, locally nesting duck species have substantially declined and are now at or near all-time lows. Hundreds of thousands of ducks spend their entire life cycles in the Valley; their habitat needs differ from wintering ducks in the region. Providing semi-permanent wetland and upland habitat as outlined in this chapter, in addition to traditional wintering habitat, is paramount to sustaining local duck populations. A robust waterfowl population is important for keeping hunters engaged, who in turn advocate for and contribute financially toward sustaining private and public wetlands in the Central Valley. This chapter highlights the need to shift the management paradigm, which currently focuses on wintering and migrating waterfowl, to achieve a more balanced approach to meeting the full life cycle needs of locally nesting waterfowl.

*Mallard brood - Mike Peters*

### The Habitat Objectives

**To meet the long-term population objectives:**

- Semi-permanent wetlands: 44,000 acres (21,000 additional acres)
- Upland nesting habitat: 177,000 acres, with 54,100 acres focused in the Sacramento region (research is needed to determine the amount of additional acreage this objective represents)

**Based on a review of existing population and habitat information, the CVJV determined that providing additional semi-permanent wetlands and upland nesting habitat in all planning regions would be the best approach to reverse the decline of locally nesting focal duck species and work toward reaching the long-term population objective.**

| PLANNING REGION | CURRENT WETLANDS (2015 ESTIMATE) | SEMI-PERMANENT WETLANDS: CURRENT | SEMI-PERMANENT WETLANDS: OBJECTIVE[a] | SEMI-PERMANENT WETLAND DEFICIT |
|---|---|---|---|---|
| **Sacramento** | 73,842 | 5,348 | 14,768 | 9,420 |
| **Yolo-Delta** | 25,965 | 4,010 | 5,193 | 1,183 |
| **Suisun** | 34,247 | 5,494 | 6,849 | 1,355 |
| **San Joaquin** | 61,247 | 2,872 | 12,250 | 9,378 |
| **Tulare** | 23,868 | 5,034 | 4,774 | 0[c] |
| **Total** | **219,169** | **22,758** | **43,834** | **21,336** |

*[a] Based on restoring an amount of semi-permanent wetlands equal to 20% of the current wetland extent.*
*[b] Deficit is the difference between the current acreage and the objective for semi-permanent wetland acreage. Deficits represents additional wetland acreage needed.*
*[c] A more recent analysis indicates semi-permanent wetlands were overestimated in Tulare for this Plan, so this result is being revised upward (C.M. Brady, unpublished data, 2019, see "Notes").*

**TABLE 8.3 Current wetlands of all types, current semi-permanent wetlands and the habitat objectives for semi-permanent wetlands, in the Valley as a whole and by planning region.** (Sums may not be exact, due to rounding in original data.)

## SUCCESS STORY

# THE CALIFORNIA WATERFOWL HABITAT PROGRAM

Established via the California Waterfowl Habitat Preservation Act, the California Waterfowl Habitat Program (also known as the Presley Program) is a statewide, private-land incentive program administered by the California Department of Fish and Wildlife (CDFW). The program compensates private landowners who are willing to manage their land in accordance with management plans cooperatively developed by CDFW and the landowners. These management plans are designed to implement waterfowl habitat goals as identified by the CVJV's most recent Implementation Plan and CDFW's State Wildlife Action Plan. Consistent with its primary waterfowl habitat objectives, the program also endeavors to enhance habitat for shorebirds, wading birds and other wetland-dependent wildlife.

The Presley Program has been in existence for close to 30 years and has remained extremely popular with private landowners. In the most recent solicitation (2019), CDFW received interest from approximately 200 properties encompassing 50,000 acres. At current funding levels, implementation of the program over the next 10 years will result in a net gain of more than 3,000 acres of semi-permanent wetlands and the annual enhancement of approximately 20,000 acres of seasonal wetlands within the Central Valley. Secure, long-term funding has been the limiting factor in implementing the Presley Program across the Central Valley.

1

*(1) Cinnamon teal brood - Mike Peters (2) Upland nesting habitat - Elliott Matchett (3) Mallard ducklings hatching - Brian Huber*

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1

# NON-BREEDING SHOREBIRDS

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# CHAPTER SUMMARY

The Central Valley supports large populations of numerous shorebird species during their 10-month non-breeding season (July – April), which includes winter as well as fall and spring migration. The Central Valley provides critical foraging habitat for these species and is a region of international significance for shorebird conservation. Protecting sufficient habitat to support resilient populations of these bird species also benefits other groups of birds, other wildlife, and the regional economy.

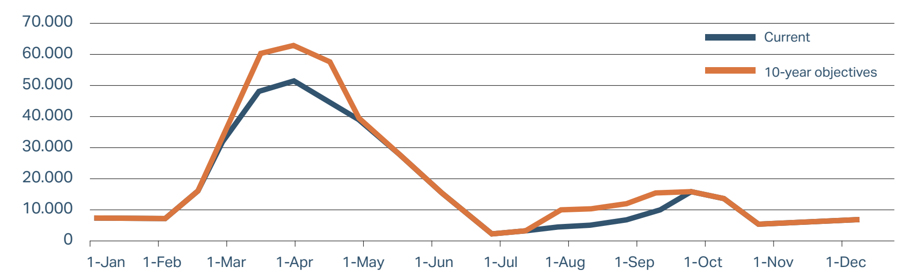
This chapter describes the conservation objectives for additional managed wetland acreage to be added during targeted fall and spring timespans. The goal is to prevent further loss and degradation of current habitat and provide additional habitat during critical time periods, to support resilient populations of Pacific Americas Flyway shorebird species. The Implementation Plan used a bioenergetics model to determine habitat needs over the course of each year.

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.

## HABITAT TYPE

Most of the shorebird species found in the Central Valley forage in shallow seasonal or semi-permanent wetlands, with water depths of less than four inches. Postharvest-flooded crop lands, especially rice and corn, also provide substantial foraging habitat for these bird species.

## FORAGING HABITAT FOR NON-BREEDING SHOREBIRDS




## HABITAT SUCCESS STORIES

since the 2006 Implementation Plan

- Efforts to work with private landowners in the Grasslands Ecological Area to enhance wetland management can provide as much as 25% of the additional habitat needed annually to reach short-term habitat objectives during the spring (S. Arthur, personal communication, 2018, see "Notes").
- Rice fields strategically flooded during the fall season through the BirdReturns program attracted some of the highest densities of foraging shorebirds ever recorded for agriculture in the Central Valley (Golet et al. 2018).
- The Waterbird Habitat Enhancement Program (WHEP) reached more than 200 agricultural producers to enhance over 120,000 acres (20%) of rice fields in the Sacramento Valley for shorebirds (MBCP 2014).

### SHORT-TERM HABITAT OBJECTIVES: WHAT'S NEEDED?

## 5,400 ADDITIONAL ACRES IN FALL

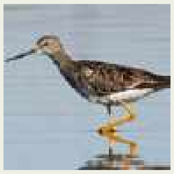
## 11,600 ADDITIONAL ACRES IN SPRING

### OF SHALLOW (<4 IN.) OPEN WATER IN MANAGED WETLANDS

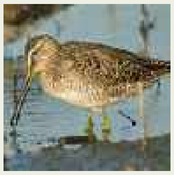
### BIRD SPECIES INCLUDE:

Representative shorebirds in the Central Valley in the non-breeding season:

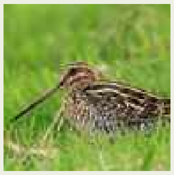
Species of heightened conservation concern:


Greater yellowlegs*


Western sandpiper*


Long-billed dowitcher**


Whimbrel*


Wilson's snipe*


Long-billed curlew*


Dunlin*

** Image: Tom Grey ** Image: Brian Gilmore*

*(1) Juvenile western sandpipers during migration - Tom Grey (2) Dunlin flock - Jim Dunn (3) Long-billed curlew - Tom Grey*

# INTRODUCTION

**The Central Valley of California is one of the most important regions for migrating and wintering shorebirds in western North America, supporting up to 500,000 shorebirds each year (Shuford et al. 1998). A significant number of shorebird species use the Central Valley during most of the year (about July 1 to May 15) when they are not in the breeding phase of their life cycle. The quality and quantity of habitat available for these shorebirds during the non-breeding season can have important impacts on body condition, survival, and subsequent migration timing and reproductive success (e.g., Burton et al. 2006). Therefore, habitat conservation and management in the Central Valley can have an important influence on shorebird population dynamics and shorebird conservation well beyond this region.**

The Central Valley is recognized as a region of international significance to shorebirds in the Pacific Americas Shorebird Conservation Strategy (Senner et al. 2016) and by the Western Hemisphere Shorebird Reserve Network (WHSRN 2009). The rice fields and wetlands in the Sacramento Valley and wetlands in the Grasslands Ecological Area of the San Joaquin Valley provide important habitat for these birds. However, the Central Valley has lost over 90 percent of its former wetlands to agriculture, channelization and urban development (Frayer et al. 1989). Central Valley shorebird populations were likely much larger prior to this habitat loss and now may be limited by the availability or quality of foraging habitat (Page and Gill 1994; Shuford et al. 1998).

Although it is no longer possible to restore wetlands to their pre-1900 extent, an extensive network of restored and managed wetlands and postharvest-flooded fields of rice, corn, and other row and field crops currently provide substantial habitat for non-breeding shorebirds in the Central Valley (Fleskes et al. 2012; Strum et al. 2013; Reiter et al. 2015). The total extent of foraging habitat required to support a robust shorebird community may be far less than historical levels, depending on how the extent, timing, and depth of flooding in these wetlands and agricultural lands are managed. Shorebirds have been the focus of multiple recent conservation programs in the Valley targeting private lands. These efforts are a mix of public (the Natural Resources Conservation Service's Waterbird Habitat Enhancement Program) and private programs (e.g., The Nature Conservancy's BirdReturns Program). The management practices supported by these programs are primarily annual. While there have been recent conservation gains through these programs, shorebird habitat remains vulnerable to changes in the availability of funding and the willingness and ability of landowners to participate every year.

Protecting and expanding Central Valley flooded habitats (including managed wetlands and seasonally-flooded agricultural fields) will benefit shorebirds and other wetland-dependent species. Deliberately flooded habitats can also benefit the people of the Central Valley in many ways, including reducing flooding that puts people and property at risk, improving air and water quality, recharging groundwater, and sequestering carbon (Finlayson et al. 1999; Zedler and Kercher 2005). They can also increase property values and attract wildlife watchers, hunters and other visitors, all of whom help support local economies (Carver 2013; Carver and Caudill 2013; Liu et al. 2013).

## CONSERVATION GOAL

**The Central Valley Joint Venture's long-term goals are to restore and enhance more shorebird habitat in the Central Valley and to reverse historical declines of shorebird populations in this region. This can be accomplished for non-breeding shorebirds by providing additional habitat during critical time periods during the non-breeding season, July 1 through May 15, thereby contributing to increasing, and more resilient, shorebird populations in the Pacific Americas Flyway.**

*Gray Lodge Wildlife Area - Brian Gilmore*

# WHICH SPECIES ARE INCLUDED?

Wilson's snipe - Tom Grey

The conservation objectives encompass all shorebird species that depend on shallow open water (less than 4 inches deep) for foraging habitat and were regularly observed during baseline surveys of Central Valley wetlands and flooded agriculture conducted during the non-breeding season between 1992 and 1995 (Shuford et al. 1998; Table 9.1). This Implementation Plan (hereafter, "the Plan") assumes availability of shallow open water foraging habitat is the primary factor limiting the size of non-breeding shorebird populations in the Central Valley.

| SPECIES (*SCIENTIFIC NAME*) | CONSERVATION STATUS [a] | CENTRAL VALLEY IMPORTANCE [b] |
|---|---|---|
| **Black-necked stilt** (*Himantopus mexicanus*) | | |
| **American avocet** (*Recurvirostra americana*) | MCCV | ● |
| **Black-bellied plover** (*Pluvialis squatarola*) | MCCV | |
| **Snowy plover** (*Charadrius nivosus*) | FT | |
| **Semipalmated plover** (*Charadrius semipalmatus*) | | |
| **Killdeer** (*Charadrius vociferous*) | CSD | ● |
| **Whimbrel** (*Numenius phaeopus*) | IM | ● |
| **Long-billed curlew** (*Numenius americanus*) | MA | ● |
| **Marbled godwit** (*Limosa fedoa*) | MA | |
| **Dunlin** (*Calidris alpina*) | MA | ● |
| **Least sandpiper** (*Calidris minutilla*) | | |
| **Western sandpiper** (*Calidris mauri*) | MCCV | ● |
| **Long-billed dowitcher** (*Limnodromus scolopaceus*) | | ● |
| **Wilson's snipe** (*Gallinago delicata*) | | ● |
| **Lesser yellowlegs** (*Tringa flavipes*) | MA | |
| **Willet** (*Tringa semipalmata*) | MA | |
| **Greater yellowlegs** (*Tringa melanoleuca*) | | ● |
| **Wilson's phalarope** (*Phalaropus tricolor*) | | |
| **Red-necked phalarope** (*Phalaropus lobatus*) | CSD | |

[a] *Conservation status designations from the U.S. Shorebird Conservation Plan Partnership (USSCPP 2015):* ***FT****, listed as Threatened under the federal Endangered Species Act;* ***IM****, requires immediate management action;* ***MA****, needs management attention;* ***MCCV****, moderate climate change vulnerability but not* ***IM*** *or* ***MA****; and* ***CSD****, common shorebird in decline. Because non-breeding shorebirds in the Central Valley may include individuals from many different breeding sub-populations, shown here are only the highest shorebird conservation designation of any breeding sub-population listed in USSCPP 2015.*
[b] *Southern Pacific Shorebird Conservation Plan (Hickey et al. 2003)*

**TABLE 9.1 Non-breeding shorebird species: Conservation status and Central Valley importance.** Shorebird species listed are those regularly occurring in managed wetlands and flooded agricultural fields of the Central Valley during the non-breeding season. These are the species incorporated into the bioenergetics model and conservation objectives. Also shown are each species' current continental conservation status and whether the Central Valley is considered to be of primary importance to the U.S. population of the species.

# WHICH GEOGRAPHIC AREAS ARE INCLUDED?

The conservation objectives apply to the CVJV's entire Primary Focus Area, except the Suisun Basin (Figure 9.1). The Suisun Basin was excluded because estimating shorebird foraging habitat availability in its tidally-influenced brackish wetlands was beyond the scope of the CVJV's current modeling efforts.

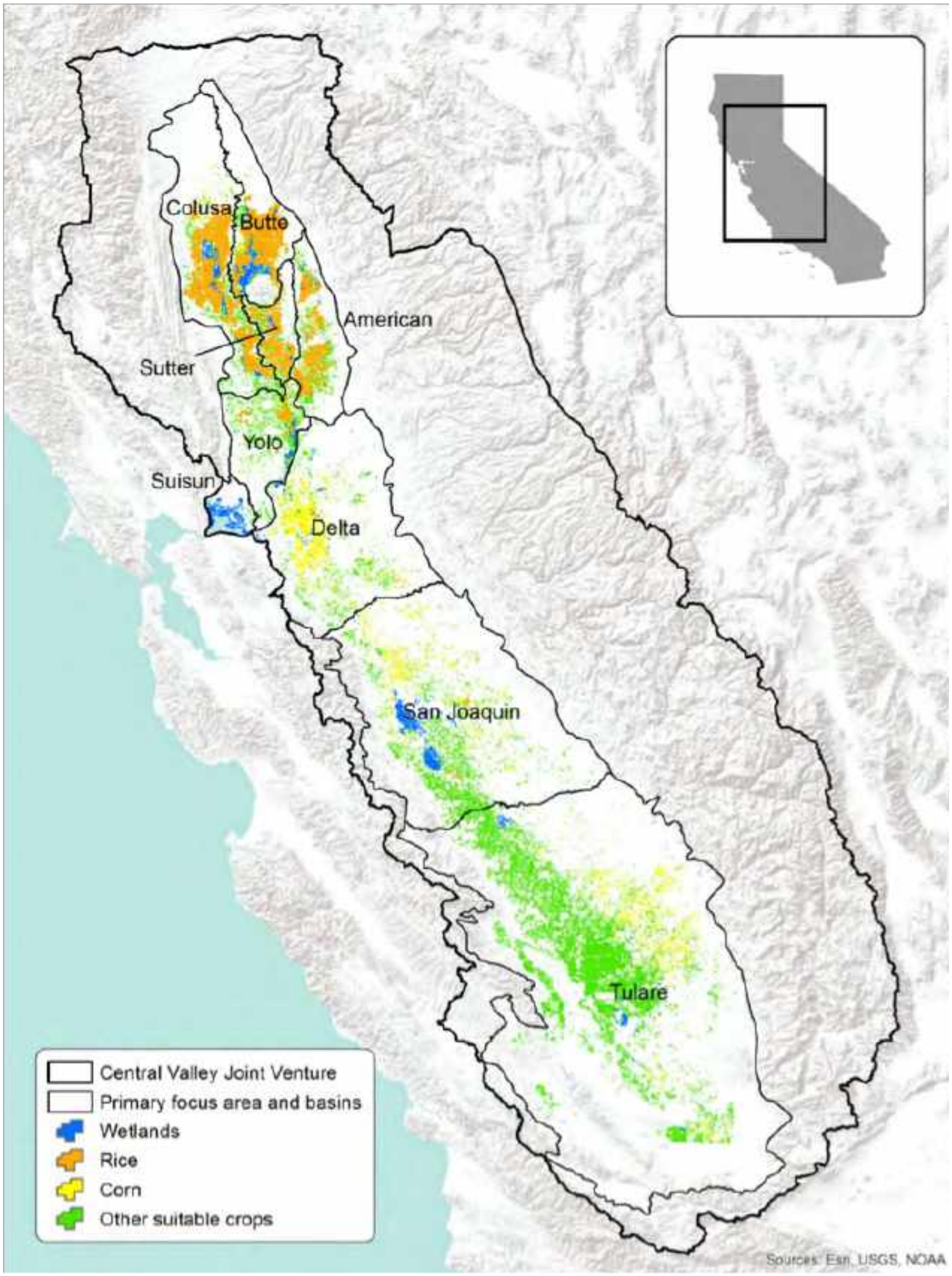



**FIGURE 9.1 Central Valley Joint Venture perimeter, Primary Focus Area, and basins.** Also shown is the distribution of potential foraging habitat for non-breeding shorebirds by land cover type. Wetlands data are from 2009; crop data are from 2007–2014.

# CURRENT CONDITIONS

## Current Population Sizes and Trends

Because over 90 percent of historical wetlands in the Central Valley have been lost (Frayer et al. 1989), the size of the non-breeding shorebird community using the Central Valley has likely declined by at least 50 percent from pre-1900 levels to the present. Current population size estimates are based on surveys of the Central Valley in the early to mid-1990s (Shuford et al. 1998), which showed an increase in shorebird abundance over the non-breeding season to peak in the spring (Figure 9.2). Although there have been no comparable comprehensive surveys since, a new program was established in 2011 to assess shorebird population trends in the westernmost United States and the Pacific Americas Flyway (Point Blue Conservation Science's Pacific Flyway Shorebird Survey, http://www.pointblue.org/pfss, which contributes data to the collaborative Migratory Shorebird Project, http://www.migratoryshorebirdproject.org/).

The CVJV reviewed continental and regional shorebird conservation assessments (Hickey et al. 2003; USSCPP 2015) to characterize the current conservation status of shorebird species that regularly occur in the Central Valley during the non-breeding season. Of the 19 species assessed, 12 species are ranked with some level of conservation concern, and these assessments consider the Central Valley to be of primary importance to the U.S. population of nine of these species (Table 9.1).

## Current Habitat

The availability of foraging habitat for shorebirds in the Central Valley changes between years and over the course of the non-breeding season. This variation depends on the total acres of managed wetlands and suitable agricultural fields each year, the proportion of these acres that are flooded on any given day, and the proportion of the flooded acres that are shallow enough (less than 4 inches) to be accessible to most shorebirds. Researchers estimated the total acres of potential shorebird habitat in each of the Central Valley basins (excluding Suisun) in managed wetlands and in rice, corn, and other field and row crops that may be flooded during irrigation or postharvest (Table 9.2).

For seasonal and semi-permanent managed wetlands, researchers used a GIS layer produced from 2009 satellite imagery (Petrik et al. 2014), supplemented by the estimated area of wetlands restored between 2009 and 2015 (D. Fehringer, personal communication, 2016, see "Notes") to estimate a recent (2015) total of 184,900 acres in the CVJV's Primary Focus Area. For crops, statewide survey statistics (NASS 2016) were combined with a GIS layer (The Nature Conservancy, unpublished data, 2015, see "Notes") to estimate the 2007–2014 average extent of planted rice (541,400 acres), corn (261,000 acres, excluding corn grown in the San Joaquin and Tulare basins, which is rarely flooded postharvest), and other field and row crops (2,051,700 acres) in the CVJV's Primary Focus Area.

The proportion of each of these land cover classes that has open water on each day of the non-breeding season was estimated using satellite imagery of surface water collected over a similar time period (2007–2011; Reiter et al. 2015). The proportion of the area with open water that is shallow enough to be used by most foraging shorebirds (less than 4 inches) was then estimated in managed wetlands using expert opinion (C. Isola, personal communication, 2015, see "Notes") and in postharvest-flooded crops using data recently collected in rice fields (Strum et al. 2013; Sesser et al. 2016; Sesser et al. 2018). The final estimates of current total shorebird foraging habitat available in managed wetlands is summarized in two-week intervals in Table 9.3 and Figure 9.3. Current estimates of available foraging habitat in flooded agricultural lands is summarized in two-week intervals in Figure 9.4. See Dybala et al. (2017) for more detailed figures.

During the 2007–2015 time period, researchers estimated that total open water habitat in the Central Valley reached an average peak of 620,400 acres in early January. The proportion of this habitat that is accessible to shorebirds reached a much smaller average peak of 279,300 acres in mid-February, over a month later. Habitat accessible to shorebirds was lowest in the early fall, when shorebirds must rely primarily on managed wetlands, contributing to an estimated energy shortfall in most years from early August through late September.

In addition, the shorebird foraging habitat currently provided by managed wetlands does not yet meet the CVJV's goal of being capable of supporting 50 percent of current shorebird daily energy needs between October and March and 100 percent from July through September and April through May (CVJV 2006). Achieving this goal would limit reliance on postharvest-flooded crops, the availability of which may change rapidly with economic and climatic conditions or environmental policies (Johnston and Carter 2000; Hagy et al. 2014; Hatfield et al. 2014). Nevertheless, increases in the availability of shorebird foraging habitat in postharvest-flooded crops during any part of the non-breeding season could contribute to eliminating energy shortfalls.

# DEVELOPING THE CONSERVATION OBJECTIVES

## Population Objectives

The international importance of the Central Valley to shorebirds, the loss of over 90 percent of historical wetlands in the Central Valley (Frayer et al. 1989), and the likely declines in shorebird abundance of at least 50 percent from historical levels warrant setting relatively large population objectives. Therefore, the long-term (100-year) population objectives were set to double the baseline Central Valley population sizes, as determined in the 1992–1995 surveys (Shuford et al. 1998), thus reducing historical population declines. The population objectives vary over the course of the non-breeding season to reflect bird movements and represent the total number of shorebirds that the Central Valley will be able to support during each day of the non-breeding season (Figure 9.2).

## Habitat Objectives

A bioenergetics modeling approach was used to estimate the amount of habitat required to support the population objectives over the course of the non-breeding season. Availability of foraging habitat is assumed to be the primary factor limiting shorebird abundance. Bioenergetics modeling is a tool to assess changes in energy supply and demand. Researchers estimated the daily shorebird energy demand from the number of birds in the community and estimates of their metabolic rate and energy assimilation efficiency. Then, the researchers estimated the daily energy supply from estimates of daily foraging habitat availability (described above in Current Conditions) and the average food energy provided per acre of foraging habitat.

For each day of the non-breeding season, the CVJV's bioenergetics model compared daily energy demand to daily energy supply, keeping track of any shortfalls in energy and allowing any surpluses to carry forward to the next day. Where energy shortfalls were identified, researchers re-ran the model to find the minimum amount of additional shorebird foraging habitat in managed wetlands that would be required to eliminate the energy shortfalls.

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

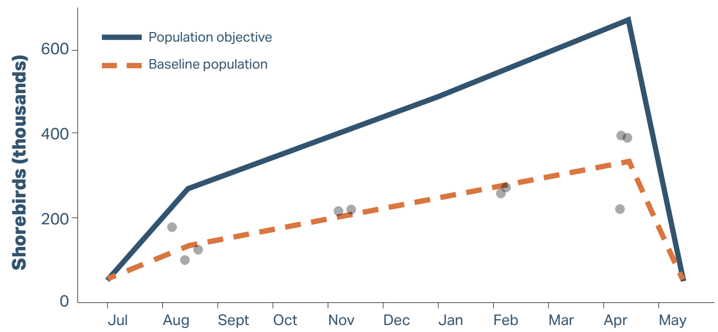



**FIGURE 9.2 Non-breeding shorebird abundance:** Current population and long-term objectives. Estimates are shown for the baseline population surveyed 1992–1995 (dashed line) and for the long-term (100-year) shorebird population objectives (2x baseline; solid line). Points show the estimates from the individual baseline surveys (Shuford et al. 1998).

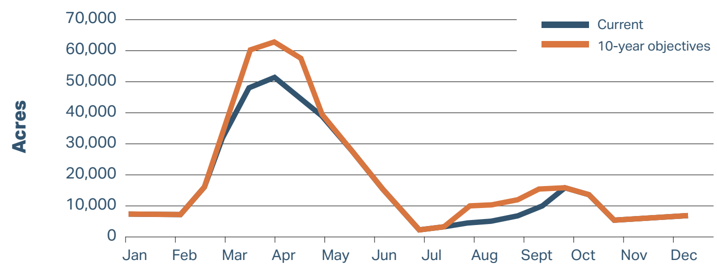



**FIGURE 9.3 Current estimates and short-term (10-year) habitat objectives for shorebird foraging habitat in managed wetlands during the non-breeding season.** Short-term objectives are equal to the current estimated acreage plus the additional acres needed by 2030.

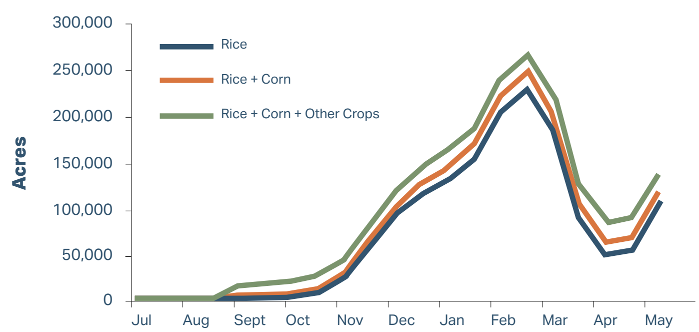



**FIGURE 9.4 Current estimates of shorebird foraging habitat in flooded agricultural lands.** Estimates include the average area of open water less than 4 inches deep between 2007 and 2014. The long-term habitat objectives are to maintain these current averages.

# CONSERVATION OBJECTIVES

## Habitat Objectives

The Plan defines short-term (10-year) and long-term (100-year) habitat objectives for shorebird foraging habitat (open water less than 4 inches deep) in the Central Valley's managed wetlands (Table 9.3). The objectives represent the estimated total extent of shorebird foraging habitat in managed wetlands required to support the long-term population objectives, assuming no change in habitat availability in postharvest-flooded crops. The habitat objectives for managed wetlands vary throughout the non-breeding season, reflecting changes in both the size of the non-breeding shorebird community and the availability of habitat in managed wetlands and postharvest-flooded crops.

Subtracting the estimated current extent of foraging habitat in managed wetlands from the acreage of the long-term or short-term habitat objectives provides the estimated additional acres of foraging habitat in wetlands needed to reach the habitat objectives. These estimates assume no loss of existing foraging habitat. The additional acres are needed to eliminate periods of projected energy shortfalls during the early fall and the spring, when foraging habitat is currently limited.

For postharvest-flooded crops, including rice, corn, and other field and row crops, the CVJV assumed no change in the average total area planted (Table 9.2) and no change in the average timing and depth of flooding. Thus, the long-term objective for postharvest-flooded crops is to at least maintain the current average shorebird foraging habitat the crops provide throughout the non-breeding season. Strategically increasing the availability of this type of shorebird foraging habitat, particularly during the shortfall periods, can be a valuable part of the strategy for meeting the habitat objectives (see below).

*Western sandpipers - Jim Dunn*

| BASIN | WETLANDS | RICE | CORN | OTHER[a] |
|---|---|---|---|---|
| Butte | 37,102 | 135,537 | 7,429 | 27,712 |
| Colusa | 26,618 | 213,778 | 18,624 | 115,916 |
| American | 6,516 | 90,052 | 2,408 | 38,303 |
| Sutter | 3,607 | 70,506 | 4,889 | 29,418 |
| Yolo | 12,943 | 21,739 | 13,699 | 155,555 |
| Delta | 13,022 | 5,214 | 213,927 | 183,123 |
| San Joaquin | 61,247 | 4,536 | – –[b] | 461,450 |
| Tulare | 23,868 | 0 | – –[b] | 1,040218 |
| **Total** | **184,922** | **541,362** | **260,976** | **2,051,697** |

*[a] Includes barley, beans, cotton, oats, safflower, sugar beets, sunflower, wheat, and total vegetables. Despite the large acreage of this crop class, only a very small fraction is ever flooded.*
*[b] Excludes the substantial amounts of corn grown in the San Joaquin and Tulare basins, which is rarely flooded postharvest.*

**TABLE 9.2 Estimated extent of potential foraging habitat for non-breeding shorebirds, by basin and land cover type.** Potential foraging habitat includes suitable land cover types that could provide foraging habitat if flooded. Basins are shown in Figure 9.1; Suisun basin not included. Estimates are given in acres and include the estimated extent of wetlands in 2015 and the average extent of 3 crop classes, 2007–2014. (Sums may not be exact, due to rounding in original data.)

| HABITAT TYPE TIMING | LONG-TERM HABITAT OBJECTIVE | CURRENT ESTIMATE | ACRES NEEDED (DIFFERENCE) | ACRES NEEDED BY 2030 (10%) |
|---|---|---|---|---|
| **Foraging Habitat In Managed Wetlands** (open water less than 4 inches deep in seasonal or semi-permanent wetlands) | | | | |
| 1-15 Jul | 2,277 | 2,277 | 0 | 0 |
| 16-31 Jul | 3,229 | 3,229 | 0 | 0 |
| 1-15 Aug | 58,111 | 4,741 | 53,370 | 5,337 |
| 16-31 Aug | 58,636 | 5,266 | 53,370 | 5,337 |
| 1-15 Sep | 60,269 | 6,899 | 53,370 | 5,337 |
| 16-30 Sep | 63,663 | 10,293 | 53,370 | 5,337 |
| 1-15 Oct | 16,239 | 16,239 | 0 | 0 |
| 16-31 Oct | 13,702 | 13,702 | 0 | 0 |
| 1-15 Nov | 5,284 | 5,284 | 0 | 0 |
| 16-30 Nov | 5,686 | 5,686 | 0 | 0 |
| 1-15 Dec | 6,335 | 6,335 | 0 | 0 |
| 16-31 Dec | 6,937 | 6,937 | 0 | 0 |
| 1-15 Jan | 7,393 | 7,393 | 0 | 0 |
| 16-31 Jan | 7,542 | 7,542 | 0 | 0 |
| 1-15 Feb | 7,307 | 7,307 | 0 | 0 |
| 16-29 Feb | 16,397 | 16,397 | 0 | 0 |
| 1-15 Mar | 34,950 | 34,950 | 0 | 0 |
| 16-31 Mar | 165,172 | 49,230 | 115,942 | 11,594 |
| 1-15 Apr | 168,426 | 52,484 | 115,942 | 11,594 |
| 16-30 Apr | 162,472 | 46,530 | 115,942 | 11,594 |
| 1-15 May | 39,614 | 39,614 | 0 | 0 |

*NOTES: Objectives are to maintain the existing extent of foraging habitat in wetlands throughout the non-breeding season, and to add habitat during spring and fall. Objectives are for the entire Central Valley Primary Focus Area (excluding Suisun Basin).*

**TABLE 9.3 Short-term (10-year) and long-term (100-year) habitat objectives for shorebird foraging habitat in managed wetlands during the non-breeding season.** Objectives are summarized for each two-week interval throughout the non-breeding season. Objectives are given in acres, along with current estimates of available foraging habitat in managed wetlands, the estimated additional acres needed to meet the long-term habitat objectives, and the short-term objective of meeting 10% of those acres by 2030.

### Population Objectives

The long-term population objectives are to double baseline shorebird abundances throughout the non-breeding season. These objectives represent the estimated abundances needed to achieve the goal of reducing the impacts of historical wetland habitat losses, thereby contributing to more stable and resilient shorebird populations in the Pacific Americas Flyway. The target shorebird populations increase linearly through the year from the assumed starting point of 50,000 birds on 1 July (CVJV 2006) to 269,100 by 15 August, reach a peak of 666,700 by 15 April, and then decline sharply back to 50,000 by 15 May (Figure 9.2).

# APPLYING THE CONSERVATION OBJECTIVES

## Applying the Habitat Objectives

The habitat objectives were defined based on the simplest habitat management scenario to model: flooding additional wetland acres during the entire shortfall periods. Any new wetlands created and flooded starting in 2016 will contribute to the additional wetland acres needed, since the bioenergetics modeling was based on the estimated wetland extent in 2015. However, only the area of shallow open water available during the entirety of one of the shortfall periods would count as contributing to the habitat objectives. Similarly, changes in the management of existing wetlands could contribute to the habitat objectives, if they are managed to maintain a larger area of shallow open water during the entirety of one of the shortfall periods than was typically provided during 2007–2014 (the years over which average open water availability was estimated).

*Whimbrel - Tom Grey*

Progress toward achieving these habitat objectives can be measured by continuing to track wetland restoration efforts throughout the Central Valley and measuring surface water availability through satellite imagery (e.g., www.pointblue.org/watertracker). Regularly sampling the area of managed wetlands with open water less than 4 inches deep would provide more direct estimates of how shorebird foraging habitat is changing and would help ground-truth the other, more indirect estimates.

In addition to this simplest case, alternate approaches could be used to contribute to the shorebird population objectives. For example, it may be possible to achieve the same outcome by sequentially flooding a smaller number of wetland acres for shorter intervals during the shortfall periods. Similarly, it may be possible to meet the habitat objectives during the shortfall periods by strategically increasing the availability of shorebird foraging habitat in postharvest-flooded crops during the shortfall periods (see BirdReturns sidebar). However, since the energy density available to shorebirds in postharvest-flooded crops is estimated to be lower than that found in managed wetlands, more total acres of foraging habitat in postharvest-flooded crops would be required under this approach. Estimating the contributions of specific dynamic management plans to meeting shorebird energy demands would require additional evaluation using the bioenergetics model (Dybala et al. 2017).

The Plan does not define shorebird habitat objectives for mid-winter because an energy shortfall is not anticipated during this timeframe for the foreseeable future. However, the extent of habitat available mid-winter should not be considered surplus. In the bioenergetics model, winter foraging habitat is crucial in determining how long energy resources will last into the spring. For example, any loss of flooded rice fields mid-winter would put more foraging pressure on food resources in managed wetlands. In turn, this loss could leave less food remaining in managed wetlands in the spring when all the rice and other croplands have been drawn down, and an even larger spring energy shortfall. On the other hand, an increase in flooded agricultural fields mid-winter, or delayed drawdown, could reduce foraging pressure on managed wetlands and preserve more of the food available in managed wetlands to support shorebirds later into the spring.

Any change in the extent of any of the land cover types considered, the proportion flooded, or the proportion of suitable depth for use by foraging shorebirds at any time of the year, would have non-linear, cascading effects on the energy shortfalls and habitat needs later in the non-breeding season, as estimated by the bioenergetics model. The impacts of changes in wetland management or postharvest-flooding practices during any part of the non-breeding season could be evaluated using the bioenergetics model (Dybala et al. 2017).

# ADDITIONAL CONSERVATION CONSIDERATIONS

*Colusa National Wildlife Refuge - Khara Strum*

## Manage for robust regional distribution of habitat

The Plan sets population objectives of doubling the baseline shorebird population throughout the Central Valley, but the relative abundance of individual species and available habitat varies by planning basin (Shuford et al. 1998). Thus, the Plan recommends that wetland restoration and management efforts are distributed across the Central Valley such that habitat is available for shorebirds throughout the region for the entire non-breeding season. This approach will increase the likelihood that all shorebird species in the Central Valley will benefit from conservation efforts, as will people and communities throughout the region. Further, distributing habitat across the Central Valley limits reliance on a single area; allows wildlife to select habitat from a broader range of environmental conditions (e.g., climate conditions, predator abundance, or disturbance from human activity); and builds in redundancy that would increase the resilience of shorebird populations and wetland ecosystem services in the face of environmental disasters in one area (Redford et al. 2011; Biggs et al. 2012).

## Match managed water levels to specific needs

For planning purposes, the objectives simplify what is considered available foraging habitat (open water less than 4 inches deep). Some practical considerations for providing this habitat in managed wetlands are provided in Hickey et al. (2003), including: 1) coinciding drawdown of wetlands to match periods of peak shorebird abundance, 2) fluctuating water levels in wetlands throughout the winter and spring to mimic historic hydrology (Isola 1998), and 3) designing wetlands with varied topography within and among management units so that water depths suitable for use by most shorebirds are provided even as water levels in the wetlands vary throughout the non-breeding season.

## SUCCESS STORY

# BIRDRETURNS HABITAT PROGRAM

Non-breeding shorebirds require adequate foraging habitat across a long season (July to May), in a dynamic landscape subject to ever-changing precipitation and crop planting patterns. Recognizing the need for a flexible, short-term habitat incentive program to effectively meet conservation objectives, The Nature Conservancy launched BirdReturns in 2014. This program financially compensates landowners who provide short-term foraging habitat in the fall and spring "shoulder" seasons, which are critical to shorebirds that migrate through or overwinter in the Central Valley.

The amount, location, and timing of BirdReturns habitat changes every season in response to changes in Valley-wide habitat availability and landowners' ability to cost-effectively create good habitat conditions. BirdReturns effectively rents off-season agricultural land to serve as shorebird habitat where and when it is needed.

Since the program launched, 50,000 acres have been conserved during one or more shoulder seasons. And the program is effective. For example, by providing habitat in rice fields during migration, the program documented some of the highest average shorebird densities ever recorded for agriculture in the region (Golet et al. 2018). BirdReturns lands provide a small, more flexible complement to other short-term conservation programs and more permanent habitat on wildlife refuges and private lands.


1


2

3

4

*(1) Ideal shorebird foraging habitat, provided by BirdReturns program - The Nature Conservancy, Greg Golet (2) Rice straw being managed by rolling to mix with water and soil - California Waterfowl Association (3) Long-billed dowitchers and dunlin, foraging in postharvest-flooded agricultural field - Ryan DiGaudio (4) Long-billed dowitchers - Brian Gilmore*

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# 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.

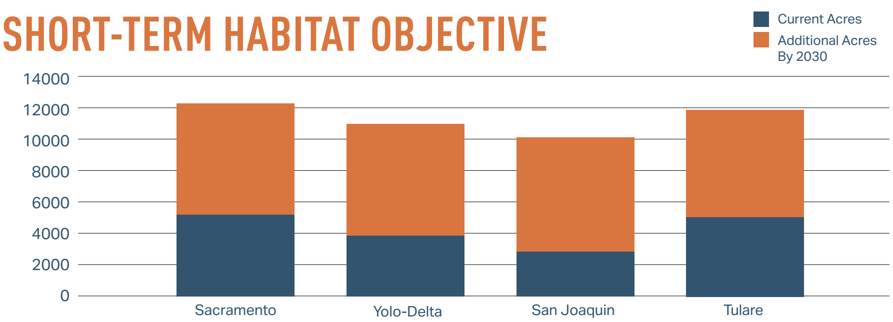
This chapter describes the process for developing conservation objectives for permanent and semi-permanent wetlands needed to support genetically robust, self-sustaining, ecologically functional, and resilient populations of breeding shorebirds in the Central Valley. Habitat objectives are based on population 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.


## 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.

**SHORT-TERM HABITAT OBJECTIVE:**

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

**TOTAL BREEDING SHOREBIRD HABITAT IN 10 YEARS:**

## 45,800 ACRES

**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.**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*(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** (*Himantopus mexicanus*) | LC | Moderate |
| **American avocet** (*Recurvirostra americana*) | MCCV | -- |
| **Killdeer** (*Charadrius vociferous*) | 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.

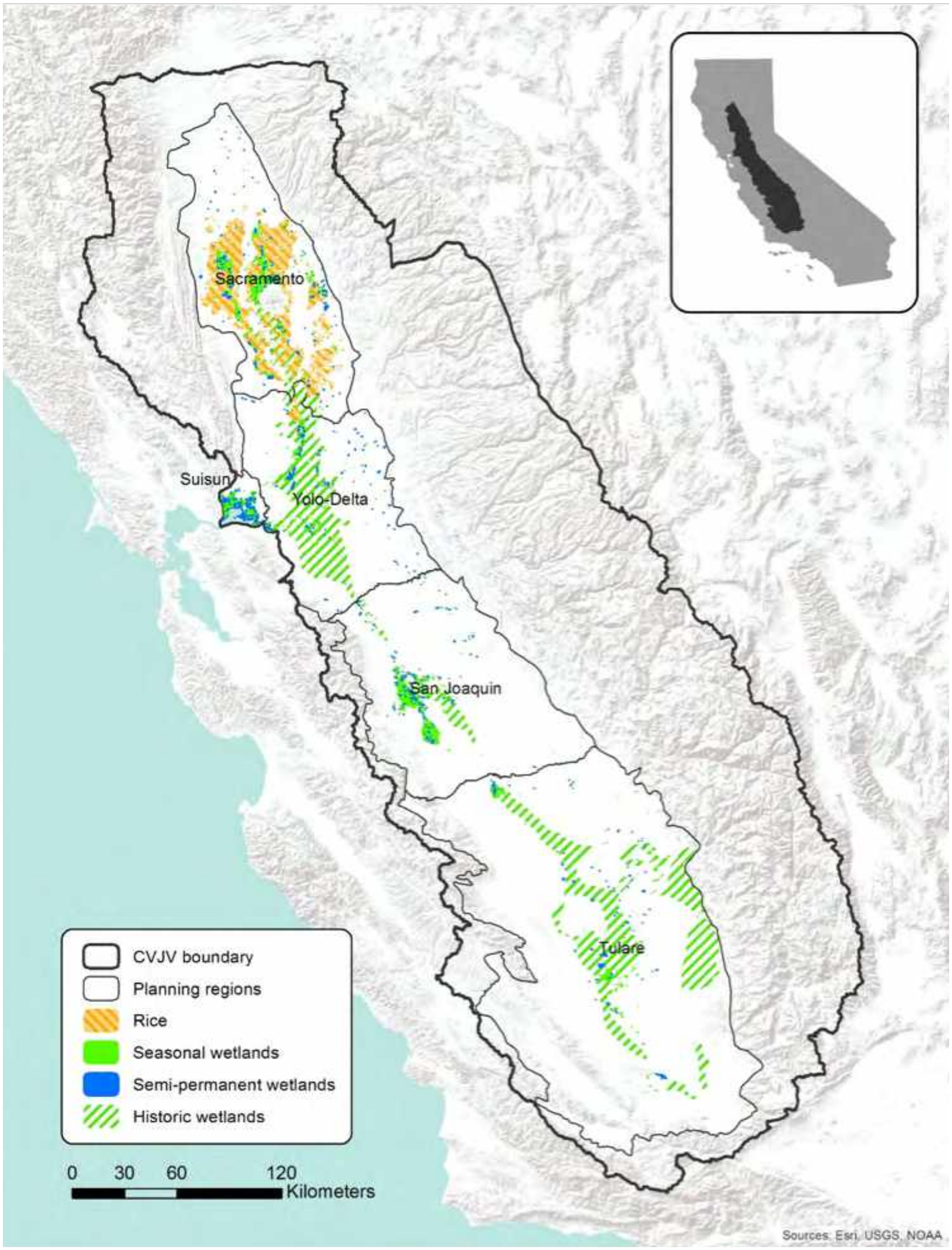


**FIGURE 10.1 Central Valley Joint Venture perimeter and Primary Focus Area**, showing estimated current extent of managed wetlands and rice agriculture and estimated historical (pre-1900) extent of wetlands.

# 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).

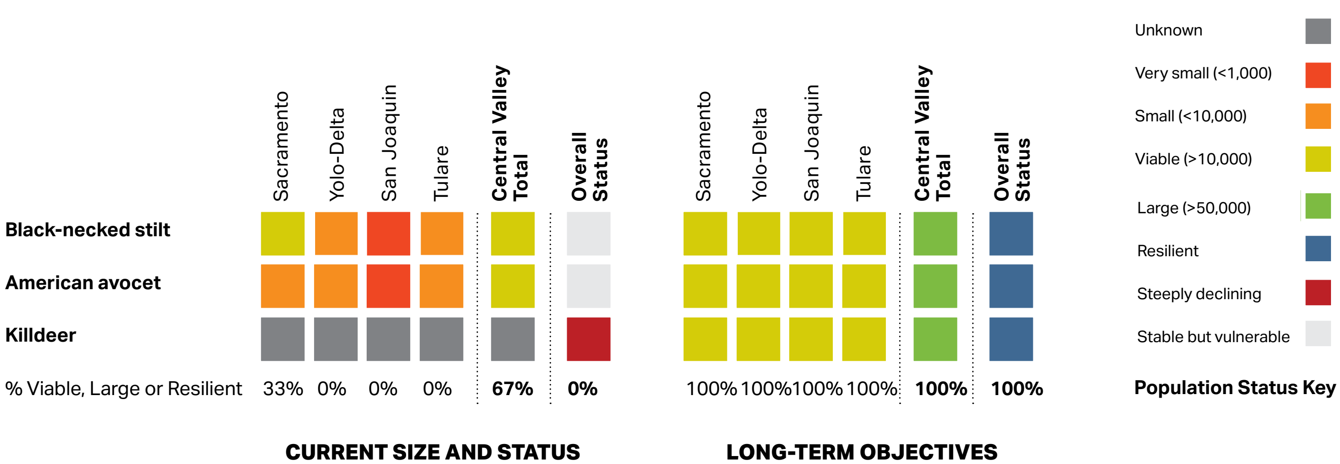


**FIGURE 10.2 Population status and objectives for breeding shorebirds in the Central Valley.**

# 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.


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

### 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.

### 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.

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# LITERATURE CITED


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# BREEDING AND NON-BREEDING WATERBIRDS 11

# CHAPTER SUMMARY


Central Valley wetlands play a vital role for North American waterbirds and provide a multitude of benefits to people. Although less than 10% of the Central Valley's historical wetland acreage remains, this region still supports populations of a diverse array of waterbird species.

This chapter describes the conservation objectives for the restoration and enhancement of wetlands, flooded croplands, and adjacent riparian forest needed to support robust populations of waterbird species in the Central Valley. The goal is to reverse historical population declines of these species. The chapter uses population objectives for a group of 10 representative species to determine overall habitat needs for waterbirds.

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 OBJECTIVE (CURRENT + ADDITIONAL):

**869,300 ACRES OF HIGH-QUALITY WATERBIRD HABITAT**

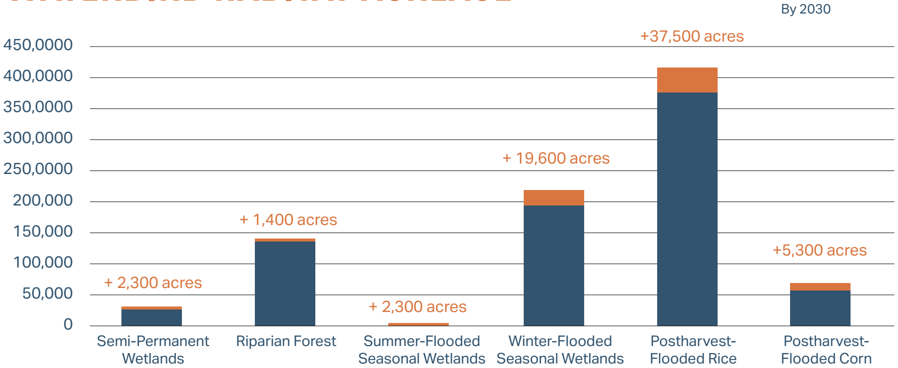
## WHAT'S NEEDED?

**68,300 ADDITIONAL ACRES**

## HABITAT TYPE

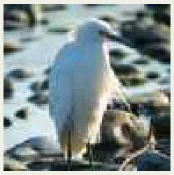
Waterbirds in the Central Valley use a wide variety of habitat types, but mainly semi-permanent and seasonally flooded wetlands, postharvest-flooded rice and corn fields, and adjacent riparian forests. Within these habitats, various bird species may respond differently to particular water depths, vegetation structure and extent, season of flooding, degree of human presence, and other factors.

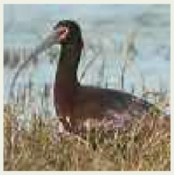
## WATERBIRD HABITAT ACREAGE



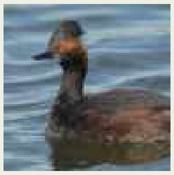

## BIRD SPECIES INCLUDE:

**Representative waterbird species in the Central Valley:**

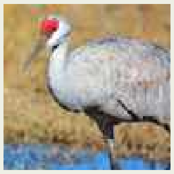

Snowy egret*


White-faced ibis*

**Species of heightened conservation concern:**


Eared grebe**


Forster's tern**


Sandhill crane***


Black rail****

*Image: Brian Gilmore **Image: Tom Grey ***Image: Steve J. McDonald ***Image: Philip Robertson

(1) Snowy egret - Tom Grey (2) Central Valley wetlands - Anders Ericsson and Lighthawk (3) Western grebe - Tom Grey

## HABITAT SUCCESS STORIES

since the 2006 Implementation Plan

Stone Lakes National Wildlife Refuge provides important foraging and roosting habitat for greater and lesser sandhill cranes during their non-breeding season. Progress over the last decade includes:

- 240 acres of suitable crane habitat added to the refuge
- Habitat enhancement completed for 80 acres of wetlands
- Number of cranes has increased: from two cranes in 1999, to 710 in 2010, to more than 1000 roosting cranes in 2015

# INTRODUCTION

**Historically, the Central Valley supported a diverse and abundant community of wetland-dependent birds, including waterfowl, shorebirds, and a group referred to here as waterbirds. This group includes loons, grebes, pelicans, cormorants, herons, egrets, night-herons, rails, coots, cranes, gulls, and terns. Despite the loss of more than 90 percent of its historical wetlands (Frayer et al. 1989), the Central Valley remains of continental importance for waterbirds (Shuford 2014a; Shuford 2014b), many of which have special conservation status at either the state or federal level.**

Waterbirds in the Central Valley use a wide variety of habitats, including managed and tidal wetlands, agricultural lands, riparian forest, and a range of water bodies. Protecting, restoring, and enhancing these habitats for waterbirds will also provide habitat for a broad suite of other animals and plants. These actions can also benefit people in surrounding communities by reducing flood risk, improving air and water quality, recharging groundwater, sequestering carbon, providing recreational opportunities, and attracting wildlife watchers who help support local economies.

In addition to facing habitat loss and degradation, waterbirds across North America are subject to a wide range of other threats, including contaminants, disease, and non-native predators. Sea-level rise and increasing prevalence of drought and other extreme weather patterns projected for the 21st century also threaten waterbirds (Kushlan et al. 2002; Shuford 2014a). The North American Waterbird Conservation Plan (Kushlan et al. 2002) provides a continental vision for the conservation of waterbirds. The Coastal California (BCR 32) Waterbird Conservation Plan, which encompasses the Central Valley in addition to central and southern coastal California (Shuford 2014a), provides regional conservation goals and objectives. These plans helped guide the development of the CVJV's conservation goals and objectives for breeding and non-breeding waterbirds.

The CVJV has established conservation objectives for habitat restoration and enhancement and for target population sizes of a representative suite of waterbird species. Improving and increasing habitat for these species will provide widespread benefits for waterbirds of all kinds in the region. This chapter explains these conservation objectives and how they can be applied to reach the conservation goals.

## CONSERVATION GOAL

**The Central Valley Joint Venture's long-term goals are to restore and enhance more waterbird habitat in the Central Valley and to reverse historical declines of waterbird populations in this region.**


1


2

*(1) White-faced ibis flock - Sara Miller (2) Sandhill cranes flying over wetlands - Tom Grey*

# WHICH SPECIES ARE INCLUDED?

The conservation objectives focus on 10 waterbird species that occur regularly in the Central Valley during either the breeding or non-breeding season (Table 11.1). These include eight species of heightened conservation concern and two additional species (snowy egret and white-faced ibis) chosen for additional representation of key habitat attributes. These focal species collectively represent the habitat needs of a broad range of waterbird species in this region. Managing habitat to support local populations of these species will likewise support diverse and healthy ecosystems (Chase and Geupel 2005).

*American white pelican - Tom Grey*

| SPECIES (*SCIENTIFIC NAME*) | CONSERVATION STATUS[a] | HABITAT ASSOCIATIONS | |
|---|---|---|---|
| | | BREEDING SEASON (MARCH – JULY) | NON-BREEDING SEASON |
| **Eared grebe** (*Podiceps nigricollis*) | WCP-32, NAWCP | Semi-permanent and summer-flooded seasonal wetlands | Semi-permanent and seasonal wetlands |
| **Western grebe** (*Aechmophorus occidentalis*) | WCP-32, NAWCP | Semi-permanent wetlands | Semi-permanent wetlands |
| **California black rail** (*Laterallus jamaicensus*) | ST, BCC, WCP-32, NAWCP | Semi-permanent wetlands | Semi-permanent wetlands |
| **Sandhill crane** (*Antigone canadensis*) | ST[b], BSSC[c], WCP-32 | NA | Forages in postharvest dry and flooded corn and rice, other cereal grains, alfalfa, pasture, and seasonal wetlands. Nighttime roosts are in shallowly flooded seasonal wetlands and agricultural fields. |
| **Black tern** (*Chlidonias niger*) | BSSC, WCP-32, NAWCP | Rice and summer-flooded seasonal wetlands | NA |
| **Forster's tern** (*Sterna forsteri*) | WCP-32, NAWCP | Semi-permanent and summer-flooded seasonal wetlands | NA |
| **American white pelican** (*Pelecanus erythrorhynchos*) | BSSC, NAWCP | NA | Semi-permanent wetlands |
| **Least bittern** (*Ixobrychus exilis*) | BSSC, WCP-32, NAWCP | Semi-permanent wetlands | NA |
| **Snowy egret** (*Egretta thula*) | NAWCP | Nests in riparian forest (or residential trees); forages in semi-permanent and summer-flooded seasonal wetlands, rice, and other irrigated crops and pasture | Roosts in riparian forest; forages in semi-permanent and seasonal wetlands, postharvest-flooded rice, and other irrigated crops and pasture |
| **White-faced ibis** (*Plegadis chihi*) | | Nests in semi-permanent wetlands; forages in semi-permanent and summer-flooded seasonal wetlands, rice, alfalfa, and other irrigated crops and pasture | Roosts in semi-permanent and seasonal wetlands; forages in semi-permanent and seasonal wetlands, postharvest-flooded rice, alfalfa and other irrigated or flooded crops and pasture |

[a] *Conservation status designations:* ***ST****, state threatened species (****CDFW*** *2016);* ***BSSC****, California Bird Species of Special Concern (Shuford and Gardali 2008);* ***BCC****, U.S. Fish and Wildlife's Birds of Conservation Concern (****USFWS*** *2008);* ***WCP-32****, species ranked as of high or moderate concern in the Coastal California Waterbird Conservation Plan (Shuford 2014a);* ***NAWMP****, species ranked as of highest, high, or moderate concern by the North American Waterbird Conservation Plan (Kushlan et al. 2002).*
[b] *State threatened status is for the greater sandhill crane (Antigone canadensis tabida).*
[c] *Bird species of special concern status is for the lesser sandhill crane (Antigone canadensis canadensis).*
*NA: Not Applicable*

**TABLE 11.1 Waterbird focal species: Conservation status and habitat associations during the breeding and non-breeding seasons.**

# WHICH GEOGRAPHIC AREAS ARE INCLUDED?

Conservation objectives were defined for each of the five planning regions in the CVJV's Primary Focus Area (Figure 11.1).

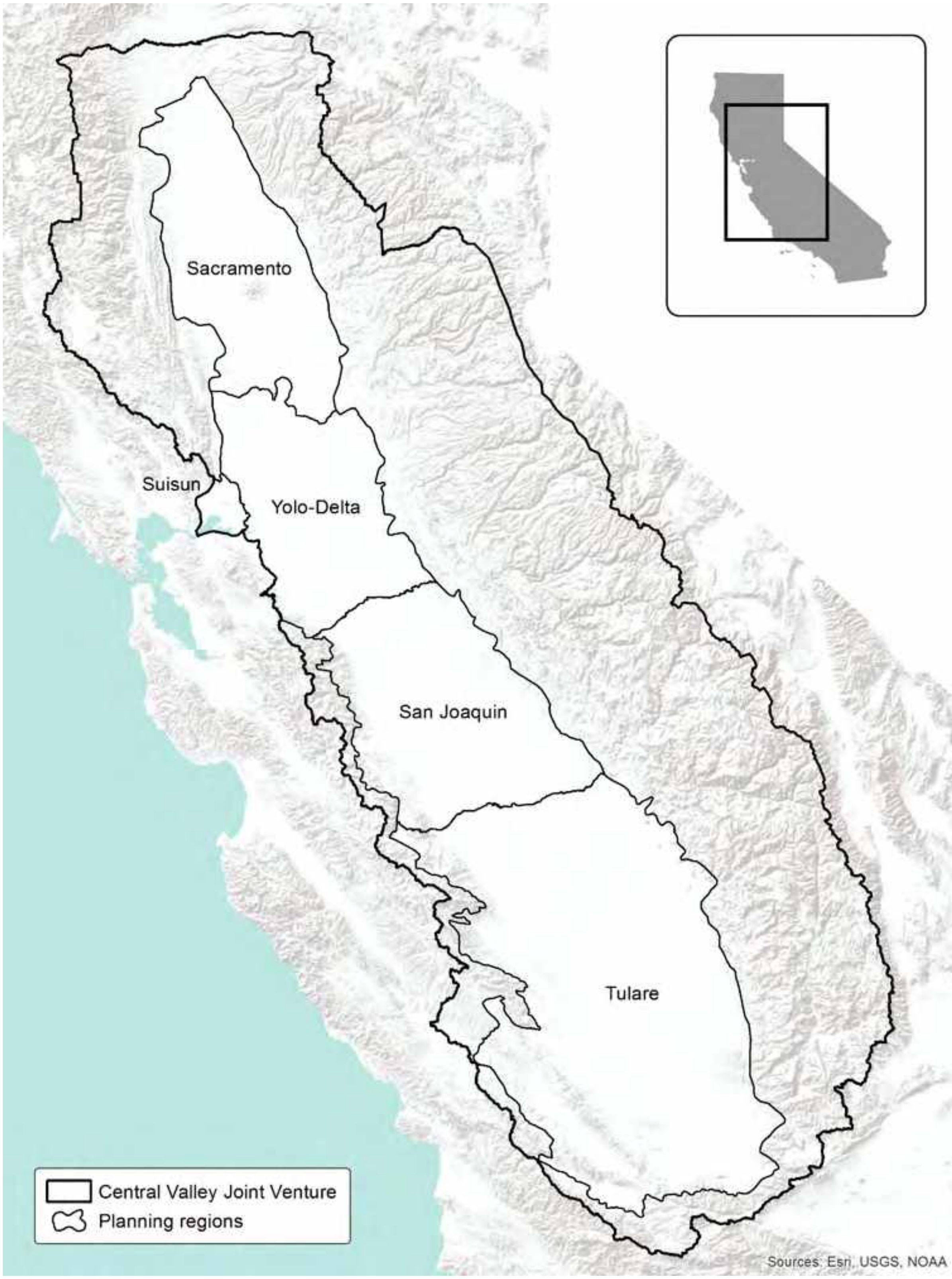



**FIGURE 11.1** Central Valley Joint Venture perimeter and Primary Focus Area, showing the five planning regions.

# CURRENT CONDITIONS

## Current Population Sizes and Trends

The current population sizes and trends of many waterbird species in the Central Valley are unknown. Recent (2010–2012) censuses of colonial nesting waterbirds throughout California (Shuford 2014b) provide data for five of the 10 focal species. These surveys estimated a total of only five breeding pairs of eared grebes and 16 pairs of Forster's terns, versus 755, 996, and 18,005 pairs of snowy egrets, black terns, and white-faced ibis, respectively. The numbers of nesting black and Forster's terns were well below those recorded in the Central Valley in 1998 (Shuford et al. 2016). The reasons for these changes are unknown but likely reflect the effects of recent drought conditions rather than a long-term trend. Waterbird populations in the Central Valley may vary substantially between years with variation in habitat availability, particularly during the breeding season. The CVJV did not find any recent, comparable population size estimates for Central Valley waterbirds during the non-breeding season.

## Current Habitat Conditions

The habitat types currently available to waterbirds in the Central Valley vary seasonally and spatially. During the breeding season, these include an estimated total of 22,800 acres of semi-permanent managed wetlands and 141,600 acres of riparian forest (Table 11.2). Some of the riparian forest is located near suitable waterbird foraging habitat and provides nesting substrate for colonies of breeding herons, egrets, night-herons, and cormorants. Researchers also estimated a 2007–2014 average of 541,400 acres of cultivated rice fields, 94 percent of which falls in the Sacramento planning region. The rice fields provide potential nesting habitat for black terns and foraging habitat for white-faced ibis, egrets, herons, and night-herons.

During the non-breeding season, available habitat types for foraging and roosting include many of the same types available during the breeding season, as well as winter-flooded seasonal wetlands and postharvest-flooded crops. There were an estimated total of 196,400 acres of winter-flooded seasonal wetlands in 2015, concentrated in the Sacramento and San Joaquin planning regions (Table 11.3). Of the 541,400 acres of planted rice, approximately 374,600 acres (69 percent) have open water during the peak of postharvest flooding in early January (Table 11.4). Similarly, there were an estimated 2007–2014 average of 227,600 acres of planted corn in the Yolo-Delta region, of which approximately 52,800 acres (23 percent) have open water during the peak of postharvest flooding in early February. Other suitable crop types planted in the Central Valley add another 2.8 million acres of potential waterbird habitat, depending on the extent and timing of irrigation and any postharvest flooding. These crops include alfalfa, irrigated pasture, field and row crops, and other grains such as winter wheat, triticale, and barley (Table 11.4). However, the estimated peak area of field and row crops and other grains that were flooded, on average, between 2007 and 2011 was just three percent (Dybala et al. 2017).

The assessment of current existing habitat acreage does not include estimates for habitat types not included in the objectives, such as alfalfa, irrigated pasture, various grain crops, field and row crops, flood-water storage or recharge facilities, freshwater reservoirs, lakes, ponds, and agricultural evaporation and wastewater treatment ponds.

# DEVELOPING THE CONSERVATION OBJECTIVES

## Population Objectives

Historical population sizes and long-term trends of waterbirds in the Central Valley are unknown. Because at least 90 percent of the Central Valley's historical wetlands have been lost, most waterbird species are likely to have experienced population declines of at least 50 percent over the last 100 years. Therefore, to meet the goal of reversing the impacts of these historical wetland losses, this Implementation Plan (hereafter, "the Plan") set long-term (100-year) conceptual population objectives of doubling the current population sizes (100 percent increase) of most of the waterbird focal species. The corresponding short-term (10-year) objective is to increase population sizes by 10 percent. For species estimated to have relatively very small populations (fewer than 500 breeding individuals), namely the eared grebe and Forster's tern, the long-term objective was increased to tripling current population sizes (200 percent increase), with a corresponding 20 percent increase over the short-term. For the white-faced ibis, which is estimated to have a relatively large population (>20,000 individuals) and an increasing population trend (Shuford et al. 1996; Shuford 2014b), the Plan defined long- and short-term objectives of maintaining current population sizes.

## Habitat Objectives

Waterbirds use a wide range of habitat types in the Central Valley. For this Plan, habitat objectives were defined for the six habitat types with the highest potential for restoration and enhancement: semi-permanent wetlands, riparian forest, summer-flooded seasonal wetlands, winter-flooded seasonal wetlands, postharvest-flooded rice, and postharvest-flooded corn.

The Plan does not call for the creation or enhancement of new lakes, ponds, reservoirs, rivers, or agricultural canals, or for crops (e.g., alfalfa, irrigated pasture, summer-flooded growing rice) for which there appears to be limited capacity or opportunity to increase their extent or enhance their suitability for waterbirds. The Plan also recognizes that the extent of cultivated rice and other crops will vary according to market forces and climatic conditions (e.g., drought). In addition, habitat objectives were not defined for nesting habitat in evaporation ponds or waste-water treatment ponds due to concerns about contaminants and disease. There still may be conservation opportunities in each of these habitat types, however, such as enhancing nesting habitat for grebes in lakes, ponds, and reservoirs (Table 11.5).

Short-term habitat objectives were defined by hypothesizing that meeting the short-term population objective of a 10 percent increase in most of the populations of waterbird focal species would likely require a 10 percent increase in the total area of each of the six key habitat types. Further research will be required to test this hypothesis by quantifying current waterbird population sizes and tracking whether increases in habitat directly correspond to increases in population size. In the meantime, short-term habitat objectives were defined as a 10 percent increase (acres needed) for most key habitat types. Because summer-flooded seasonal wetlands are currently rare and their extent unknown, the short-term habitat objective for this cover type was set to be equivalent to the acres needed for semi-permanent wetlands. In addition, because the specific location of riparian vegetation is more limiting than its total acreage, the habitat objective for riparian forests was set as a 1 percent increase, that should be strategically located adjacent to waterbird foraging habitat.

Portions of each habitat objective were then assigned to each of the five planning regions. For winter-flooded seasonal wetlands and postharvest-flooded rice and corn, these were simple 10 percent increases in the existing habitat estimated for each region. For semi-permanent wetlands, riparian vegetation, and summer-flooded seasonal wetlands, larger proportions of the overall habitat objective were assigned to the San Joaquin and Tulare planning regions, where there is the greatest need for improvement. In addition, objectives for more extensive increases in semi-permanent and summer-flooded seasonal wetlands in these planning regions will benefit eared grebes and Forster's terns, the two focal species with very small breeding populations and the most ambitious relative population objectives.

Extending this general approach leads to the assumption that meeting the long-term objectives of doubling the populations of most waterbird focal species would require long-term habitat objectives of doubling the extent of corresponding habitats. At this time, however, the Plan is focusing only on the short-term habitat objectives, given the uncertainty in the current population sizes and trends of the focal species and in the relationship between increases in habitat and increases in waterbird population size.

Additional details on the sources of data, methods, results, and references relative to setting conservation objectives for waterbirds in the Central Valley can be found in Shuford and Dybala (2017).

*(1) White-faced ibis flock - R. McLandress (2) Fledgling Forster's tern - Tom Grey*

# CONSERVATION OBJECTIVES

## Habitat Objectives

The Plan defines short-term (10-year) habitat objectives for each of six key habitat types used by waterbirds during either the breeding or non-breeding seasons for nesting, roosting, and/or foraging (Tables 11.2 and 11.3). These objectives represent the estimated total extent of each habitat type required to meet the short-term population objectives.

The key waterbird habitat types include:

- Semi-permanent wetlands, used year-round for nesting, roosting, and foraging. Some of these target increases are in addition to the wetland habitat objectives for waterfowl and shorebirds.

- Riparian forest, used year-round for nesting and roosting during the breeding season and roosting during the non-breeding season. These objectives are not in addition to the objectives for riparian landbirds, but should be strategically placed adjacent to waterbird foraging habitat (i.e., wetlands and irrigated crops and pasture).

- Summer-flooded seasonal wetlands (also called “reverse-cycle” wetlands), used during the breeding season for nesting, foraging, and roosting. These objectives may have to be increased to account for year-to-year fluctuations in availability of this habitat type (see Applying the Conservation Objectives).

- Winter-flooded seasonal wetlands, used during the non-breeding season for roosting and foraging.

- Postharvest-flooded rice and corn fields, used during the non-breeding season for roosting and foraging. The objectives for these two habitat types assume no change in the average annual extent of rice and corn planted (Table 11.4), but rather an enhancement of these cover types by increasing the proportion that is flooded postharvest.

*Gray Lodge Wildlife Area - Brian Gilmore*

| **HABITAT TYPE** PLANNING REGION | **SHORT-TERM HABITAT OBJECTIVE** | **CURRENT ESTIMATE** | **ACRES NEEDED BY 2030** (difference) |
|---|---|---|---|
| **Semi-Permanent Wetlands** | | | |
| **Sacramento** | 5,575 | 5,348 | 228 |
| **Yolo-Delta** | 4,238 | 4,010 | 228 |
| **Suisun** | 5,722 | 5,494 | 228 |
| **San Joaquin** | 3,668 | 2,872 | 796 |
| **Tulare** | 5,830 | 5,034 | 796 |
| **Total** | **25,033** | **22,758** | **2,276** |
| **Riparian Forest** | | | |
| **Sacramento** | 70,022 | 67,897 | 213 |
| **Yolo-Delta** | 34,995 | 32,869 | 213 |
| **Suisun** | 1,408 | 0 | 141 |
| **San Joaquin** | 29,198 | 24,949 | 425 |
| **Tulare** | 20,144 | 15,893 | 425 |
| **Total** | **155,768** | **141,608** | **1,416** |
| **Summer-Flooded Seasonal Wetlands**[a] | | | |
| **Sacramento** | 228 | – | 228 |
| **Yolo-Delta** | 228 | – | 228 |
| **Suisun** | 0 | – | 0 |
| **San Joaquin** | 682 | – | 682 |
| **Tulare** | 1,138 | – | 1,138 |
| **Total** | **2,276** | **–** | **2,276** |

*[a] Although there do not appear to be any estimates for the extent or distribution of summer seasonal wetlands in the Central Valley, this type of wetland generally appears to be rare in the region overall.*

**TABLE 11.2 Short-term (10-year) habitat objectives for waterbirds: year-round or breeding season.** Breeding season is mainly March–July. Objectives (in acres) are shown by planning region along with current estimates of each habitat type and the estimated additional acres needed to meet the habitat objectives. (Sums may not be exact, due to rounding in original data.)

| **HABITAT TYPE** PLANNING REGION | **SHORT-TERM HABITAT OBJECTIVE** | **CURRENT ESTIMATE** | **ACRES NEEDED** (DIFFERENCE) |
|---|---|---|---|
| **Winter-Flooded Seasonal Wetlands** | | | |
| **Sacramento** | 75,344 | 68,495 | 6,849 |
| **Yolo-Delta** | 24,150 | 21,955 | 2,195 |
| **Suisun** | 31,628 | 28,752 | 2,876 |
| **San Joaquin** | 64,213 | 58,375 | 5,837 |
| **Tulare** | 20,718 | 18,834 | 1,884 |
| **Total** | **216,053** | **196,411** | **19,641** |
| **Postharvest-Flooded Rice** | | | |
| **Sacramento** | 391,395 | 355,814 | 35,581 |
| **Yolo-Delta** | 20,690 | 18,809 | 1,881 |
| **Suisun** | 0 | 0 | 0 |
| **San Joaquin** | 0 | 0 | 0 |
| **Tulare** | 0 | 0 | 0 |
| **Total** | **412,085** | **374,623** | **37,462** |
| **Postharvest-Flooded Corn** | | | |
| **Sacramento** | 0 | 0 | 0 |
| **Yolo-Delta** | 58,084 | 52,804 | 5,280 |
| **Suisun** | 0 | 0 | 0 |
| **San Joaquin** | 0 | 0 | 0 |
| **Tulare** | 0 | 0 | 0 |
| **Total** | **58,084** | **52,804** | **5,280** |

**TABLE 11.3 Short-term (10-year) habitat objectives for waterbirds: Non-breeding season.** Objectives (in acres) are shown by planning region, along with current estimates of the peak availability of each habitat type during the non-breeding season and the estimated additional amount needed to meet the habitat objectives. For postharvest-flooded rice and corn, the peak availability is less than the total extent planted (Table 11.4) because it includes only the proportion that has open water during the non-breeding season. Note that objectives for semi-permanent wetlands and riparian vegetation (Table 11.2) also contribute to habitat during the non-breeding season. (Sums may not be exact, due to rounding in original data.)

## Population Objectives

The Plan defines long-term (100-year) population objectives of doubling (100 percent increase) the population sizes of most of the focal species; tripling (200 percent increase) populations of the eared grebe and Forster's tern, and maintaining the current population sizes of the white-faced ibis. Corresponding short-term (10-year) objectives are increases of 10 percent and 20 percent for the grebe and tern, respectively, and no increase for the ibis. These objectives represent current estimates of the population sizes needed to achieve the goal of reversing the impacts of historical habitat losses and degradation on waterbird populations in the Central Valley. However, these population objectives are not currently quantifiable because the current population sizes of many waterbird species in the Central Valley are unknown. Thus, these population objectives are solely conceptual, used to estimate the increase in habitat required to double or triple current population sizes.

| **PLANNING REGION** | **RICE** | **CORN** | **ALFALFA** | **IRRIGATED PASTURE** | **OTHER GRAINS** | **FIELD AND ROW CROPS** |
|---|---|---|---|---|---|---|
| **Sacramento** | 509,873 | 33,350 | 47,274 | 24,083 | 75,960 | 135,389 |
| **Yolo-Delta** | 26,953 | 227,626 | 162,887 | 24,950 | 162,395 | 176,283 |
| **Suisun** | 0 | 17 | 220 | 1,737 | 4,407 | 154 |
| **San Joaquin** | 4,536 | 143,178 | 176,839 | 35,818 | 127,444 | 334,006 |
| **Tulare** | 0 | 202,761 | 251,693 | 67,937 | 352,854 | 687,365 |
| **Total** | **541,362** | **606,932** | **638,915** | **154,525** | **723,061** | **1,333,198** |

**TABLE 11.4 Estimated total area of crops potentially compatible for waterbird habitat.** Estimates (in acres) shown by planning region and for crops that could be used by waterbirds, depending on the extent and timing of flooding or other management efforts. The estimate for irrigated pasture is from 2013; all other estimates represent the 2007–2014 average. (Sums may not be exact, due to rounding in original data.)

# APPLYING THE CONSERVATION OBJECTIVES

## Habitat Objectives

Because the understanding of waterbird population sizes and dynamics is uncertain, the Plan focuses on short-term objectives. For the flooded habitat types, the objectives represent the total extent that will need to be reliably flooded every year by the end of the 10-year period, i.e., current acres plus additional acres needed, assuming none of the current acreage is lost. These additional acres can be achieved through restoration and, in some cases, through enhancement as described below.

For the purposes of this Plan, "habitat restoration" means conversion of land that does not currently consist of the target land cover type into that cover type. For seasonal and semi-permanent wetlands, this includes creating and flooding new wetlands (measured from 2015, the most recent estimate for the extent of Central Valley managed wetlands). For riparian forest, this includes establishing new areas with native riparian-associated shrubs and trees (measured from 2012, the year of the most recent riparian vegetation GIS layer). The acreage of new wetlands that are reliably flooded, and new riparian habitat created by a restoration project adjacent to waterbird foraging habitat, would both count as contributing to the waterbird habitat objectives.

"Habitat enhancement," in this situation, indicates increasing the extent of flooding of existing habitat, making it more available and more useful to waterbirds. For rice and corn, this includes increasing the proportion of planted croplands that are regularly flooded postharvest.

Similarly, the additional acres of summer-flooded seasonal wetlands can be met through restoration or by opportunistically flooding dormant wetlands or fallow agricultural fields in years of exceptional runoff (when water is freely available). Managing summer-flooded seasonal wetlands can be costly due to high evaporation rates, rapid vegetation growth, and mosquito abatement. Therefore, it may be more feasible to provide summer seasonal wetlands opportunistically. In this case, the habitat objectives for summer seasonal wetlands should be increased to make up for the lack of this habitat type in most years. For example, if such conditions occur only once every 10 years, the habitat objectives would be increased 10-fold.

*Suisun Marsh - Steve Martarano/USFWS*

The CVJV can track overall progress toward the semi-permanent and seasonal wetland objectives through a combination of tracking wetland restoration projects and recording satellite imagery of surface water to estimate the area flooded. Similarly, progress toward the postharvest-flooded rice and corn objectives can be tracked through a combination of National Agricultural Statistics Service surveys and satellite imagery of surface water. Overall progress toward the riparian habitat objectives can be tracked through updates to California Department of Fish and Wildlife vegetation GIS layers (http://www.dfg.ca.gov/biogeodata/bios/dataset_index.asp).

*(1) Greater sandhill crane - Steve J. McDonald (2) Lesser sandhill cranes - Bruce Miller, Elk Grove, CA (3) Birdwatchers - Shelley Hammon*

## SUCCESS STORY

# SANDHILL CRANE FESTIVAL

Every year in November, thousands of visitors make their way to public wetlands and private farmlands around Lodi, California to see overwintering migratory birds.  The annual festival is timed to coincide with the arrival of thousands of sandhill cranes from their long migratory journey from nesting grounds as far away as Siberia. The cranes remain in the Central Valley through February.

Since 1996, the Lodi Sandhill Crane Festival has helped to promote bird and wetland conservation and connect people with nature in the Central Valley. Significantly, the event also brings an influx of dollars to the area, as bird- and wildlife-watchers pay for hotels, meals and local transportation and support local artists, in addition to paying for the various festival events. This consumer activity provides an incentive to area landowners and voters to protect crane habitat.

The CVJV is one of numerous sponsors of the Lodi Sandhill Crane Festival. This annual event showcases the private/public partnerships that are key to meeting the goals of the CVJV Implementation Plan.

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# ADDITIONAL CONSERVATION CONSIDERATIONS

## Manage habitat for species-specific needs

In addition to meeting the habitat objectives for each of the key waterbird habitat types, achieving the CVJV's long-term goals will require providing specific habitat features required by individual waterbird species. Such requirements may include a particular combination of vegetation cover, water depth, timing of flooding and water level stability, or proximity of foraging habitat to roosting or nesting sites (Table 11.5). For example, American white pelicans require extensive open water ranging from 1 to 8 feet deep with robust fish populations for foraging, whereas California black rails require wetlands with shallow water (less than 1.2 inches deep) and dense vegetation cover.

Also, habitat requirements for particular species may vary among geographic regions of the Central Valley. Consequently, the Plan makes species-specific conservation recommendations that sometimes vary by planning region (Table 11.5). For example, at least half of the wetland habitat acreage in the Sacramento and Yolo-Delta planning regions should have features suitable for black rails, and at least half of the habitat acreage in the Sacramento, San Joaquin, and Tulare planning regions should have features suitable for western grebes or Forster's terns. These specific habitat features do not overlap extensively with those needed by most waterfowl and shorebirds.

Half of the additional semi-permanent wetlands created to meet the habitat objective for each planning region should have features specifically suitable for particular waterbird species. Meeting the needs of all of these waterbird species will likely require coordination of restoration, enhancement, and management across the Central Valley.

*Western grebes performing a courtship dance - Tom Grey*

| FOCAL SPECIES | KEY PLANNING REGIONS | CONSERVATION RECOMMENDATIONS |
|---|---|---|
| **Eared grebe** | San Joaquin<br>Tulare | Provide nesting habitat in shallow wetlands with emergent or surface vegetation for building floating nests and abundant aquatic invertebrates. Avoid botulism outbreaks by rotating wetlands among areas with no prior evidence of disease. Avoid human disturbance of floating nests (e.g., airboats). |
| **Western grebe** | Sacramento<br>San Joaquin<br>Tulare | Provide extensive areas of open, clear water (e.g., reservoirs) with emergent or aquatic vegetation for building floating nests and abundant fish prey. Maintain water levels and establish low-wake zones or enforce closed zones for boats around nesting colonies. Use signage and public outreach to reduce other causes of mortality (e.g., boat propeller strikes, fishing line entanglement). Restore nesting substrates where feasible (Ivey 2004; Robison et al. 2010). |
| **Black rail** | Sacramento<br>(and Sierra Nevada foothills) | Provide shallow (<1.2 inch deep) semi-permanent wetlands (particularly those >0.25 acres) with flowing water and dense vegetation. Avoid overgrazing at spring- or stream-fed marshes, especially during the breeding season (March–July). Maintain and improve wetland connectivity (Richmond et al. 2010, 2012). |
| | Yolo-Delta<br>Suisun | Protect and restore tidally influenced in-stream islands with dense wetland and riparian cover (particularly those >30 acres; Tsao et al. 2015). Maintain or establish upland habitats for escape cover during flood events. |
| **Sandhill crane** | Sacramento<br>Yolo-Delta<br>San Joaquin<br>Tulare | Protect vulnerable roost sites by fee-title acquisition or conservation easements; protect foraging landscapes around existing roosts through easements restricting incompatible crop types and development. Enhance food availability (e.g., waste grain) on conservation lands and encourage crane-friendly management on private lands. Develop new protected roost sites toward the edge of crane use areas to enable them to access additional foraging areas (Ivey et al. 2014). |
| **Black tern** | Sacramento | Maintain sufficient acreage of rice fields for breeding and foraging. Avoid short-term draw-downs of water during the tern breeding season (May-July). |
| | San Joaquin | Create tern nesting habitat primarily in years of exceptional runoff, when it will have the greatest impact (Shuford et al. 2001; Shuford 2008). For example, spread water (~ 5 inches deep) over large areas within the Eastside Bypass near Los Banos and the James Bypass/ Fresno Slough south of Mendota Wildlife Area, or draw water from upstream, circulate it through wetland impoundments, and drain it back into the bypass downstream. Maintain a slow but steady flow to reduce botulism risk. |
| | Tulare | In wet years, flood fields with residual vegetation or crop stubble for use as breeding habitat; retire fields with marginal crop yields and put them in a conservation bank to be flooded when water is available. Avoid botulism outbreaks by rotating wetlands among areas with no prior evidence of disease (Shuford et al. 2001; Shuford 2008). |
| **Forster's tern** | San Joaquin<br>Tulare | Provide semi-permanent wetlands and reservoirs with abundant small fish and features attractive for nesting, including barren, isolated islands and clumps of emergent vegetation surrounded by open water. Reduce human disturbance through signage or by closing zones around nesting islands (Shuford 2010, 2014a). In the Tulare planning region, create tern nesting habitat primarily in years of exceptional runoff, as described for the black tern above. |
| **American white pelican** | All | Provide large and deep (1-8 ft) semi-permanent wetlands with robust fish populations for foraging during late summer through early winter. Also provide isolated loafing and roosting areas, such as islands and gravel bars (Shuford 2014a). |
| **Least bittern** | All | Provide shallow marshes (>25 acres) with dense emergent vegetation, particularly in semi-permanent wetlands already occupied by bitterns. Manage summer wetlands to increase dense emergent vegetation and prevent the spread of invasive plant species (Sterling 2008; Poole et al. 2009). |
| **Snowy egret** | All | Restore riparian woodlands for nest colonies near rice fields, wetlands, or flood-irrigated agriculture for foraging. Protect nest colonies from development, human disturbance, and if needed, excessive nest predation (Kelly 2014). |
| **White-faced ibis** | Sacramento<br>Yolo-Delta<br>San Joaquin<br>Tulare | Provide shallow marshes with tall, open (early successional) emergent vegetation for nesting. Encourage growers to flood-irrigate (particularly pasture and alfalfa) to provide additional foraging habitat, and promote practices that favor earthworms and other invertebrate prey (e.g., organic). Reduce pesticide use, particularly in wintering areas where currently unregulated (Shuford 2014a). |

**TABLE 11.5 Conservation recommendations for waterbird focal species**, by key planning regions.

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# BREEDING RIPARIAN LANDBIRDS

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# CHAPTER SUMMARY

Central Valley riparian areas – land alongside rivers and streams – were severely degraded by the end of the 20th century. Partnerships between landowners, non-profits, and government agencies aimed at restoring and protecting riparian areas have seen success, especially in the last decade.

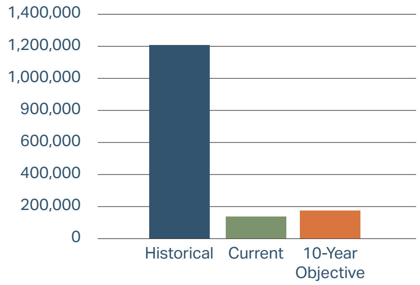
This chapter describes the conservation objectives for riparian habitat restoration and enhancement needed to support self-sustaining, resilient populations of breeding riparian landbirds in the Central Valley. These objectives are based on population and breeding density objectives for a group of 12 focal bird species.

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.

## HABITAT TYPE

Riparian habitats are transitional areas between land and water ecosystems, ranging from swift rapids and waterfalls of steep canyons to slow moving water in floodplains. Riparian vegetation is structurally complex and may contain a canopy, subcanopy, and understory layers.


## RIPARIAN HABITAT ACREAGE




## HABITAT SUCCESS STORIES

since the 2006 Implementation Plan

- A total of 8,102 acres of riparian forest has been restored in the Central Valley since the last CVJV update in 2006. This has increased the total riparian habitat in the Central Valley by approximately 20 percent.
- Counting only large-scale riparian restoration efforts, more than 1.8 million trees and shrubs have been planted across the Central Valley since 2006.
- In 2017, the U.S. Congress approved a boundary expansion for the San Joaquin River National Wildlife Refuge. This expanded boundary now encompasses 34 river miles on both sides of California's second largest river, providing a blueprint for river corridor conservation that benefits the birds of the Pacific Flyway as well as fish and terrestrial wildlife.
- A stable population of yellow warblers has recolonized restored agricultural fields along the San Joaquin River. This species was thought to be locally extinct, with the nearest occurrences more than 40 miles away.

**SHORT-TERM OBJECTIVE (CURRENT + ADDITIONAL):**

## 173,500 ACRES OF HIGH-QUALITY RIPARIAN HABITAT

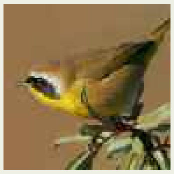
**WHAT'S NEEDED?**

## 32,000 ADDITIONAL ACRES

**BIRD SPECIES INCLUDE:**

Representative bird species in Central Valley riparian habitats:

Black-headed grosbeak*

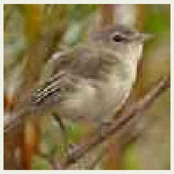


Common yellowthroat*

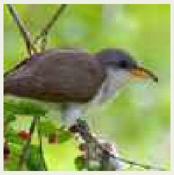
Spotted towhee**

Ash-throated flycatcher*

Species of special concern:



Least Bell's vireo***



Yellow-billed cuckoo****

Bank swallow*****

** Image: Tom Grey ** Image: Stephen Fettig *** Image: Robert A. Hamilton **** Image: Ed Harper ***** Image: Stephen Fettig*

*(1) Common yellowthroat - Tom Grey (2) San Joaquin River NWR - River Partners (3) Lazuli bunting - Tom Grey (4) Dos Rios Ranch and San Joaquin River NWR - River Partners*

# INTRODUCTION

**Riparian areas provide important ecosystem services, recreational opportunities, and habitat for wildlife. The Central Valley was once a vast mosaic of native riparian forest, wetlands, and uplands. Historically, riparian habitat was concentrated along the Sacramento and San Joaquin Rivers and their tributaries, as well as the rivers and streams flowing into the Tulare Basin. By the end of the 20th century, over 95 percent of the Central Valley's historical riparian forest had been lost and almost all the major rivers were dammed and are now highly regulated (Katibah 1984). Several riparian landbird species in this region are endangered, threatened, or have some level of special conservation status. This is an indication that the loss of Central Valley riparian forest has severely degraded conditions for wildlife.**

Protecting, restoring, and managing Central Valley riparian areas can increase habitat connectivity, restore ecosystem processes, and improve ecosystem function. In turn, this provides wildlife habitat and benefits people in the surrounding communities. These benefits include improving water quality, recharging groundwater, reducing flood risk, supporting pollinators and organisms that help control agricultural pests, providing recreational opportunities, increasing property values, and attracting wildlife watchers and hunters who help support local economies.

In recent decades, government agencies and private organizations have worked together to begin restoring riparian ecosystems by planting riparian vegetation, restoring or mimicking natural hydrology, and reconnecting floodplains and habitat fragments (Golet et al. 2008). These efforts are reflected in several major planning or restoration projects that are underway. For example, the San Joaquin River Restoration Program is returning flows to the river with the goal of restoring naturally-producing and self-sustaining populations of salmon and other fish (Matthews 2007). The recently-adopted 2017 Central Valley Flood Protection Plan Update, developed by the California Department of Water Resources, includes a sophisticated Conservation Strategy that is intended to integrate riparian restoration into projects designed to reduce flood risk to Central Valley communities.

The CVJV has established conservation objectives for riparian habitat restoration, and for population size and breeding density of a representative suite of bird species. This chapter explains these conservation objectives and how they can be applied to reach the conservation goal.

## CONSERVATION GOAL

**The Central Valley Joint Venture's long-term goal is for Central Valley riparian ecosystems to have sufficient high-quality riparian habitat to support genetically robust, self-sustaining, and resilient bird populations.**

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*(1) Yellow warbler - Tom Grey (2) Riparian habitat at Bobelaine Sanctuary - Brian Gilmore (3) Riparian habitat - Steve Martarano, USFWS*

# WHICH SPECIES ARE INCLUDED?

The conservation objectives focus on 12 bird species that breed in riparian habitat in the Central Valley and that represent a broad range of life histories and specific habitat needs (Table 12.1). They include species that have or warrant special management status or have experienced population declines or reductions in breeding range in the Valley, and/or species that are useful for monitoring the effects of management actions in Valley riparian ecosystems.

For some species, this is because they are common enough to provide sufficient sample sizes for analyses. Managing riparian habitat to support local populations of this full suite of focal species should, in turn, support diverse and healthy riparian ecosystems (Chase and Geupel 2005).

*Nuttall's woodpecker - Tom Grey*

| **SPECIES** (*SCIENTIFIC NAME*) | **CONSERVATION STATUS**[a] | **MIGRATORY STATUS** | **NEST SUBSTRATE** | **HABITAT & VEGETATION ASSOCIATIONS** |
|---|---|---|---|---|
| **Yellow-billed cuckoo** (*western distinct population segment*) (*Coccyzus americanus*) | FT, SE, CCV | Migrant | Tree | Large contiguous patches of riparian forest, especially cottonwood-willow |
| **Nuttall's woodpecker** (*Picoides nuttallii*) | -- | Resident | Tree, 1° cavity | Mature riparian woodland |
| **Ash-throated flycatcher** (*Myiarchus cinerascens*) | -- | Migrant | Tree, 2° cavity | Mature, open riparian woodland |
| **Least Bell's vireo** (*Vireo bellii pusillus*) | FE, SE, CCV | Migrant | Shrub | Dense, shrubby early- to mid-successional riparian |
| **Bank swallow** (*Riparia riparia*) | ST | Migrant | Burrow | Cut banks, dependent on meander migration, colonial breeder |
| **Spotted towhee** (*Pipilo maculatus*) | -- | Resident | Ground | Dense understory and ground cover |
| **Song sparrow** (*Melospiza melodia*) | BSSC[b], CCV[b] | Resident | Herb, Shrub | Dense understory |
| **Yellow-breasted chat** (*Icteria virens*) | BSSC | Migrant | Shrub | Dense, shrubby riparian thickets |
| **Common yellowthroat** (*Geothlypis trichas*) | -- | Migrant | Herb, Shrub | Dense understory and ground cover, especially near river edges and wetlands |
| **Yellow warbler** (*Setophaga petechia*) | BSSC | Migrant | Shrub | Riparian thickets, especially willows |
| **Black-headed grosbeak** (*Pheucticus melanocephalus*) | -- | Migrant | Tree | Complex habitat with large trees and dense understory |
| **Lazuli bunting** (*Passerina amoena*) | -- | Migrant | Herb, Shrub | Open scrubby and early-successional riparian, edges |

*[a] Conservation status designations: FE, FT, federally endangered or threatened species; SE, ST, state endangered or threatened species; BSSC, state bird species of special concern; and CCV, species ranked among the most vulnerable to climate change (Gardali et al. 2012).*
*[b] In the Central Valley, only the Suisun and Modesto subspecies are considered species of special concern or ranked as climate change vulnerable.*

**TABLE 12.1 Riparian focal species:** Conservation status and habitat associations during the breeding season.

# WHICH GEOGRAPHIC AREAS ARE INCLUDED?

Conservation objectives were defined for four of the five planning regions in the CVJV's Primary Focus Area, excluding Suisun: Sacramento, Yolo-Delta, San Joaquin, and Tulare (Figure 12.1). Suisun was excluded for its lack of freshwater riparian habitat.

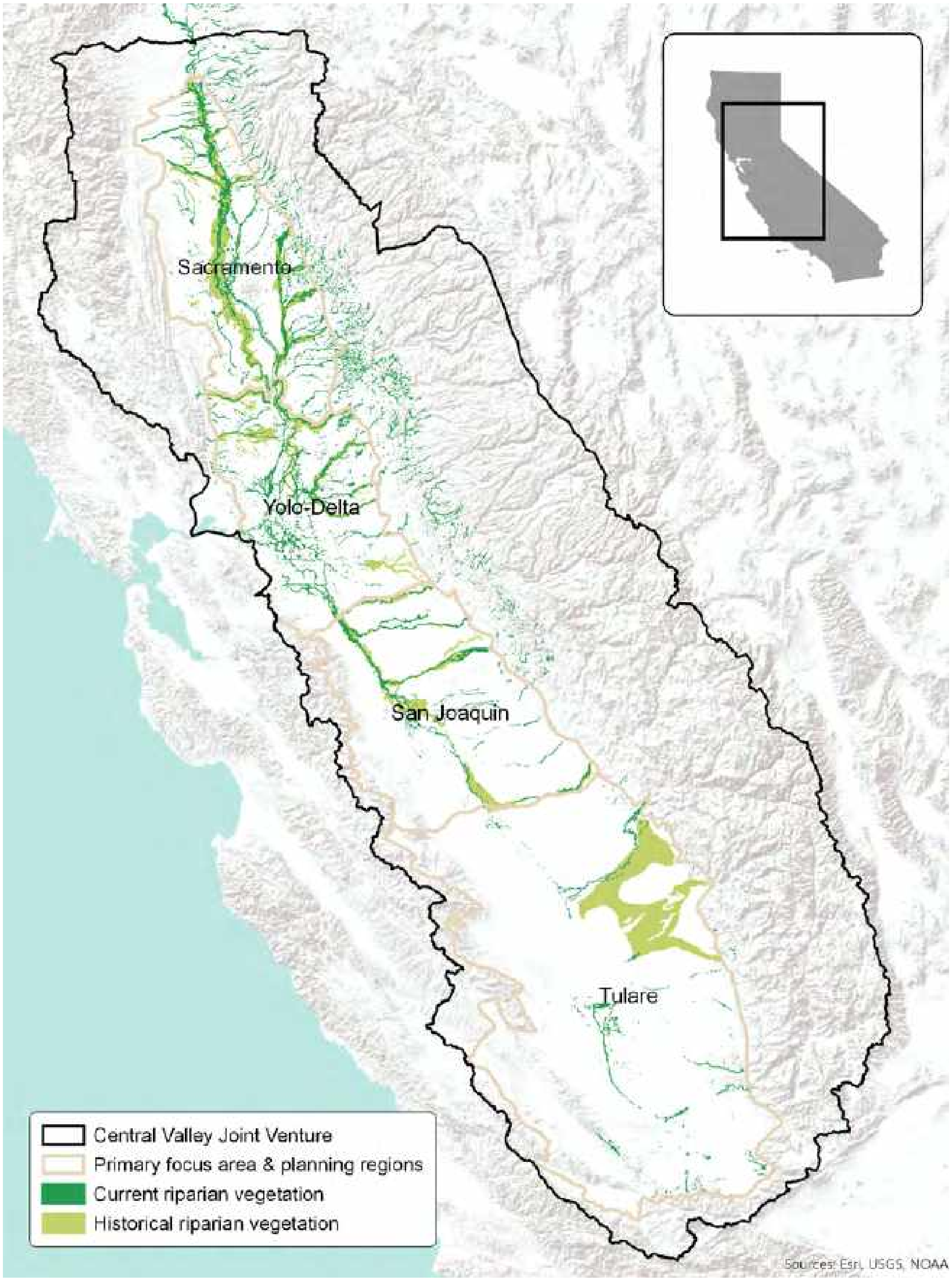



**FIGURE 12.1 Central Valley Joint Venture perimeter and Primary Focus Area, divided into planning regions. Also shown are estimated areas of historical (pre-1900) and current riparian vegetation.**

# CURRENT CONDITIONS

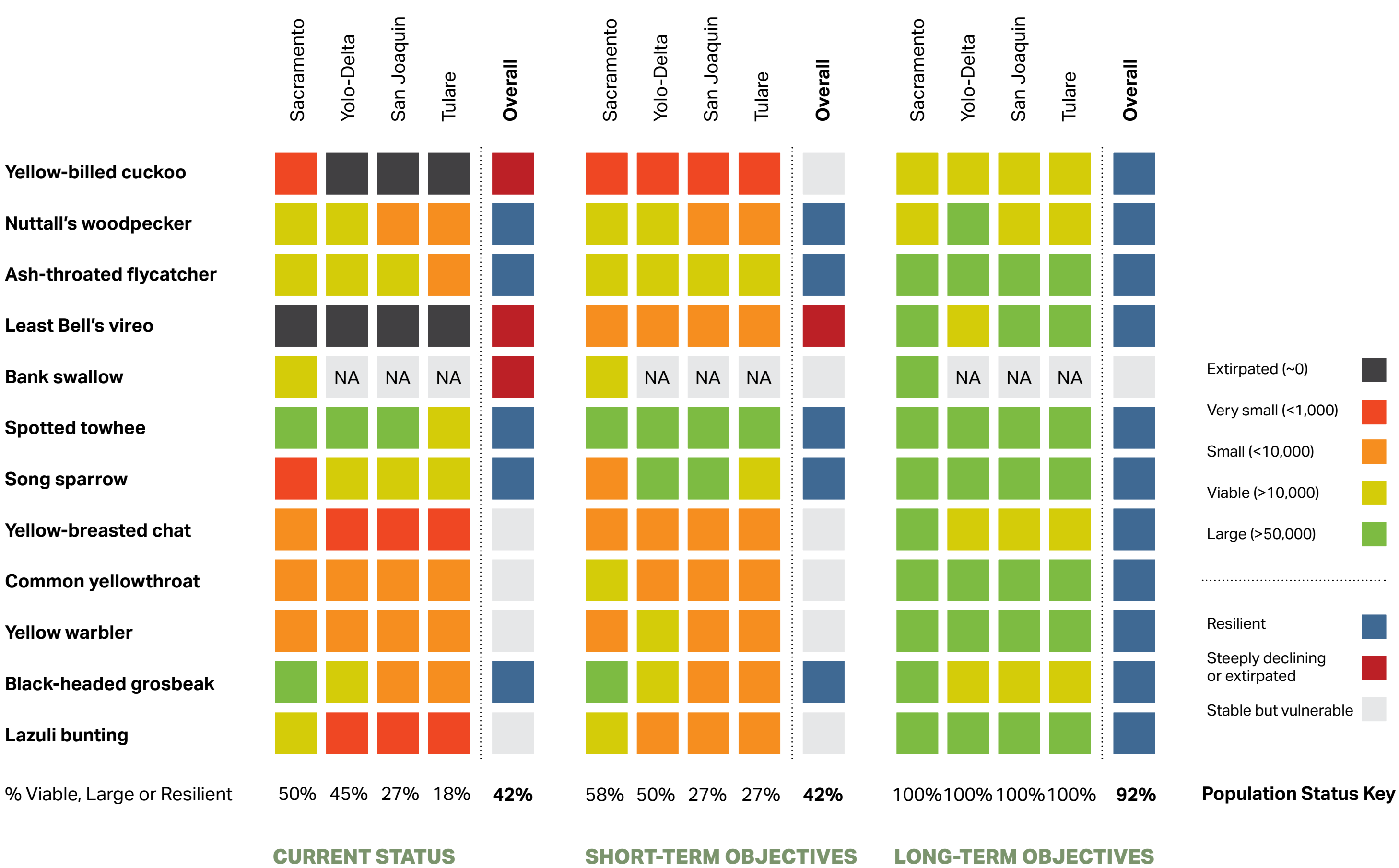
## Current Population Sizes and Trends

Survey data collected between 2008 and 2014 were used to estimate current Valley breeding population sizes of the focal bird species. These population sizes range from very small (<1,000 individuals) to large (>100,000 individuals) (Figure 12.2). More than half of the populations are currently small (<10,000 individuals) or very small (<1,000 individuals) and may be at risk of extirpation. Least Bell's vireo is largely extirpated in the Central Valley so population sizes are assumed to be near zero. Yellow-breasted chat and black-headed grosbeak both exhibit significant, long-term declining trends in the Coastal California Bird Conservation Region (BCR 32), which encompasses the Central Valley, and both bank swallow and yellow-billed cuckoo populations are estimated to have steeply declining trends with an average decline of more than 30 percent every 10 years. The cuckoo's population size is small and the trend estimates are uncertain. In addition, only five of the 12 focal species are currently considered resilient, meaning they have viable or large populations in at least two planning regions.

## Current Habitat

Historically, the CVJV's Primary Focus Area contained more than 1.2 million acres of riparian habitat (and possibly much more; estimates of historical habitat acreage vary widely). In contrast, today only an estimated total of 141,600 acres of riparian vegetation exists in this area, of which nearly half is within the Sacramento planning region (Figure 12.1 and Table 12.2). Data from 2012 California Department of Fish and Wildlife (CDFW) riparian vegetation GIS layers (references in Dybala et al. 2017b) were used to estimate the current extent of riparian vegetation.

As a further indicator of current habitat conditions, the findings that over half of the regional focal species' populations are currently small or very small, that two species have steeply declining population trends, and that fewer than half of the focal species are considered resilient, suggest significant habitat loss and degradation. These findings indicate there is considerable room for improvement in Central Valley riparian ecosystems.




*(NA: Not applicable)*

**FIGURE 11.2** Population status and objectives for Central Valley focal riparian bird species.

# DEVELOPING THE CONSERVATION OBJECTIVES

*Bank swallows - Tom Grey*

## Population Objectives

To develop the long-term population objectives for each focal species in each of the study's planning regions, the first step was to develop a population status framework based on general principles of conservation and population biology (Dybala et al. 2017a). The framework is structured as a hierarchy of four population size categories that mark milestones in becoming a genetically robust, self-sustaining, ecologically functional, and resilient population. The categories are: very small (<1,000), small (<10,000), viable (>10,000), and large (>50,000). Two additional modifiers 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.

The population status framework was used to define long-term (100-year) population objectives for each focal species in each planning region. The objectives are for each species to be stable or increasing, at least viable (>10,000 individuals), preferably large (>50,000 individuals), and resilient (more than one viable or large regional population). Special status species are treated slightly differently. For bank swallow, this Implementation Plan simply adopts the population objective defined in the existing bank swallow conservation strategy: 50,000 (equivalent to large) for the Sacramento region (BANS-TAC 2013), the only region of the Valley with evidence of current colony occupation. Because yellow-billed cuckoo does not yet have a recovery plan with already defined population objectives, this Plan defines a preliminary population objective of viable (>10,000 individuals) for all four planning regions. Least Bell's vireo does have a draft recovery plan (USFWS 1998), but it does not define specific numerical population objectives, so this Plan treats it like any other focal species.

## Breeding Density and Habitat Objectives

Because so much historical riparian habitat in the Central Valley has been lost and degraded, it is likely that many of the focal species' regional populations are currently limited by available habitat and that the current breeding densities of many of the focal species may be unusually low due to reduced habitat quality. Therefore, meeting the population objectives would require both habitat restoration and enhancement efforts to increase both the total area of habitat available to species and their average breeding densities. The Plan defines long-term habitat and breeding density objectives such that achieving both would result in meeting the long-term population objectives.

Excluding bank swallow and yellow-billed cuckoo (which were treated separately), potential breeding densities were determined by examining density estimates reported for Breeding Bird Census (BBC) plots in riparian vegetation in the western United States (1988-2009; Gardali and Lowe 2006). In many cases, current Central Valley breeding densities are far lower than BBC densities. The Plan defines long-term density objectives for each species in each planning region as the 75th percentile of the observed BBC densities, unless the species' current regional density already exceeded this objective. In that case, the objective is to maintain the current density.

The next step was to calculate the minimum area of riparian habitat in each planning region that would be required to reach specified benchmarks. The benchmarks include: All 10 remaining focal species reach the threshold for a viable population (>10,000 individuals) in each planning region; 7 of the 10 focal species reach the threshold for a large population (>50,000 individuals) in each planning region; and each focal species has at least one large regional population.

To track progress during the lifespan of this Plan, short-term (10-year) habitat objectives were established that represent one-tenth of the long-term objectives.

Density objectives for bank swallow were not defined because an average density per unit area of riparian vegetation is less applicable to a colonial-nesting species. These species are expected to respond more to the availability of suitable nesting sites than to the addition of riparian vegetation acres. Yellow-billed cuckoo was also treated differently because breeding densities for this species are highly variable and difficult to estimate (Hughes 2015). Instead, the cuckoo's regional breeding density objective was calculated as the average density required to reach a population size of viable in each region, assuming the long-term habitat objectives were met. These density objectives are well within the range of observed cuckoo breeding densities in other regions.

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

# CONSERVATION OBJECTIVES

## Habitat

The Plan defines short-term (10-year) and long-term (100-year) habitat objectives for riparian vegetation in each of the four planning regions (Table 12.2). These habitat objectives represent the estimated total extent of riparian vegetation required to meet the population objectives for all 12 focal species in each planning region. In total, the long-term objectives represent 36 percent of the estimated historical extent of riparian vegetation in the Central Valley.

| PLANNING REGION | LONG-TERM HABITAT OBJECTIVE | CURRENT ESTIMATE | ACRES NEEDED (DIFFERENCE) | ACRES NEEDED BY 2030 (10%) |
|---|---|---|---|---|
| Riparian Vegetation | | | | |
| **Sacramento** | 151,671 | 67,897 | 83,774 | 8,377 |
| **Yolo-Delta** | 91,925 | 32,869 | 59,056 | 5,906 |
| **San Joaquin** | 108,626 | 24,949 | 83,677 | 8,368 |
| **Tulare** | 108,626 | 15,893 | 92,733 | 9,273 |
| **Total** | 460,849 | 141,608 | 319,241 | 31,924 |

**TABLE 12.2 Short-term (10-year) and long-term (100-year) habitat objectives for breeding riparian birds.** Objectives (in acres) are shown by planning region along with current estimates of existing habitat and the estimated additional acres needed to meet the habitat objectives. (Sums may not be exact, due to rounding in original data.)

## Population

The Plan defines long-term (100-year) population objectives of >10,000 or >50,000 individuals for each of the focal species in each planning region (Figure 12.2). These population objectives represent the estimated population sizes needed to reach the goal of genetically robust, self-sustaining, resilient populations.

## Breeding Density

The Plan defines long-term (100-year) average breeding density objectives for each focal species in each planning region (Table 12.3). These density objectives represent the estimated average breeding densities that could be reached with improvements in both the quality and quantity of riparian ecosystems in each planning region.

| SPECIES | SACRAMENTO | YOLO-DELTA | SAN JOAQUIN | TULARE |
|---|---|---|---|---|
| **Yellow-billed cuckoo** | 0.066 | 0.109 | 0.092 | 0.092 |
| **Nuttall's woodpecker** | *0.274 | *0.544 | 0.227 | 0.227 |
| **Ash-throated flycatcher** | *0.498 | *0.866 | *0.460 | 0.460 |
| **Least Bell's vireo** | 0.497 | 0.497 | 0.497 | 0.497 |
| **Bank swallow** | – – | – – | – – | – – |
| **Spotted towhee** | *2.134 | *2.166 | *2.334 | 2.334 |
| **Song sparrow** | 1.213 | *1.349 | *1.755 | 1.755 |
| **Yellow-breasted chat** | 0.330 | 0.330 | 0.330 | 0.330 |
| **Common yellowthroat** | 0.606 | 0.606 | 0.606 | 0.606 |
| **Yellow warbler** | 0.557 | 0.557 | 0.557 | 0.557 |
| **Black-headed grosbeak** | *0.881 | 0.382 | 0.382 | 0.382 |
| **Lazuli bunting** | 0.611 | 0.611 | 0.611 | 0.611 |

*No density objectives were set for bank swallow, and density objectives for the Tulare region were set equal to objectives for the adjacent San Joaquin region. * Density objective is to maintain current average density.*

**TABLE 12.3 Long-term (100-year) average breeding density objectives for each riparian focal species in each planning region.**


1 2

# APPLYING THE CONSERVATION OBJECTIVES

## Applying the Breeding Density Objectives

The breeding density objectives can be used in several ways. At habitat restoration sites, they can be used to demonstrate that the restoration activities are creating quality habitat in which the focal species are ultimately able to meet or exceed the density objectives. Similarly, in existing habitat, they can be used to demonstrate the effectiveness of habitat enhancement activities in which the focal species' breeding densities improve and ultimately meet or exceed the density objectives. Finally, they can be used as part of a project planning process to project the potential number of individuals of each focal species that a restoration or enhancement project site may be able to support. Progress toward the breeding density objectives can be tracked through regular surveys of riparian breeding birds at project sites, and overall by surveying throughout each planning region.

By improving species densities, fewer acres of habitat are required to meet the population objectives, and in turn the conservation goals. Therefore, the CVJV encourages efforts to improve conditions in existing riparian vegetation. Such habitat enhancement efforts might include removing invasive plant species or increasing diversity in the composition and structure of riparian vegetation.

## Applying the Habitat Objectives

The habitat objectives represent estimates of the total area of riparian habitat required to enable focal species' Central Valley populations to reach the long-term population objectives, and therefore the total area required to reach the Plan's long-term conservation goal. Subtracting the estimated current amount of riparian vegetation from the long-term objective provides the estimated additional acres needed in each region (Table 12.2), assuming none of the current extent is lost.

To track progress within this Plan's timeline, short-term (10-year) habitat objectives for each region were set at one-tenth of the long-term additional acreage needed. These additional acres can be achieved through habitat restoration.

For the purposes of this chapter, "habitat restoration" means conversion of land that is not currently covered by the target land cover type into the target land cover type. For riparian habitat, this includes establishing new areas with native riparian-associated shrubs and trees (based upon the 2012 riparian vegetation GIS layer).

The acreage of new riparian vegetation created by a restoration project in one of the planning regions would count as contributing to these habitat objectives. Overall progress toward the riparian vegetation objectives can be tracked through updates to CDFW vegetation GIS layers (https://www.wildlife.ca.gov/Data/BIOS/Dataset-Index).

"Habitat enhancement," in this situation, indicates managing existing riparian vegetation to improve habitat quality. The acreage of enhanced riparian vegetation should not be counted toward the habitat objectives. Instead, habitat enhancement should be measured using the breeding density objectives as described previously.

The habitat objectives can be used to measure the contribution of an individual project to the CVJV goals. They can also be used to guide other planning processes with respect to the magnitude of restoration that is needed within each region.

*(1-4) Habitat restoration at San Joaquin NWR Hageman Unit - River Partners*


## SUCCESS STORY

# LEAST BELL'S VIREO REAPPEARS IN THE CENTRAL VALLEY

The 2005 discovery of least Bell's vireo, a species previously thought extinct in the Central Valley, heralded a huge success in efforts to restore riparian bird habitat in the San Joaquin Valley. The birds were found on the San Joaquin River National Wildlife Refuge, in a tree planted by River Partners (a CVJV partner) two years earlier. Engaged since 2002 in the largest contiguous riparian restoration project in California, CVJV partners have detected least Bell's vireo in five additional years in forests planted on the refuge.

1

River Partners adapts restoration methods in response to feedback from CVJV partners. As a result, 1- to 2-year-old restoration sites in the most recent phase of the project achieved breeding densities equivalent to 3- to 6-year-old densities in the first phase for six CVJV riparian focal species. River Partners is now achieving the CVJV breeding density objective for song sparrows within two years of completing restoration.

River Partners' restoration efforts – based on recommendations from the California Partners in Flight Riparian Bird Conservation Plan – will protect and restore more than 5,000 acres within the San Joaquin River NWR and adjacent private lands, including the Dos Rios Ranch. Over the past 10 years, the project has attracted more than $50 million for the permanent protection of 2,285 acres, including restoration of 600 acres.

2 BEFORE

3 AFTER

*(1) Least Bell's vireo - Robert A. Hamilton (2) & (3) Vireo habitat restoration at San Joaquin River NWR Hageman Unit - River Partners*

# ADDITIONAL CONSERVATION CONSIDERATIONS

### Adapt habitat restoration to extreme weather events

The CVJV recommends anticipating extreme weather events, like drought and flood, when developing plans and designing riparian restoration (Gardali et al. In prep.; Perry et al. 2015). For example, consider whether current designs use plant species and varietals that will continue to thrive under projected climate conditions, including changes in temperature and precipitation, more extreme weather patterns, and changes in hydrology and groundwater availability. The long-term success of current riparian restoration efforts will depend on whether species being planted now will survive for decades. Incorporating shifting climate patterns into restoration planning should become as standard as the typical attention paid to soils and hydrology (Griggs 2008).

### Plan for species-specific habitat needs

In addition to a general strategy of restoring and enhancing riparian vegetation, individual species have habitat needs that will require attention to patch size, location, and vegetation structure. For example, the yellow-billed cuckoo requires large, contiguous patches of riparian vegetation (Gaines 1974). Restoration efforts must therefore strategically locate habitat to maximize continuous, uninterrupted areas of riparian vegetation. Nesting least Bell's vireos use a well-developed and layered canopy, with highest foliage density within one to two meters of the ground (Kus 1998), thus requiring restoration efforts to pay specific attention to vegetation structure.

### Restore hydrological processes

Specific attention should be given to promoting natural river processes where it is feasible. These efforts could include removing river bank revetment, using set-back levees and conservation easements to protect river meander, and adopting flow regimes that maintain and improve river processes. For example, bank swallows depend on suitable nesting sites in cut banks created by river flows. Similarly, the least Bell's vireo, yellow-breasted chat, and lazuli bunting are all associated with scrubby, early- to mid-successional riparian vegetation, and seasonal flooding would help provide the disturbance that generates the early-successional vegetation used by these species. In addition, promoting natural river processes may improve the conditions for further riparian restoration and management through sediment deposition, groundwater recharge, and seed dispersal (Florsheim and Mount 2003; Opperman 2012), ultimately benefitting many riparian species. Integrating the habitat needs of riparian wildlife with recovery efforts for Central Valley fishes, including salmon, is an exciting opportunity.

### Inhibit brown-headed cowbirds

Recommendations for minimizing the risk of cowbird parasitism are well-established and include managing for a dense shrub layer, managing grazing and mowing near riparian areas, and minimizing the availability of nearby cowbird food sources, such as those provided by dairies and feedlots (Dybala et al. 2014). The most common recommendation for minimizing cowbird risk is simply to restore habitat. Specifically, improve the continuity of large tracts of high-quality habitat, widen narrow corridors, and minimize edges, all of which may have the added benefit of reducing access by many nest predators (Dybala et al. 2014).

### Consider benefits to waterbirds

In addition to providing habitat for riparian landbirds, riparian vegetation also provides roosting and nesting habitat for some waterbirds (see Breeding and Non-Breeding Waterbirds chapter). For these waterbirds, the amount of riparian vegetation is not as important as the location of this habitat near suitable foraging habitat, such as managed wetlands and postharvest-flooded crops. Riparian vegetation that is strategically located adjacent to waterbird foraging habitat will contribute to the habitat objectives for both breeding riparian landbirds and some waterbirds.

1

2

*(1) Least Bell's vireo nest - Julie Rentner (2) Yellow-breasted chat - Tom Grey*

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*Yellow-billed cuckoo - Mark Dettling*


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1

# BREEDING GRASSLAND - OAK SAVANNAH LANDBIRDS

13

2

3

# CHAPTER SUMMARY

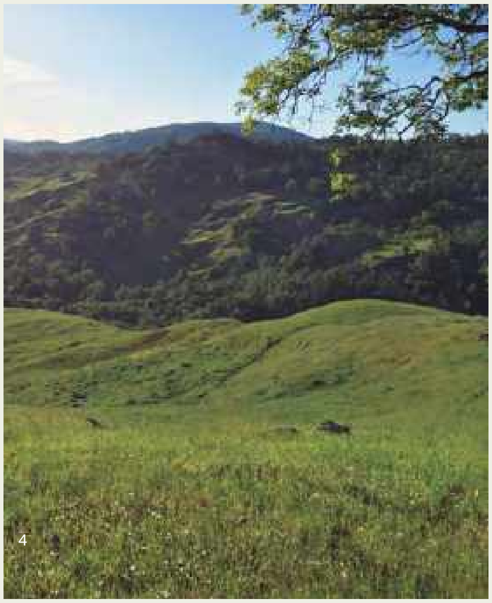

The landscape of the Central Valley includes grassland and oak savannah ecosystems that are important both to native wildlife and to the people living in this region. These upland ecosystems form a ring of open country, foothills and rangelands surrounding the valley floor. Though more than half of historical grassland and oak savannah acreage has been lost, the remaining habitat supports a thriving community of native landbirds.

This chapter describes the conservation objectives for enhancing existing grassland and oak savannah lands and restoring additional acreage of these habitat types. The goal is to support resilient populations of Central Valley upland bird species.

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.


## HABITAT TYPE

Grasslands in the Central Valley are landscapes dominated by grasses and other herbaceous plant species with less than 10 percent tree canopy cover. Oak savannahs are woodlands with sparse (10 percent to 40 percent) canopy cover, with oaks (*Quercus* spp.) as the dominant tree species and primarily grass-dominated understories.




## BREEDING DENSITY OBJECTIVES:

Three actions are needed to reach the breeding density objectives:

- Enhance existing habitat to increase breeding density of focal species. Goal: reach viable (>10,000) or large (>50,000) populations, depending on the species.
- Restore additional acres of habitat.
- Protect existing habitat from development.

## GRASSLAND AND OAK SAVANNAH HABITAT: A New Focus

Grassland and oak savannah ecosystems in the Central Valley provide multiple economic and social benefits, ecosystem services, and vital bird habitat. There is a growing interest in protecting, restoring, and managing these ecosystems, and the Central Valley Joint Venture provides leadership in the formulation of conservation goals and objectives.

### SHORT TERM HABITAT OBJECTIVES: WHAT'S NEEDED?"

**10,300 ADDITIONAL ACRES OF HIGH-QUALITY GRASSLAND HABITAT**

**8,500 ADDITIONAL ACRES OF HIGH-QUALITY OAK SAVANNAH HABITAT**

### BIRD SPECIES INCLUDE:

Representative bird species of the Central Valley's grassland-oak savannah:


Western meadowlark*


Western bluebird**


Acorn woodpecker**


American kestrel***

Species of heightened conservation concern:


Burrowing owl***


Grasshopper sparrow***


Loggerhead shrike***


Yellow-billed magpie**

*Stephen Fettig ** Brian Gilmore *** Tom Grey

(1) Western bluebirds - Tom Grey (2) Native perennial grasslands, Llano Seco Ranch - Joe Silveira (3) Yellow-billed magpie - Brian Gilmore (4) Mixed grassland-oak savannah habitat, South Fork American River - Mark Leder Adams

# INTRODUCTION

**Grassland and oak savannah ecosystems are an important component of Central Valley uplands, particularly the ring of open country, low-elevation (<3,000 feet) foothills and rangelands surrounding the valley floor (Figure 13.1). Roughly 60 percent of the Central Valley's historic grasslands have been lost due to conversion to intensive agriculture and urban development (CPIF 2000; DGP-GIC 2003). Comparable historical data on the extent of oak savannah ecosystems in the Central Valley are lacking, but the magnitude of loss is believed to be similar, based on the reported loss of rangeland habitat in the state (which by definition includes oak savannah; Cameron et al. 2014). Today, grasslands and oak savannahs are still at risk of conversion to land uses that do not provide the suite of ecosystem services that these land types currently generate (Cameron et al. 2014; Byrd et al. 2015).**

These ecosystems are critically important to landbirds. Across North America, grassland-associated birds have declined by as much as 40 percent since 1968 (NABCI 2014). In California, several landbird species associated with grassland and oak savannah have declined in abundance and are now considered Species of Special Concern (Shuford and Gardali 2008).

Ensuring that these species do not become threatened or endangered in the future will help to minimize regulatory oversight on private landowners. Furthermore, a number of other conservation targets overlap with these ecosystems, including the many special status species associated with vernal pools and the habitat for the Central Valley population of California tiger salamanders (*Ambystoma californiense*).

In addition to providing important habitat for landbirds and other wildlife, these ecosystems provide a number of important functions, including providing nutrient and water cycling, sequestering carbon, supporting pollinator populations, and producing food and fiber for people through livestock operations (Havstad et al. 2007; Kroeger et al. 2009; Chaplin-Kramer et al. 2011).

*Vernal pool, Llano Seco Ranch - Joe Silveira*

## CONSERVATION GOAL

**The Central Valley Joint Venture's long-term goal is for Central Valley grassland and oak savannah ecosystems to have sufficient high-quality habitat to support genetically robust, self-sustaining, and resilient native bird populations.**

# WHICH SPECIES ARE INCLUDED?

The conservation objectives focus on 12 bird species that breed in grassland and oak savannah ecosystems and that represent a broad range of life histories and a continuum of specific habitat needs (Table 13.1).

The focal species are divided into two major groups: five species that principally use grassland vegetation and seven that principally use oak savannah vegetation. Managing habitat to support local populations of the full suite of focal species should in turn support diverse and healthy grassland and oak savannah ecosystems (Chase and Geupel 2005).

*Western kingbird - Stephen Fettig*

| SPECIES (*SCIENTIFIC NAME*) | CONSERVATION STATUS[a] | MIGRATORY STATUS | NEST SUBSTRATE | HABITAT & VEGETATION ASSOCIATIONS |
|---|---|---|---|---|
| **GRASSLAND** | | | | |
| **Northern harrier** (*Circus cyaneus*) | BSSC | Resident/ migrant | Ground/ shrub | Forages over a variety of open landscapes but prefers to nest in shrubby or weedy fields |
| **Burrowing owl** (*Athene cunicularia*) | BSSC | Resident/ migrant | Burrow | Open, low stature grassland, and/or a significant amount of bare ground |
| **Horned lark** (*Eremophila alpestris*) | CBSD | Resident/ migrant | Ground | Open, low stature grassland, and/or a significant amount of bare ground |
| **Grasshopper sparrow** (*Ammodramus savannarum*) | BSSC, CBSD | Migrant | Ground | Grassland; tolerant of some shrub cover; may favor sloped landscapes rather than flat areas |
| **Western meadowlark** (*Sturnella neglecta*) | – – | Resident | Ground | Grassland, though will use trees for singing perches |
| **OAK SAVANNAH** | | | | |
| **Acorn woodpecker** (*Melanerpes formicivorus*) | – – | Resident | Tree, 1° cavity | Oak savannah and oak woodland |
| **American kestrel** (*Falco sparverius*) | – – | Resident | Tree, 2° cavity | Dense understory oak savannah and grassland |
| **Western kingbird** (*Tyrannus verticalis*) | – – | Migrant | Tree | Oak savannah |
| **Loggerhead shrike** (*Lanius ludovicianus*) | BSSC, CBSD | Resident | Shrub/ tree | Grassland, oak savannah, and open shrubland; less frequently riparian and oak woodland |
| **Yellow-billed magpie** (*Pica nuttalli*) | CCV, UCC, NT | Resident | Tree | Oak savannah, woodland, and riparian edge |
| **Western bluebird** (*Sialia mexicana*) | – – | Resident | Tree, 2° cavity | Oak savannah and woodland, nests in tree cavities but often forages in open areas and grassland edge |
| **Lark sparrow** (*Chondestes grammacus*) | – – | Resident/ migrant | Ground | Oak savannah and grassland/woodland ecotones; requires trees for foraging and singing |

*[a] Conservation status designations: BSSC, state bird species of special concern (Shuford and Gardali 2008); CCV, species ranked among the most vulnerable to climate change (Gardali et al. 2012); CBSD, common birds in steep decline (PIF 2012); UCC, U.S.-Canada species of conservation concern (PIF 2012); and NT, near threatened (BirdLife International 2014)*

**TABLE 13.1 Breeding grassland and oak savannah focal species: Conservation status, life history traits, and habitat/vegetation associations.** Species are listed under their principal breeding habitats.

# WHICH GEOGRAPHIC AREAS ARE INCLUDED?

The conservation objectives encompass the CVJV's Primary Focus Area (the valley floor) and the Secondary Focus Area (the surrounding foothills; Figure 13.1). Because mountain meadows are ecologically distinct and should be treated separately from valley and foothill grasslands, the conservation objectives only address grassland and oak savannah in the Secondary Focus Area up to a maximum elevation of 3,000 feet. This is the first time the CVJV has defined conservation objectives for the Secondary Focus Area.

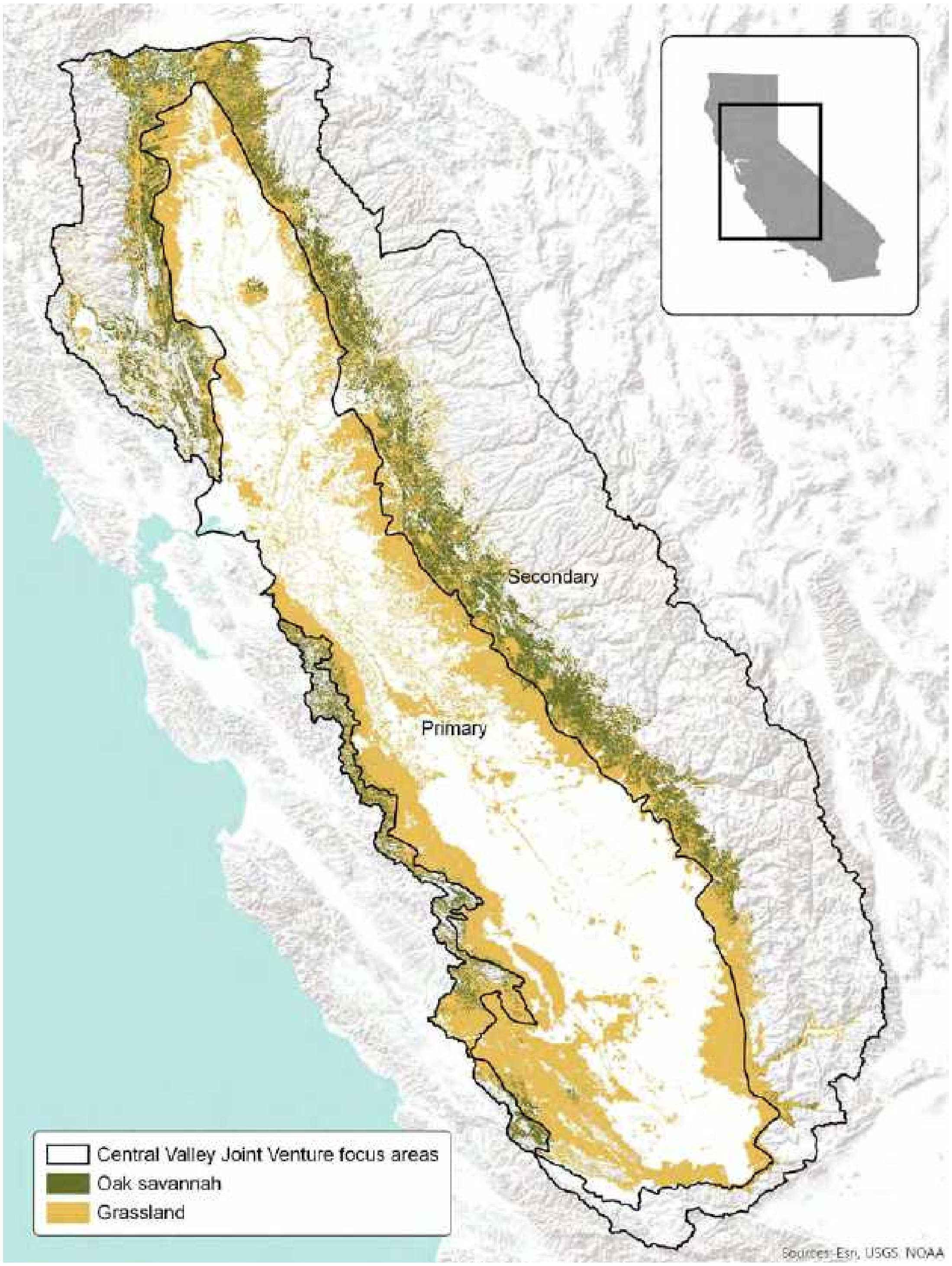



**FIGURE 13.1 Central Valley Joint Venture perimeter and Primary and Secondary Focus Areas, showing extent of grassland and oak savannah habitats.** Estimated current extents of grassland and oak savannah vegetation are shown up to a maximum elevation of 3,000 ft.

# CURRENT CONDITIONS

## Current Population Sizes and Trends

Researchers used survey data collected between 2002 and 2015 to estimate current breeding population sizes that ranged widely from very small (310 burrowing owls in the Secondary Focus Area) to large (more than 300,000 western meadowlarks in the Primary Focus Area) (Figure 13.2). Burrowing owl, loggerhead shrike, and yellow-billed magpie had the smallest population size estimates; current population sizes of northern harrier and American kestrel are unknown. Fully two-thirds of the focal species have significant long-term declining trends in the Coastal California Bird Conservation Region (BCR 32), and both horned lark and burrowing owl are estimated to have steeply declining trends, with an average decline of more than 30 percent every 10 years.

## Current Habitat

The CVJV's Primary and Secondary Focus Areas currently contain an estimated six million acres of grassland habitat, with more than half (64 percent) in the Primary Focus Area on the valley floor (Table 13.2). These estimates include annual and perennial grassland and pasture. These areas also contain an estimated 1.8 million acres of oak savannah habitat, with the vast majority (94 percent) in the Secondary Focus Area, including valley oak woodland, coast oak woodland, blue oak-foothill pine, and blue oak woodland. These estimates indicate that oak savannah habitat is extremely limited in the Primary Focus Area.

As a further indicator of current habitat conditions, the finding that two-thirds of the focal species have declining population trends and two focal species have steeply declining population trends suggests significant, ongoing habitat loss and degradation. In addition, only four of the seven focal species associated with oak savannah habitat (57 percent) and two of the five focal species associated with grassland habitat (40 percent) are currently resilient, with viable or large populations in each focus area (Figure 13.2). These findings indicate there is considerable room for improvement in the restoration and enhancement of Central Valley grassland and oak savannah ecosystems.

*Horned lark - Stephen Fettig*


**FIGURE 13.2 Population status and objectives for Central Valley grassland and oak savannah bird species.**
Current size and status of each focal species population, and Long-Term Objectives, grouped by grassland species (top) and oak savannah species (bottom). A status of NA (Not Applicable) in one of the focus areas means the species is not expected to breed in that focus area. A status of "unknown" means the current population size or trend is currently unknown and the species is assumed not to be viable, large, or resilient. Thus, the calculation of "% Viable, Large or Resilient" represents a minimum value.

# DEVELOPING THE CONSERVATION OBJECTIVES

## Population Objectives

To develop the long-term population objectives for each focal species in each region, researchers 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 resilient population: very small (<1,000), small (<10,000), viable (>10,000), and large (>50,000). 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.

To meet the conservation goal of supporting genetically robust, self-sustaining, and resilient focal species populations, this population status framework was used to define long-term (100-year) population objectives for each focal species population in each focus area. For the less common and special status species that currently have small, very small, or unknown population sizes, the CVJV set lower targets for the long-term population objectives. Population objectives for northern harrier and yellow-billed magpie were only defined for the Primary Focus Area since these species historically have scarcely ever occurred in the Secondary Focus Area (CWHR 1995; Shuford and Gardali 2008).

## Density and Habitat Objectives

Because so much historical grassland and oak savannah vegetation has been lost and degraded, many of the focal species populations are likely to be limited by available habitat, and the current densities of many of the focal species may be unusually low due to reduced habitat quality. Therefore, meeting the population objectives will require both habitat restoration and habitat enhancement efforts, to increase both the total area of habitat available to species and their average breeding densities. Long-term habitat and density objectives were defined such that achieving both will result in meeting the long-term population objectives.

For many of the focal species, researchers believe that improvements in habitat quality could produce at least half of the additional individual birds needed to meet the population objectives. This assumption was incorporated into the objectives by calculating the average breeding densities in each species' principal breeding habitat required to meet half of that species' target population size. Long-term objectives for the restoration of additional acres of habitat were defined to bridge any remaining gap to the population objectives. This assumes the same breeding densities will also be met in any newly restored habitat.

To track progress during the lifespan of this Implementation Plan (hereafter, "the Plan"), short-term (10-year) habitat objectives for additional acres needed by 2030 were set at 10 percent of the long-term objectives.

Breeding density objectives were defined last for the less common and special-status species that currently have small, very small, or unknown population sizes. These objectives were set by calculating the density required to meet the species' population objectives, once the habitat objectives are met.

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

*(1) Image: Valley oak woodland - Llano Seco Ranch (2) Burrowing owls - Tom Grey (3) Lark sparrow - Stephen Fettig*

# CONSERVATION OBJECTIVES

## Habitat

The Plan defines separate short-term (10-year) and long-term (100-year) habitat objectives for grassland and oak savannah, in both the Primary and the Secondary Focus Areas (Table 13.2). Where the long-term habitat objectives are equal to the current estimated extent and no additional acres are needed (i.e., grassland in the Primary Focus Area and oak savannah in the Secondary Focus Area), the objective is to maintain and enhance the current extent and ensure that no net loss occurs. Because much of this habitat already exists, the restoration needs are relatively modest. The habitat objectives represent the estimated total area of each habitat type required to enable focal species to reach the long-term population objectives in both CVJV focus areas.

| HABITAT TYPE FOCUS AREA | LONG-TERM HABITAT OBJECTIVE | CURRENT ESTIMATE | ACRES NEEDED (DIFFERENCE) | ACRES NEEDED BY 2030 (10%) |
|---|---|---|---|---|
| Grassland (<10% canopy cover) | | | | |
| Primary | 3,872,771 | 3,872,771 | 0 | 0 |
| Secondary | 2,277,867 | 2,174,499 | 103,367 | 10,337 |
| **Total** | **6,150,637** | **6,047,270** | **103,367** | **10,337** |
| Oak Savannah (10-40% canopy cover) | | | | |
| Primary | 197,541 | 112,712 | 84,829 | 8,483 |
| Secondary | 1,672,076 | 1,672,076 | 0 | 0 |
| **Total** | **1,869,617** | **1,784,788** | **84,829** | **8,483** |

**TABLE 13.2 Short-term (10-year) and long-term (100-year) habitat objectives for breeding grassland and oak savannah landbirds.** Objectives are shown in acres, along with current estimates of each habitat type, the estimated additional acres needed to meet the long-term habitat objectives, and the short-term objective of meeting 10% of those acres by 2030. (Sums may not be exact, due to rounding in original data.)

## Population

The long-term (100-year) population objectives are to reach >50,000 individuals for the majority of the focal species in each focus area, and >10,000 for species that currently have small, very small, or unknown population sizes (Figure 13.2). These population objectives represent the estimated population sizes needed to reach the goal of genetically robust, self-sustaining, and resilient populations.

## Breeding Density

The Plan defines long-term (100-year) average breeding density objectives for each species' principal habitat type in each focus area (Table 13.3). The density objectives represent the estimated average breeding densities that could be reached with improvements in the both the quality (enhancement) and quantity (restoration) of grassland and oak savannah habitat in each focus area.

| SPECIES | PRIMARY FOCUS AREA | SECONDARY FOCUS AREA[a] |
|---|---|---|
| Grassland | | |
| **Burrowing owl** | 0.002 | –– |
| **Grasshopper sparrow** | 0.020 | 0.020 |
| **Horned lark** | *0.038 | *0.059 |
| **Northern harrier** | 0.002 | –– |
| **Western meadowlark** | *0.079 | *0.071 |
| Oak Savannah | | |
| **Acorn woodpecker** | 0.235 | *0.087 |
| **American kestrel** | 0.051 | 0.006 |
| **Lark sparrow** | 0.197 | *0.118 |
| **Loggerhead shrike** | 0.029 | 0.004 |
| **Western bluebird** | 0.150 | *0.037 |
| **Western kingbird** | *0.208 | *0.125 |
| **Yellow-billed magpie** | 0.051 | –– |

*[a] No density objectives were defined for burrowing owl, northern harrier, or yellow-billed magpie in the Secondary Focus Area.*
** Density objective is to maintain current average density.*

**TABLE 13.3 Long-term breeding density objectives for grassland and oak savannah focal species.** Objectives are listed as individuals/acre. Species are grouped by focus area and principal breeding habitat.

# APPLYING THE CONSERVATION OBJECTIVES

## Habitat Objectives

The habitat objectives represent the estimate of the total area of grassland and oak savannah habitat that is required to enable focal species populations to reach the long-term population objectives, and therefore the total area required to reach the CVJV's conservation goal. Subtracting the estimated current extent of each habitat type provides the estimated additional acres needed, assuming none of the current extent is lost. Securing the required additional acres can be achieved through habitat restoration.

"Habitat restoration" is defined here as conversion of land that does not currently consist of the target land cover type into the target land cover type. For grassland and oak savannah habitat, this includes establishing new areas with native and/or naturalized grassland- and oak savannah-associated plants, that are not already shown in the CAL-FIRE 2015 GIS layer (http://frap.fire.ca.gov/data/frapgisdata-sw-fveg_download). The acreage of new grassland or oak savannah habitat created by a restoration project in one of the focus areas and up to a maximum elevation of 3,000 feet would count as contributing to these habitat objectives.

"Habitat enhancement" in this situation indicates managing existing grassland or oak savannah habitat to improve habitat quality. The acreage of enhanced grassland or oak savannah habitat should not be counted toward the habitat objectives. Instead, habitat enhancement should be measured using the breeding density objectives, as described below.

## Breeding Density Objectives

The breeding density objectives can be used in several ways. At habitat restoration sites, they can be used to demonstrate that the restoration activities are creating quality habitat in which the focal species are ultimately able to meet or exceed the density objectives. Similarly, in existing habitat, they can be used to demonstrate the effectiveness of habitat enhancement activities in which the focal species' breeding densities improve and ultimately meet or exceed the density objectives. Finally, they can be used as part of a project planning process to project the potential number of individuals of each focal species that a restoration or enhancement project site may be able to support. Progress toward the breeding density objectives can be tracked through regular surveys of grassland and oak savannah breeding birds at project sites, and overall by surveying throughout each focus area.

By improving species densities, fewer acres of habitat are required to meet the population objectives, and in turn the conservation goal. Therefore, efforts to improve conditions in existing grassland and oak savannah habitat should be prioritized. Such habitat enhancement efforts might include the removal of noxious weeds, such as yellow star-thistle (*Centaurea solstitialis*), and encouraging regeneration of blue oaks (*Quercus douglasii*) and greater cover of native bunch grasses, such as purple needlegrass (*Stipa pulchra*).

*Northern harrier - Tom Grey*

## SUCCESS STORY

# LOCAL LAND TRUSTS IN THE SIERRA NEVADA FOOTHILLS

In the Sierra Nevada foothills, local land trusts can play an important role in conserving grassland and oak savannah habitat that would otherwise be threatened by development. For example, the American River Conservancy and the Sierra Foothill Conservancy have protected a combined total of over 50,000 acres of foothill rangelands, which include substantial areas of grassland and oak savannah habitat.


1


2

Bird surveys on various parcels owned by these land trusts have found thriving populations of several CVJV grassland and oak savannah focal species. In El Dorado County between 2014 and 2018, the American River Conservancy protected over 3,000 acres of healthy oak savannah habitat along the Cosumnes River that was threatened by development. The group is now working to acquire an adjacent 6,200 acres of habitat. Spring bird surveys found abundant bird life, including seven CVJV focal species and nesting golden eagles.

Both land trusts are actively working with partner biologists at Point Blue Conservation Science and the Natural Resources Conservation Service to develop, implement and evaluate management practices that enhance biodiversity and soil health.


3

*(1-3) El Dorado Ranch, Cosumnes River - Elena DeLacy, American River Conservancy*

# ADDITIONAL CONSERVATION CONSIDERATIONS

## Increase patch size and connectivity

There are numerous examples of relatively small-scale (<250 acres) grassland restoration projects in the Central Valley. While these sites have been readily colonized by some species (e.g., northern harriers), for certain other species (e.g., grasshopper sparrows), grassland restoration has had limited success in supporting breeding grassland birds. Researchers believe these restored grasslands are smaller than the patch size requirements for many grassland birds (DiGaudio et al. 2009; Young and DiGaudio 2011), limiting breeding success. Future restoration projects should be strategically located to improve habitat connectivity and patch size.

## Manage habitat for species-specific needs

Given that each of the focal species has its own distinct set of habitat requirements (e.g., horned larks and burrowing owls prefer short-stature grassland whereas meadowlarks prefer taller grassland), managers of each restoration or enhancement project should consider what the target management species are relative to their habitat requirements and attempt to create habitat mosaics across the landscape to accommodate multiple species' needs. Recommendations have been put forward for improving habitat conditions for the grassland and oak savannah focal species; however, most recommendations are hypothetical, and evaluating their effectiveness will require further testing and validation. For example, grasshopper sparrows are associated with the perennial bunch grasses, such that increasing perennial grass cover should increase grasshopper sparrow density (Vickery 1996). Specific recommendations can be found for each focal species in the California Partners in Flight grassland bird conservation plan (CPIF in review).

## Investigate the role of livestock grazing practices

Managed livestock grazing could play a significant role in enhancing grassland and oak savannah habitat for birds, especially given that the vast majority of California's grasslands and oak savannahs are currently used for livestock production (Stromberg et al. 2007). There is still much to learn, however, about rangeland management and livestock grazing practices for the benefit of birds.

*(1) Cattle grazing with greater white-fronted geese at vernal pool - Joe Silveira (2) Grasshopper sparrow - Tom Grey*

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1

# AT-RISK BIRD SPECIES

14


2


3

# CHAPTER SUMMARY

This chapter presents the results of the first effort to create a list of at-risk bird species focused specifically on the Central Valley (Shuford and Hertel 2017). Because the list includes all at-risk species found in the region—not just those with threatened or endangered status—it can be used to broaden the scope and improve the effectiveness of large-scale conservation planning efforts in the region.

How conservation objectives have been set for birds has evolved over time (CVHJV 1990; CVJV 2006; this Implementation Plan update). The 2006 Implementation Plan focused on just waterfowl, but this current Implementation Plan includes chapters for several bird groups, members of which are allied by a combination of taxonomic association, seasonal occurrence, or habitat affinity. Yet, these chapters do not cover all birds, or all key seasons or habitats for some birds. Conservation objectives in the other bird-group chapters are currently set for only 50% of the at-risk species identified, even though their populations have declined out of proportion to overall habitat loss compared to other species using the same broad habitat types. To address these gaps, this chapter presents a framework for setting conservation objectives to ensure that all at-risk species are covered in future Plan updates.

## HABITAT TYPE

Virtually all of the habitat types in the Central Valley are home to at-risk bird species, including wetlands, agricultural crops, grasslands, riparian, oak woodland/oak savannah, and saltbush scrub. The habitats used and to what degree varies among species, by sub-region, and seasonally or annually depending on the management or hydrologic regime. Importantly, there are some at-risk species that are not captured elsewhere in this Plan, in part because of their habitat preferences, particularly those associated with saltbush scrub and open-water habitats.

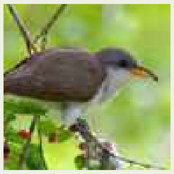
## HABITAT SUCCESS STORIES

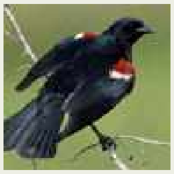
- In 2011, The Urban Bird Foundation garnered the support of over 20 conservation organizations for a statewide Comprehensive Conservation Strategy for burrowing owls. The group was also recognized in 2012 by the California Department of Fish and Wildlife as being responsible for the state's new mitigation guidelines to protect burrowing owls.
- Since 2004 the Tricolored Blackbird Working Group has focused on halting or reversing the sharp population decline of this nomadic, colonial-nesting landbird by various means, including using innovative incentives to protect birds nesting in grain crops (see Success Story sidebar).
- In 2013, the Bank Swallow Technical Advisory Committee published the Bank Swallow Conservation Strategy for the Sacramento River Watershed, California. This collaborative group of state, federal and NGO interests produced quantitative objectives for restoration for this at-risk species. These objectives supported the development of targets that were identified as state funding priorities in the 2017 Central Valley Flood Protection Plan, which will guide near and long-term investments in flood protection projects throughout the Central Valley. This is an excellent example of how planning for an at-risk species can result in direct investments in habitat creation and species recovery.

### BIRD SPECIES INCLUDE:

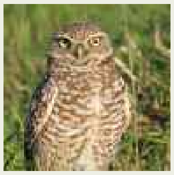
**Examples of Central Valley at-risk bird species:**

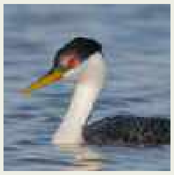

Greater sandhill crane*


Yellow-billed cuckoo****


Tricolored blackbird**


Black tern***


Burrowing owl***


Western grebe***


Snowy plover***


Short-eared owl***


Loggerhead shrike***


Northern harrier***

** Image: Bruce Miller ** Image: Ted Beedy *** Image: Tom Grey **** Image: Ed Harper*

*(1) Tri-colored blackbird - Lee Karney/USFWS (2) Sacramento-San Joaquin River Delta - Steve Martarano/USFWS (3) Burrowing owls - Tom Grey*

# INTRODUCTION

**Once a vast mosaic of wetlands, riparian forests, grasslands, oak woodlands, and saltbush scrub, California's Central Valley has been dramatically transformed over the last century. The loss of a large proportion of native habitat by conversion to agriculture, channelization and urban development (Katibah 1984; Frayer et al. 1989; CPIF 2000; DGP-GIC 2003) has caused a dramatic decline of Central Valley wildlife. Many bird species that were formerly abundant are now reduced to relatively small populations or have been entirely extirpated from the Central Valley. A number of these species have been listed as threatened or endangered by the state or federal governments; some of these have recovery or conservation plans that should guide Central Valley conservation efforts. Additional at-risk bird species identified by various conservation assessments should also be considered in Central Valley conservation activities. If possible, conservation actions for these additional at-risk species should be implemented while they are in the early stages of decline, reducing their risk of becoming threatened or endangered.**

The comprehensive list of at-risk bird species in the Central Valley presented here is an important resource to guide Central Valley habitat restoration, enhancement, and management efforts. The habitat conservation objectives for more common species defined in other chapters of this Plan often overlap with the habitat needs of at-risk species. However, meeting the needs of at-risk species frequently requires more focused conservation actions, given that many at-risk species have declined out of proportion to overall habitat loss compared to other species using the same broad habitat types. After all, rare species are rare for a reason and, hence, they typically have subtler habitat needs than those of more common species. They may not respond well to restoration of general habitat types unless their more specific habitat needs are met.

Protecting, restoring, and managing habitat to benefit at-risk bird species can also provide many benefits for other native animals and plants of the Central Valley. These species, in turn, collectively benefit the people and communities of the Central Valley. For example, restoring and enhancing riparian habitat and wetlands can reduce flood risk, improve water quality, sequester carbon, and recharge groundwater (Finlayson et al. 1999; Zedler and Kercher 2005). Restored grassland and oak savannah can sequester carbon, provide habitat for pollinators, and contribute to food and fiber production (Havstad et al. 2007; Kroeger et al. 2009; Chaplin-Kramer et al. 2011; Cameron et al. 2014). All of these efforts can collectively increase property values, provide recreational opportunities, and attract wildlife viewers and hunters who help support local economies (Carver 2013; Carver and Caudill 2013; Liu et al. 2013).

## CONSERVATION GOAL

**The Central Valley Joint Venture's long-term goal is to increase populations of at-risk bird species in the Central Valley to robust, self-sustaining levels that will reduce or eliminate conservation concern on their behalf. Success will be measured by changes in population trajectories of the at-risk species, and, ultimately, by removal of species from this list and from the other lists from which this one was derived.**

*(1) Agency personnel and private landowner partnering to protect bird habitat - USFWS. (2) Fulvous whistling-duck - Tom Grey.*

# WHICH SPECIES ARE INCLUDED?

The CVJV identified 38 at-risk species, subspecies, or distinct populations of birds (hereafter referred to as "species"; Table 14.1). At the time of writing, eight of the 38 are listed, or are candidates for listing, as state or federally threatened or endangered; 23 are considered bird species of special concern in California at various priority levels (Shuford and Gardali 2008); and seven were chosen on the basis of their inclusion on one or more conservation lists at the national or regional level.

*Loggerhead shrike - Tom Grey*

| SPECIES COMMON NAME (*SCIENTIFIC NAME*) | CONSERVATION STATUS[a] | CONSERVATION OBJECTIVES[b] | KEY HABITATS | OTHER MAJOR THREATS |
|---|---|---|---|---|
| **Fulvous whistling-duck**[c] (*Dendrocygna bicolor*) | BSSC, CCV | – – | Semi-permanent wetlands and grain crops | Disease |
| **Tule greater white-fronted goose** (*Anser albifrons elgasi*) | BSSC | – – | Seasonal wetlands and grain crops | – – |
| **Redhead** (*Aythya americana*) | BSSC | – – | Semi-permanent wetlands | – – |
| **Eared grebe** (*Podiceps nigricollis*) | NAWCP, WCP-32, CCV | Waterbirds | Semi-permanent wetlands; less frequently seasonal wetlands | – – |
| **Western grebe** (*Aechmophorus occidentalis*) | NAWCP, WCP-32, CCV | Waterbirds | Semi-permanent wetlands | – – |
| **Yellow-billed cuckoo** (western distinct population segment) (*Coccyzus americanus*) | FT, SE, BCC, BCC-32, WL, CCV | Riparian | Riparian | – – |
| **Yellow rail** (*Coturnicops noveboracensis*) | BSSC, NAWCP, WCP-32, BCC, BCC-32, WL, CCV | – – | Seasonal wetlands | – – |
| **California black rail** (*Laterallus jamaicensis coturniculus*) | ST, NAWCP, WCP-32, BCC, BCC-32, WL, CCV | Waterbirds | Semi-permanent wetlands; less frequently riparian | – – |
| **Greater sandhill crane** (*Grus canadensis tabida*) | ST, WCP-32 | Waterbirds | Seasonal wetlands, grain crops, and grassland/rangeland; less frequently forage and other row/field crops | Crop conversion |
| **Lesser sandhill crane** (*Grus canadensis canadensis*) | BSSC, WCP-32 | Waterbirds | Seasonal wetlands, grain and forage crops, and grassland/rangeland; less frequently other row/field crops | Crop conversion |
| **Snowy plover (interior)** (*Charadrius nivosus*) | BSSC, SCC, BCC, BCC-32, WL, CCV | Non-Breeding Shorebirds | Semi-permanent wetlands (alkali); less frequently seasonal wetlands | – – |
| **Mountain plover** (*Charadrius montanus*) | BSSC, SCC, BCC, BCC-32, WL | – – | Row/field crops and grassland/rangeland | – – |
| **Whimbrel** (*Numenius phaeopus*) | SCC, BCC, BCC-32, CCV | Non-Breeding Shorebirds | Forage crops; less frequently seasonal wetlands and grain crops | – – |
| **Long-billed curlew** (*Numenius americanus*) | SCC, BCC, BCC-32, WL | Non-Breeding Shorebirds | Forage crops; less frequently seasonal wetlands, grain crops, and grassland/rangeland | – – |
| **Black tern** (*Chlidonias niger*) | BSSC, NAWCP, WCP-32, CCV | Waterbirds | Grain crops; less frequently semi-permanent and seasonal wetlands | – – |
| **Forster's tern** (*Sterna forsteri*) | NAWCP, WCP-32, CCV | Waterbirds | Semi-permanent wetlands; less frequently seasonal wetlands and grain crops | – – |
| **Least bittern** (*Ixobrychus exilis*) | BSSC, NAWCP, WCP-32, CCV | Waterbirds | Semi-permanent wetlands | – – |
| **Bald eagle** (*Haliaeetus leucocephalus*) | SE, BCC, BCC-32 | – – | Semi-permanent and seasonal wetlands; less frequently riparian and oak woodland/savannah | Pollution |
| **Northern harrier** (*Circus cyaneus*) | BSSC | Grassland/oak savannah | Semi-permanent wetlands and grassland/rangeland; less frequently grain, forage, or other row/field crops | Crop conversion |

| | | | | |
|---|---|---|---|---|
| **Swainson's hawk** (*Buteo swainsoni*) | ST, BCC, CCV | – – | Riparian, grassland/rangeland, forage and other row/field crops; less frequently grain crops and oak woodland/savannah | Crop conversion |
| **Burrowing owl** (*Athene cunicularia*) | BSSC, BCC-32 | Grassland/oak savannah | Row/field crops and grassland/rangeland | Crop conversion |
| **Long-eared owl** (*Asio otus*) | BSSC, WL | – – | Habitat preferences not well known; uses riparian, grassland/rangeland, forage crops and other row/field crops | – – |
| **Short-eared owl** (*Asio flammeus*) | BSSC, BCC | – – | Habitat preferences not well known; uses semi-permanent wetlands, grassland/rangeland, and grain, forage, and other row/field crops | – – |
| **Loggerhead shrike** (*Lanius ludovicianus*) | BSSC[d], BCC, BCC-32 | Grassland/oak savannah | Grassland, oak savannah, and open shrubland; less frequently riparian and oak woodland | – – |
| **Least Bell's vireo[c]** (*Vireo bellii pusillus*) | FE, SE, WL, CCV | Riparian | Riparian | – – |
| **Yellow-billed magpie** (*Pica nuttalli*) | BCC, BCC-32, WL, CCV | Grassland/oak savannah | Oak woodland/savannah[e]; less frequently riparian and grain, forage, and other row/field crops | Pollution, disease |
| **Purple martin** (*Progne subis*) | BSSC | – – | Very limited distribution[f] | Invasive alien species |
| **Bank swallow** (*Riparia riparia*) | ST, CCV | Riparian | Riparian | – – |
| **Oak titmouse** (*Baeolophus inornatus*) | BCC, BCC-32, WL | – – | Riparian and oak woodland/savannah | – – |
| **LeConte's thrasher** (*Toxostoma lecontei*) | BSSC[g], BCC, BCC-32, WL, CCV | – – | Saltbush scrub | Invasive alien species |
| **Oregon vesper sparrow** (*Pooecetes gramineus affinis*) | BSSC, WL | – – | Grassland/rangeland | – – |
| **Grasshopper sparrow** (*Ammodramus savannarum*) | BSSC | Grassland/oak savannah | Grassland/rangeland; less frequently forage crops | Invasive alien species |
| **"Modesto" song sparrow** (*Melospiza melodia*) | BSSC, CCV | Riparian | Semi-permanent and seasonal wetlands; less frequently riparian | – – |
| **Suisun song sparrow** (*Melospiza melodia maxillaris*) | BSSC, BCC-32, CCV | – – | Semi-permanent wetlands; less frequently seasonal wetlands | – – |
| **Yellow-breasted chat** (*Icteria virens*) | BSSC | Riparian | Riparian | – – |
| **Yellow-headed blackbird** (*Xanthocephalus xanthocephalus*) | BSSC | – – | Semi-permanent wetlands | – – |
| **Tricolored blackbird** (*Agelaius tricolor*) | ST, BSSC, BCC, BCC-32, WL | – – | Semi-permanent wetlands, grassland/rangeland, and grain and forage crops; less frequently seasonal wetlands and riparian | Crop conversion, pollution, direct mortality from harvest. |
| **Yellow warbler** (*Setophaga petechia*) | BSSC, BCC-32 | Riparian | Riparian | – – |

[a] *Conservation status designations: **FE**, federally endangered, or **FT**, federally threatened species; **SE**, state endangered or **ST**, state threatened species; **SC**, candidate for state listing; **BSSC**, state bird species of special concern (Shuford and Gardali 2008); **SCC**, U.S. Shorebirds of Conservation Concern species categorized as needing Immediate Management or Management Attention (USSCPP 2015); **NAWCP**, colonial waterbird species of continental conservation concern in the North American Waterbird Conservation Plan (Kushlan et al. 2002); **WCP-32**, waterbirds of conservation concern in the Coastal California Bird Conservation Region (Shuford 2014); **BCC**, USFWS Birds of Conservation Concern (USFWS 2008); **BCC-32**, USFWS Birds of Conservation Concern in the Coastal California Bird Conservation Region (USFWS 2008); **WL**, species on the North American Bird Conservation Initiative's 2016 Watch List or subspecies on the 2014 list (Rosenberg et al. 2014; NABCI 2016); and **CCV**, species ranked among the most vulnerable to climate change (Gardali et al. 2012).*

[b] *Population and/or habitat objectives for the species can be found in the chapter dealing with the bird/habitat group listed.*

[c] *Largely extirpated.*

[d] *Mainland population only (vs. Channel Island population).*

[e] *Also uses ranch yards, wind breaks, roadside plantings, and orchards with large trees and open ground.*

[f] *Formerly nested in the northern Central Valley in riparian habitats and in urban buildings, but a remnant population is now confined to bridge nest sites in Sacramento.*

[g] *San Joaquin population only.*

**TABLE 14.1 Bird species at risk in the Central Valley: Conservation status, broad-scale habitat affinities, and major threats (from Shuford and Hertel 2017). "Other major threats" are those beyond habitat loss and degradation, which threatens all of these species. See Shuford and Hertel (2017) for additional threats (realized or potential) not yet known to have caused substantial impacts.**

# WHICH GEOGRAPHIC AREAS ARE INCLUDED?

The Plan evaluated at-risk species within the five planning regions of the CVJV's Primary Focus Area (Figure 14.1).

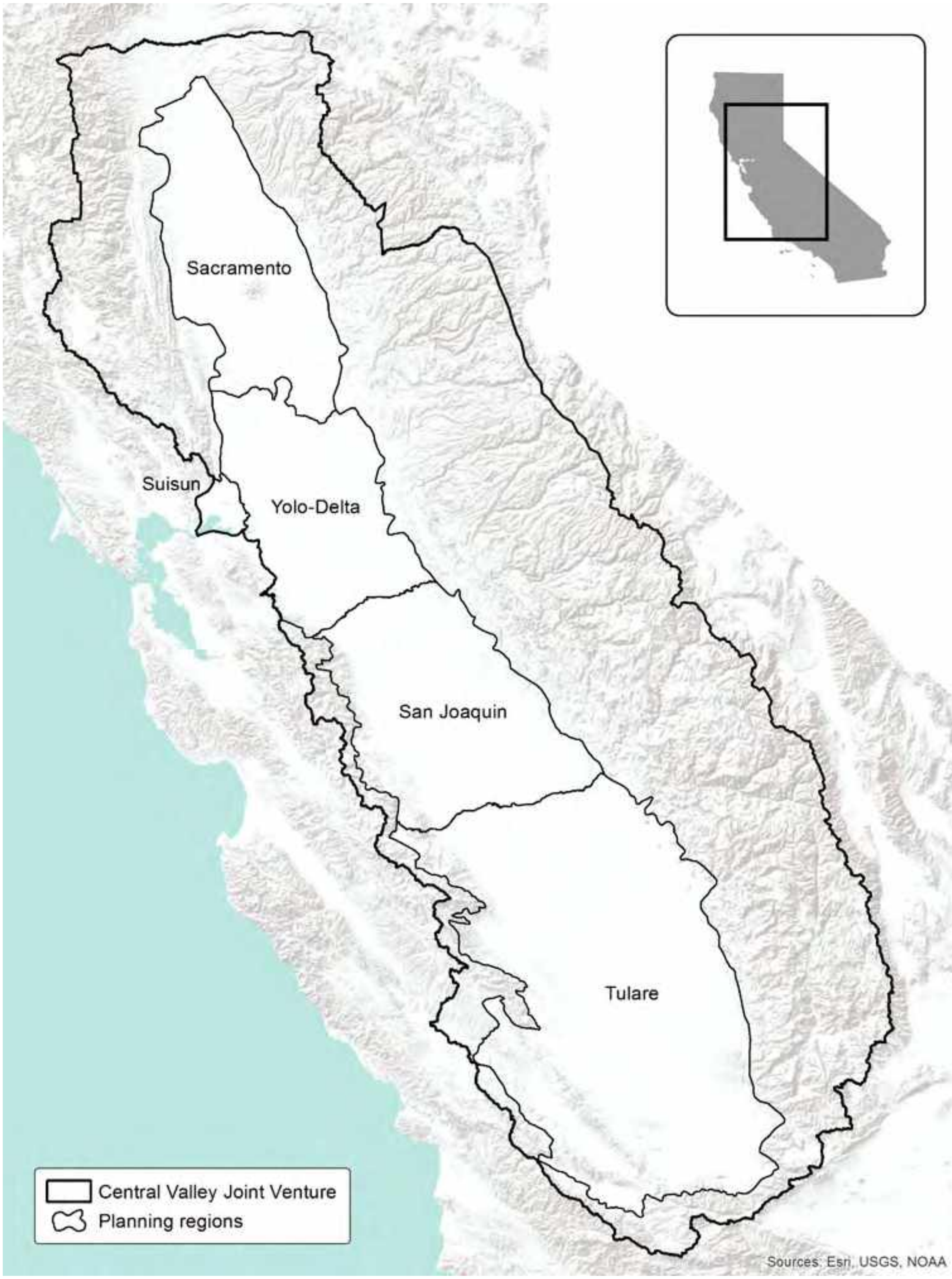



**FIGURE 14.1 Central Valley Joint Venture perimeter and Primary Focus Area, showing the five planning regions.**

# DEVELOPING THE AT-RISK SPECIES LIST

The CVJV used a two-step process to develop the list of bird species at risk in the Central Valley (Figure 14.2). First, all bird species were considered that occur regularly in the Central Valley at some point in their life cycles in numbers sufficient to expect that conservation actions on their behalf would be likely to benefit their populations, or species that formerly met this criterion and reasonably could be expected to recover with appropriate conservation actions. Researchers then gauged which of these species should be considered at risk in the Central Valley, including species that are (1) state and/or federally threatened or endangered (or a current candidate for listing) or ranked as a California Bird Species of Special Concern; (2) ranked in the category of "Immediate Management Action" or "Management Action" on the Watch List of Shorebirds of Conservation Concern in the United States; (3) ranked as highest, high, or moderate concern at the continental level by the North American Waterbird Conservation Plan and ranked either of high or moderate concern by the Coastal California (BCR 32) Waterbird Conservation Plan; or (4) included on both the national and BCR 32 lists for U.S. Fish and Wildlife Service's list of Birds of Conservation Concern and on the North America Bird Conservation Initiative's national/continental Watch List.

For each of the 38 species identified as at-risk, researchers used books, peer-reviewed papers, accounts in Birds of North America Online (BNA 2016), unpublished materials, and regional experts to identify the species' broad-scale habitat affinities, threats they face, and the season(s) and region(s) of the Central Valley they use. Affinities were considered for nine habitat types, including two wetland types, four native upland habitats, and three agricultural crop categories. Wetland types were seasonal and semi-permanent (managed) wetlands (including ponds, lakes, reservoirs, rivers, or other water bodies with extensive open water). The four native upland habitats were riparian forest, oak woodland/oak savannah, grassland/rangeland, and saltbush (*Atriplex* spp.) scrub. The three categories of agricultural crops were grain crops (rice, corn, wheat, triticale, barley, etc.), forage crops (alfalfa, irrigated pasture, and other hay crops), and miscellaneous field and row crops (also including weedy and bare fallow fields).

Finally, researchers assessed the severity of known historical and current threats to at-risk birds in the Central Valley, including habitat loss (and degradation), invasive alien species, pollution, overexploitation, and disease (Wilcove et al. 1998, 2000; Shuford and Gardali 2008). "Crop conversion" (from suitable to incompatible crops, e.g., orchards or vineyards) was added as a specific form of habitat loss and degradation.

*Bald eagle - Tom Grey*

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

## TWO-STEP PROCESS TO DEVELOP A LIST OF BIRD SPECIES AT RISK IN THE CENTRAL VALLEY

### STEP 1
**SPECIES DETERMINATION**

Species either (a) occur regularly in the Central Valley during the relevant season(s) in numbers sufficient to expect conservation success, or (b) do not currently meet these conditions but formerly did and are reasonably expected to recover with appropriate conservation.

### STEP 2
**SUFFICIENT CONSERVATION CONCERN IN STUDY REGION**

Species meet one or more of the following criteria:

1. State or Federally Endangered – OR – California Bird Species of Special Concern
2. "Immediate Management Action" or "Management Action" on Watch List of Shorebirds of Conservation Concern
3. At Least Moderate Concern, Continental Level, N. Am. Waterbird Conservation Plan – AND – At Least Moderate Concern By the BCR 32 Waterbird Conservation Plan
4. On National and BCR 32 Lists for USFWS List of Birds of Conservation Concern – AND – the N. Am. Bird Conservation Initiative's National/Continental Watch List

**FIGURE 14.2. The two-step process to identify at-risk bird species in the Central Valley. "Species" can also indicate a subspecies or distinct population.**

# CURRENT CONDITIONS

## Current Population Sizes, Trends, and Distribution

Many of the at-risk species lack current estimates of their population sizes and trends in the Central Valley. Available population size estimates, however, range from near zero for the nearly extirpated least Bell's vireo to over 40,000 for the grasshopper sparrow and the "Modesto" song sparrow (DiGaudio et al. 2017; Dybala et al. 2017). The yellow-billed cuckoo, burrowing owl, bank swallow, and horned lark were all estimated to be steeply declining in the Coastal California Bird Conservation Region (BCR 32; Sauer et al. 2014), with an average decline of more than 30 percent over 10 years (DiGaudio et al. 2017; Dybala et al. 2017). Tricolored blackbird numbers have declined by more than 80 percent from historical population levels (see Success Story side bar). Populations of many waterbirds change dramatically with short-term fluctuations in precipitation, making assessment of medium to long-term trends difficult (e.g., black and Forster's terns; Shuford et al. 2016).

The primary "season of concern" (the season[s] for which there is conservation concern in the Central Valley) for the various at-risk bird species include the breeding, non-breeding, and migration seasons and year-round (Table 14.2). Hence, the Central Valley is important to seasonally at-risk species throughout the calendar year. At-risk species are unevenly distributed among the five planning regions of the CVJV's Primary Focus Area, with substantial portions of the total Central Valley populations of these species occurring in the Sacramento (19 species), Tulare (16 species), San Joaquin (14 species), Yolo-Delta (13 species), and Suisun (five species) planning regions (Table 14.2).

## Current Habitat

Primary habitat types in the Central Valley for at-risk birds are wetlands (18 species), various agricultural crops (eleven species), grasslands (ten species), riparian (seven species), oak woodland/oak savannah (two species), and saltbush scrub (two species) (Table 14.1; Shuford and Hertel 2017). As detailed in the other bird chapters, the current extent of habitat types varies by sub-region. The extent of some types varies greatly seasonally and annually, depending on the timing and extent of intentional flooding in managed wetlands and crops (during irrigation and postharvest) as well as natural flooding more broadly during periods of extreme precipitation and runoff. Some at-risk species use habitats not included elsewhere in the Plan, such as saltbush scrub, which was formerly widespread in the San Joaquin and Tulare planning regions but has declined greatly in extent in parallel with decreasing numbers of the LeConte's thrasher (Fitton 2008). Likewise, some species (e.g., western grebe) use reservoirs and other open water bodies that are not accounted for in estimates of wetland extent in other bird chapters.

| SPECIES | SEASON OF CONCERN | SACRAMENTO | SUISUN | YOLO-DELTA | SAN JOAQUIN | TULARE |
|---|---|---|---|---|---|---|
| **Fulvous whistling-duck** | breeding | -- | -- | -- | -- | • |
| **Tule gr. white-fronted goose** | wintering | ● | • | -- | -- | |
| **Redhead** | breeding | ● | -- | -- | ● | ● |
| **Eared grebe** | breeding | -- | -- | -- | • | ● |
| **Western grebe** | breeding | ● | -- | • | ● | ● |
| **Yellow-billed cuckoo** | breeding | • | -- | -- | -- | -- |
| **Yellow rail** | wintering | -- | • | -- | -- | -- |
| **California black rail** | year-round | ● | ● | ● | -- | -- |
| **Greater sandhill crane** | wintering | ● | -- | ● | • | -- |
| **Lesser sandhill crane** | wintering | • | -- | ● | ● | ● |
| **Snowy plover (interior)** | breeding | -- | -- | • | • | ● |
| **Mountain plover** | wintering | • | -- | • | ● | ● |
| **Whimbrel** | migration | • | • | • | ● | ● |
| **Long-billed curlew** | non-breeding | • | • | ● | ● | ● |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Black tern** | breeding | ● | – – | – – | • | • |
| **Forster's tern** | breeding | – – | – – | – – | • | ● |
| **Least bittern** | breeding | ● | • | • | • | ● |
| **Bald eagle** | year-round | ● | • | • | • | • |
| **Northern harrier** | breeding | ● | ● | ● | ● | ● |
| **Swainson's hawk** | breeding | ● | • | ● | ● | • |
| **Burrowing owl** | breeding | ● | • | ● | ● | ● |
| **Long-eared owl** | breeding | • | – – | – – | – – | • |
| **Short-eared owl** | breeding | • | ● | • | • | • |
| **Loggerhead shrike** | breeding | • | • | ● | ● | ● |
| **Least Bell's vireo** | breeding | — | – – | – – | • | – – |
| **Yellow-billed magpie** | year-round | ● | – – | ● | • | • |
| **Purple martin** | breeding | • | – – | – – | – – | – – |
| **Bank swallow** | breeding | ● | • | – – | – – | – – |
| **Oak titmouse** | year-round | ● | ● | ● | ● | • |
| **LeConte's thrasher** | year-round | – – | – – | – – | – – | • |
| **Oregon vesper sparrow** | wintering | ● | – – | ● | ● | ● |
| **Grasshopper sparrow** | breeding | • | ? | • | • | – – |
| **"Modesto" song sparrow** | year-round | ● | – – | ● | – – | – – |
| **Suisun song sparrow** | year-round | – – | ● | – – | – – | – – |
| **Yellow-breasted chat** | breeding | ● | – – | • | • | • |
| **Yellow-headed blackbird** | breeding | ● | • | ● | ● | ● |
| **Tricolored blackbird** | breeding | ● | • | • | ● | ● |
| **Yellow warbler** | breeding | • | – – | – – | • | – – |

**Distribution across the five planning regions is designated as:**

● **Substantial:** This planning region supports a substantial portion of the species' population in the Central Valley. This category not used at all if the Valley-wide population of the species is very small.

• **Low to Modest:** This planning region supports a low to modest portion of the species' population in the Central Valley; or, the species occurs in the indicated planning region(s), but the entire population in the Valley is very small.

**TABLE 14.2 Patterns of current distribution of at-risk species during their "season of concern," across five planning regions of the Central Valley (Figure 14.1). For species that occur in the Central Valley in more than one season (breeding, wintering, migration), the "season of concern" is the season for which there is conservation concern. "Non-breeding" encompasses wintering and migration seasons. "Year-round" indicates there is conservation concern for this species in the Valley during every season.**

# CONSERVATION OBJECTIVES

The Plan does not define specific habitat or population objectives for at-risk species, except those that are included within one of the other bird chapters (referenced in Table 14.1). Of the 38 species identified as at risk, 19 (50 percent) have habitat and population objectives developed in other chapters of this Plan. Another 14 species use habitats in which species of their taxonomic or habitat group were evaluated but the at-risk species were not selected as focal species; still, some of these species are likely to benefit to some degree from the habitat objectives defined in the other chapters. Only five species were not otherwise addressed in the current Plan: bald eagle, purple martin, LeConte's thrasher, Suisun song sparrow, and yellow-headed blackbird.

*(1) Water control structure, Gray Lodge Wildlife Area - Ducks Unlimited*
*(2) Tricolored blackbird flock in a field farmed for silage - Samantha Arthur*

# CONSERVATION CONSIDERATIONS FOR AT-RISK SPECIES

## Framework for Setting Objectives in Future Plan Updates

The CVJV endorses a framework for setting conservation objectives for at-risk species in the future that includes (1) evaluating assumptions about limiting factors, (2) considering adopting objectives already set for threatened or endangered species, (3) assessing whether objectives set for species groups or focal species meet the needs of at-risk species otherwise lacking objectives, (4) applying established methods to at-risk species with respect to habitats or seasons not currently addressed, and (5) determining whether new information is needed to effectively set objectives.

## Unique habitats and species

As noted earlier, some habitats important to at-risk species are not included in other chapters of this Plan. LeConte's thrasher is the only species dependent solely on saltbush scrub and so its conservation and management require a special focus on this habitat type. Additionally, purple martins currently nest in the Central Valley only under bridges in the Sacramento region (Airola and Williams 2008; Airola et al. 2014), but at present, the CVJV Plan does not consider urban cover types for conservation. Some species with very specialized ecological needs, such as the tricolored blackbird, face difficult conservation challenges, which may best be addressed by species-specific working groups (TBWG 2009).

## Multiple habitats

Some at-risk species use multiple habitats but currently have conservation objectives set for only one habitat. The northern harrier, for example, uses both grassland and wetland habitats, but conservation objectives have been set only for grasslands. Still, the wetland objectives that the Plan establishes for other taxonomic groups (e.g., breeding shorebirds and waterbirds) can also benefit the northern harrier, yellow-headed blackbird, and other at-risk species that use wetlands, as long as their needs are taken into consideration in habitat restoration, enhancement, and management decisions.

## Multiple Threats

There are multiple major threats for at-risk species in the Central Valley. The greatest of these is habitat loss and degradation, which affects all 38 species. Other important threats are crop conversion (compatible to incompatible; six species), invasive alien species (three species), pollution (e.g., pesticides or other contaminants; three species), and disease (two species) (Table 14.1).

For some at-risk species, limiting factors have changed over time or are obscure, complicating conservation efforts. The purple martin, for example, formerly nested in riparian trees in the Sacramento Valley, but declines in its populations were closely linked to the expansion of the European starling (*Sturnus vulgaris*), which outcompetes martins for nesting cavities (Airola and Williams 2008). Starlings are no longer a major threat to the small remnant population of purple martins breeding under bridges in the Sacramento region (Airola et al. 2014). However, new factors have been contributing to a sharp decline in this martin population since 2006, including predation by American kestrels (*Falco sparverius*), vehicle collisions, and, perhaps, the large increase in use of neonicotinoid pesticides (Airola et al. 2014).

Similarly, the yellow-billed cuckoo continues to decline in the Sacramento Valley despite large-scale riparian habitat restoration over the past 30 years. An estimated 97 percent of suitable restored habitat appears to be unoccupied (Dettling et al. 2015). Hence the primary limiting factor for cuckoos may not currently be suitable breeding habitat in the Central Valley, but instead could be any of several other factors such as limitations of food resources, or the habitat quantity or quality on their wintering grounds or at migratory stopovers (Dettling et al. 2015). Because of the substantial losses of historical habitat in the Central Valley, the first assumption is that habitat loss and degradation is the primary limiting factor for most at-risk species. However, when habitat restoration appears to have limited success, further study is required to guide the most strategic conservation actions that should be considered, particularly for migratory species that spend large portions of their annual cycle outside the Central Valley.

## Recovery Plans for Threatened and Endangered Species

Of the eight at-risk bird species in the Central Valley that are currently state or federally listed, four have a recovery or conservation plan: Swainson's hawk (FOSH 2009), least Bell's vireo (USFWS 1998), bank swallow (CDFG 1992; BANS-TAC 2013), and tricolored blackbird (TBWG 2009). Of the four, only the plans for the vireo and the swallow have quantitative population or habitat objectives. In many cases, these recovery plans include detailed recommendations for the restoration and management of habitat for these species. When implementing restoration projects designed to meet the CVJV habitat objectives, it is strongly recommended that practitioners consult these recovery plans to ensure that any unique habitat requirements for at-risk species are met.

## SUCCESS STORY

# TRICOLORED BLACKBIRD WORKING GROUP

The Tricolored Blackbird Working Group was formed in 2004 to bring together state, federal, and academic biologists, non-governmental organizations, and industry representatives to address the population decline of tricolored blackbirds. This colonial-nesting species, found almost exclusively in California, has seen a decline of more than 80 percent from historical population levels. The working group's multifaceted, cooperative approach focuses on voluntary conservation actions.

Coordinated by Audubon California, the working group developed an updated conservation plan (TBWG 2009) and has collaborated with others to conduct triennial population surveys, enhance wetland and upland habitat, and protect tricolored blackbird nesting colonies established in forage crops (e.g., triticale and wheat).

Partnering with the working group, the Natural Resources Conservation Service enrolls farmers in practices to delay harvest of forage crops, thus allowing tricolored blackbird colonies to complete the nesting cycle. This effort has significantly reduced tricolored blackbird mortality, saving the reproductive output of more than 200,000 nesting birds in the past four years.


1

*(1) Biologists banding a tricolored blackbird - USFWS (2) Tricolored blackbirds - Jerry Ting*

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# GLOSSARY

| TERM | DEFINITION |
|---|---|
| **10-year goal** | See Short-term goal. |
| **100-year goal** | See Long-term goal. |
| **Acquisition** | The purchasing of land in fee-title (complete ownership) or placing land under a conservation easement to protect it from development and/or with the intention to restore or enhance habitat. |
| **Adaptive management** | A systematic approach integrating project design, management and monitoring to provide a framework to systematically test assumptions, promote learning and supply timely information to improve management decisions. (See also Strategic Habitat Conservation.) |
| **Association of Joint Venture Management Boards (AJVMB)** | An organization comprised of board members from the 21 North American migratory bird joint ventures. The AJVMB works closely with joint venture partners to share messages with legislators and other decision makers (MBJV 2019). |
| **Assumption** | A statement that is believed to be true, but is uncertain, such as the cause-and-effect relationship between a management action and its effect on a conservation target. |
| **Basin** | A geographic area defined by hydrologic, geologic and floristic information. |
| **Best available science** | A synthesis of the most reliable knowledge at a point in time, derived from scientific inquiry defined by the following criteria: The questions are clearly stated; the investigation is well designed; and the results are analyzed logically, documented clearly and may be subjected to peer review (Sullivan et al. 2006). |
| **Biological diversity, biodiversity** | The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur. |
| **Biological population** | All individuals of the same species living together in a defined area at the same time. This area should be sufficiently large that changes in the population's size are primarily due to births and deaths, not movement. However, the size of this area can be difficult to define, especially for mobile species, leading to the use of "management population." (See also Management population.) |
| **Boundary, CVJV** | The line that marks the limits of the Central Valley Joint Venture's geographic coverage area. (See also Geographic area, CVJV.) |
| **California Floristic Province** | The primary focus area of the Plan is based on the California Floristic Province as identified by The Jepson Herbarium. This is the largest and most botanically diverse geographic unit in California, comprising all of California west of the Great Basin Province in the north and the Desert Province in the south (Jepson Herbarium 2019). |
| **Central Valley Landscape Conservation Project (CVLCP)** | A project that identified climate-smart conservation actions that will maximize the adaptive capacity of priority species, habitats and ecosystems to support an ecologically connected Central Valley landscape. (CVLCP 2017). |
| **Central Valley Project (CVP)** | A network of dams, reservoirs, canals, hydroelectric power plants and other facilities that provides flood protection for the Central Valley and supplies water for agriculture, as well as for domestic and industrial water in the Valley and to several major urban centers. The CVP, a federal project, also produces electrical power and offers various recreational opportunities as well as water to restore and protect fish and wildlife. |
| **Central Valley Project Improvement Act (CVPIA)** | A federal law that mandates changes in management of the Central Valley Project for the protection, restoration and enhancement of fish and wildlife. It requires the Secretary of the Interior to provide firm water supplies of suitable quality to maintain and improve wetland habitat areas identified in the act. |
| **Climate-Smart Conservation** | Employs principles for designing and carrying out conservation in the face of a changing climate. Principles include: Act with intentionality through linking actions to impacts; manage for change, not just persistence; reconsider goals, not just strategies; integrate adaptation into existing work (Stein et al. 2014). |

# GLOSSARY

| TERM | DEFINITION |
|---|---|
| **Conservation objectives** | Science-based targets for focal species population size and/or density, and the quantity and quality of habitat types needed to support those desired populations. Includes specific, measurable, results-oriented and time-fixed outcomes that measure incremental progress toward achieving conservation goals. |
| **Conservation target** | An element of biodiversity that a plan or project has chosen to focus on, such as a species, habitat, or ecological system. |
| **Cost-share** | Programs available to private landowners through various federal or state agencies and/or private conservation organizations. Typical cost-share habitat improvement programs pay for a percentage of the agreed-upon habitat restoration and/or enhancement activities. In turn, the landowner agrees to maintain the improvements for a given period of time. Cost-share programs may also be known as incentive programs. |
| **CVJV partner** | An individual or organization who works with the Central Valley Joint Venture (CVJV) to achieve the Implementation Plan's conservation objectives. They may or may not be a board member or belong to a member organization. |
| **CVPIA refuges** | Central Valley Project Improvement Act (CVPIA) refuges consist of 19 areas on federal National Wildlife Refuges (NWR), state Wildlife Areas (WA), and one privately-managed wetland complex. These include Sacramento NWR; Delevan NWR; Colusa NWR; Sutter NWR; units of San Luis NWR including East Bear Creek, Freitas, Kesterson, San Luis, and West Bear Creek; Merced NWR; Pixley NWR; Kern NWR; Gray Lodge WA; Los Banos WA; units of Los Banos WA including Salt Slough and China Island; Volta WA; Mendota WA; and the private wetlands of the Grassland Resource Conservation District. |
| **Demonstration project** | A project primarily employing and displaying new techniques to further verify outcomes, that will be used as a case study for other projects in the future. |
| **Easement** | A voluntary real estate transaction in which all or a portion of a property's development rights are purchased from a landowner to protect resource values on private lands (USFWS 2015a). |
| **Ecological Reserve** | Designation given to certain lands owned or managed by the California Department of Fish and Wildlife as a way of regulating appropriate use. This designation is usually reserved for land with special status plants, animals, or vegetation types (CDFW 2015). (Compare to Wildlife Area.) |
| **Ecoregion** | An area defined by a combination of biological, social and geographic criteria. A system of related, interconnected ecosystems. |
| **Ecosystem** | A dynamic and interrelated complex of plant and animal communities and their associated nonliving environments. |
| **Ecosystem services** | The beneficial outcomes for the natural environment or for people that result from ecosystem functions. Some examples are support of the food chain, harvesting of animals or plants, clean water, or scenic views. For an ecosystem to provide services to humans, some interaction with, or at least some appreciation by humans, is required (CDFW 2015). |
| **Endangered species, federal** | A plant or animal species listed under the Endangered Species Act of 1973, as amended, that is in danger of extinction throughout all or a significant portion of its range. Populations of these species are at critically low levels or their habitats have been degraded or depleted to a significant degree (USFWS 1998). |
| **Endangered species, state** | A plant or animal species in danger of becoming extinct in a particular state within the near future, if factors contributing to its decline continue. Populations of these species are at critically low levels or their habitats have been degraded or depleted to a significant degree (CDFW 2019). |
| **Enhancement** | The physical manipulation of a site to improve ecological functions and increase the quality of habitat. Also includes infrastructure improvements (e.g., levees, water control structures, pumps, etc.) to increase habitat management capability. |
| **Environmental education** | A process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions (EPA). May include education, outreach, stewardship, and access activities. |
| **Extirpated** | Locally extinct; a species that has disappeared from a given area. |

# GLOSSARY

| TERM | DEFINITION |
|---|---|
| **Farm Bill** | The primary agricultural and food policy tool of the U.S. government. Beginning in 1933, farm bills have included titles on commodity programs, trade, rural development, farm credit, conservation, agricultural research, food and nutrition programs, marketing and others. The Farm Bill is passed approximately every 5 years and is under the purview of the U.S. Department of Agriculture. As of this Plan, the current Farm Bill is the Agriculture Improvement Act of 2018. |
| **Flooded agriculture** | Agricultural crops (e.g., rice, corn) that are inundated with water to manage vegetation (e.g., stimulate growth or stubble decomposition), increase access to waste grain and invertebrates for waterfowl, shorebird, and other waterbird consumption, or for other purposes. |
| **Geographic area, CVJV** | The region where the CVJV has formally accepted the responsibility of implementing national bird conservation planning and has received general acceptance in the bird conservation community for this responsibility. (See also Boundary, CVJV.) |
| **Geographic Information System (GIS)** | An organized assembly of people, data, techniques, computers, and programs for acquiring, analyzing, storing, retrieving, and displaying spatial information about the real world (CDFW 2015). |
| **GIS layer** | Geographic Information Systems document and present data about multiple variables, each in a separate layer. Layers can be combined to give a landscape-level view of a geographical area. |
| **Goal** | A formal statement detailing the desired impact of a plan or project, such as the desired future condition of a conservation target. |
| **Grassland** | A landscape dominated by grasses and other herbaceous plant species with less than 10% woody cover (DiGaudio et al. 2017) |
| **Grassland Resource Conservation District (GRCD)** | One of the 19 wetland areas collectively identified as refuges in the Central Valley Project Improvement Act. It contains approximately 75,000 acres and is composed primarily of privately-owned hunting clubs and wildlife-beneficial agriculture. |
| **Grassland Water District (GWD)** | A California Water District formed under Section 34000 of the State Water Code. The majority of the District is managed as wetland habitat. The District's primary function is the delivery of water to the landowners within its boundaries. |
| **Grasslands Ecological Area (GEA)** | The wetlands and associated grasslands of the Grassland Resource Conservation District, complemented by state and federal lands, including national wildlife refuges, state wildlife areas, and one state park, comprising over 160,000 acres. |
| **Habitat creation** | Construction of habitat that did not previously exist, or would not progress naturally, in a particular location. |
| **Habitat objectives** | The amount of protected habitat (usually expressed in acres) needed to meet the population objective and/or combined population objectives for target wildlife species. (See also Conservation objectives.) |
| **Human dimensions of natural resource management** | A field of study that incorporates how humans value natural resources into the decision-making processes that influence management, planning and actions. |
| **Hydroperiod** | The timing and duration of flooding of wetlands. |
| **Land use trends** | The general direction in which management and modification of the natural environment by people is changing. |
| **Long-term goal** | As defined in this Plan, the intent of a long-term goal is to identify a future condition that is desired within 100 years. |
| **Management Board, CVJV** | Representatives from 19 public and private conservation organizations. These CVJV partners work together at local and regional levels to promote conservation for the benefit of birds, associated wildlife and the people of California. |

# GLOSSARY

| TERM | DEFINITION |
|---|---|
| **Management population** | A group of individuals of the same species, that occupies a particular area that has been delineated for management purposes. Depending on the species, a management population may occupy an area that is smaller or larger than the biological population. The management populations for the CVJV Implementation Plan are the planning regions (Sacramento, Yolo-Delta, Suisun, San Joaquin and Tulare) and/or the basins therein. (See also Biological population.) |
| **Management, habitat** | The annual maintenance or manipulation of a site to promote desired vegetation and achieve desired habitat performance. Management actions can include application of water, mowing, discing, and maintaining desired water levels. |
| **Member organization** | An organization that has membership on the CVJV Management Board. |
| **Migratory Bird Joint Ventures (JVs)** | Cooperative, regional partnerships that work to conserve habitat for the benefit of birds, other wildlife, and people. There are twenty-two habitat-based Joint Ventures across North America, each addressing the bird habitat conservation issues found within their geographic area, as well as three species-based Joint Ventures. |
| **Migratory birds** | Birds that follow a seasonal movement between their breeding grounds and their wintering grounds. For purposes of regulation, a migratory bird is defined as a bird of a species that belongs to a family or group of species present in the United State as well as Canada, Japan, Mexico, or Russia. Most native bird species (birds naturally occurring in the United States) belong to a protected family and are therefore protected by the Migratory Bird Treaty Act (USFWS 2015b) |
| **Mitigation** | A measure designed to counteract an undesirable environmental effect or to make an effect less severe. |
| **Monitoring** | The collection and evaluation of data relative to stated project goals and objectives. |
| **Multiple-benefit projects** | Projects designed to meet societal needs and enhance ecological function and habitat quality for fish and wildlife. |
| **National Wildlife Refuge (NWR)** | A designated area of land and/or water within the National Wildlife Refuge System of the U.S. Fish and Wildlife Service. |
| **National Wildlife Refuge System** | The U.S. Fish and Wildlife Service manages the National Wildlife Refuge System. The mission of the Refuge System, as stated in the Refuge System Improvement Act of 1997, is "…to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (USFWS 2009). |
| **North American Bird Conservation Initiative (NABCI)** | A forum of government agencies, private organizations, and bird initiatives helping partners across the continent meet their common bird conservation objectives (NABCI 2016). |
| **North American Waterbird Conservation Plan (NAWCP)** | Provides a continental-scale framework for the conservation and management of waterbirds throughout North America, Central America, the Caribbean and western Atlantic, the U.S.-associated Pacific Islands and pelagic waters of the Pacific (Kushlan et al. 2002). |
| **North American Waterfowl Management Plan (NAWMP)** | A strategy to restore waterfowl populations through habitat protection, restoration and enhancement using an international conservation partnership approach (NAWMP 2018). Signed in 1986 by the United States and Canada and in 1994 by Mexico. |
| **North American Wetlands Conservation Act (NAWCA)** | Public Law 101-233, enacted in 1989, provides funding and administrative direction for implementation of the North American Waterfowl Management Plan and the Tripartite Agreement on wetlands between Canada, U.S. and Mexico. The NAWCA program provides funding for wetlands conservation projects in these countries through a competitive grant program. |
| **Oak savannah** | Woodlands with sparse (10% to 40%) tree cover, with oaks (Quercus spp.) as the dominant tree species and primarily grass-dominated understories (Di Gaudio et al. 2017). |
| **Plan life span** | The amount of time intended for a planning document to serve as guidance in support of the implementation actions laid out in the document. |
| **Planning horizon** | The amount of time an organization looks into the future when preparing a strategic plan. The period covered by a particular plan or planning cycle. |

# GLOSSARY

| TERM | DEFINITION |
|---|---|
| **Planning region** | Areas delineated for planning purposes. They can be subjective and informed by ecology, such as natural barriers, gaps in habitat or ecoregional boundaries. In this Plan, planning regions may incorporate multiple basins to reflect the current scientific knowledge and conservation needs of the different bird communities. (See also Basin.) |
| **Population objective** | The desired number of individuals of a given wildlife species in a management population. (See also Conservation objectives.) |
| **Postharvest flooding of cropland** | A management technique used to break down material left in the field after harvest. Postharvest flooding of rice facilitates residual straw decomposition and provides habitat for waterfowl, waterbirds and shorebirds. |
| **Primary Focus Area of the CVJV Plan** | The Central Valley floor, approximately 50 miles wide by 400 miles long; composed of nine hydrologic basins. This is the area where the CVJV focuses most of its efforts. (See also Secondary focus area.) |
| **Protection, habitat** | The removal of the threat of loss of bird habitat via fee-title acquisition, conservation easement or agricultural easement from willing sellers. This action does not result in a gain in habitat acreage. |
| **Ramsar Convention on Wetlands of International Importance** | An intergovernmental treaty for the conservation and sustainable use of wetlands. It provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Also known as the Ramsar Convention or the Convention on Wetlands. |
| **Reclamation District** | Legal subdivisions within California's Central Valley that are responsible for managing and maintaining the levees, fresh-water channels, sloughs, canals, pumps and other flood protection structures in the area. |
| **Reclamation District 10** | Also known as District 10, this area in Yuba County is directly north of the city of Marysville. It was established in 1913 to designate authorities responsible for maintaining the levees in that area to prevent floods. This area includes approximately 12,000 acres of land and 23 miles of levees. The private wetlands within the district and other irrigated fields provide important habitat for waterfowl. |
| **Refuge water supplies, Full Level 2 (L2)** | CVPIA water supply requirement based on the average volume of water historically available annually to a managed wetland. This was the existing average water supply delivered to each refuge in the period between 1974 and 1983 (USBR 1989); or two-thirds of the water supply needed for full habitat development for those habitat areas identified in the San Joaquin Action Plan/Kesterson Mitigation Action Plan (USBR et al. 1989). The Bureau of Reclamation provides this water primarily from CVP yield through long-term contractual agreements with the California Department of Fish and Wildlife, the USFWS, and Grassland Water District. The Bureau of Reclamation was to provide this water when CVPIA was enacted in 1992. |
| **Refuge water supplies, Full Level 4 (L4)** | CVPIA water supply requirement based on the volume of water per month needed at a managed wetland for optimum habitat management. This is listed for each CVPIA refuge in the "Refuge Water Supply Needs" section of the 1989 Report (USBR 1989); or the full water supply needed for full habitat development for those habitat areas identified in the San Joaquin Action Plan/Kesterson Mitigation Action Plan Report (USBR et al. 1989). |
| **Refuge water supplies, Incremental Level 4 (IL4)** | The difference between Full Level 4 and Full Level 2 refuge water supplies. |
| **Resilience, landscape** | The ability of a landscape to sustain desired ecological functions, robust native biodiversity, and critical landscape processes over time, under changing conditions, and despite multiple stressors and uncertainties (Standish et al. 2014). |
| **Resource Conservation Districts (RCDs)** | Special districts of the State of California, set up to conserve soil and water, control runoff, prevent and control soil erosion, manage watersheds, protect water quality, and develop water storage and distribution. RCDs are locally governed agencies with their own locally appointed or elected, independent boards of directors. RCDs implement projects on public and private lands and educate landowners and the public about resource conservation (California Department of Conservation 2019). |
| **Restoration, habitat** | The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning lost natural functions to degraded native habitat. |
| **Riparian area** | The transition area between a body of water (lakes or rivers) and the upland habitat. Usually dependent upon the existence of perennial, intermittent or ephemeral surface or subsurface water drainage. |
| **Scenario planning** | A process of visualizing possible future conditions or events, what their consequences or effects would be like, and how to respond to or benefit from them. |

# GLOSSARY

| TERM | DEFINITION |
|---|---|
| **Secondary Focus Area of the CVJV Plan** | The area bordering the Central Valley floor and generally following the crest of the mountain ranges that rim the Valley; outside of the CVJV planning regions but within the larger geographic area of the CVJV. |
| **Short-term goal** | As defined in this Implementation Plan, a short-term goal is a future condition that is desired within 10 years. |
| **Social science** | A major category of academic disciplines, concerned with society and the relationships among individuals within a society. The social sciences include economics, political science, human geography, demography, psychology, sociology, anthropology, archaeology, jurisprudence, history, and linguistics. |
| **Special status species** | A universal term used in the scientific community for species that are considered sufficiently rare that they require special consideration and/or protection. These include, but are not limited to, species listed as rare, threatened or endangered by the federal and/or state governments. |
| **Species of concern** | A plant or animal species, while not falling under the definition of special status species, that is of management interest by virtue of being a federal trust species such as a migratory bird or an important game species; or, a species that has documented or apparent population declines, small or restricted populations, or dependence on restricted or vulnerable habitats. |
| **Species of Special Concern** | A designation by the California Department of Fish and Wildlife. A Species of Special Concern (SSC) is a species, subspecies, or distinct population of an animal native to California that currently satisfies one or more of the following (not necessarily mutually exclusive) criteria:<br>• is extirpated from the state or, in the case of birds, is extirpated in its primary season or breeding role;<br>• is listed as federally-, but not state-, threatened or endangered; meets the state definition of threatened or endangered but has not formally been listed;:<br>• is experiencing, or formerly experienced, serious (noncyclical) population declines or range retractions (not reversed) that, if continued or resumed, could qualify it for state status as threatened or endangered;<br>• has naturally small populations exhibiting high susceptibility to risk from any factor(s) that, if realized, could lead to declines that would qualify it for state status as threatened or endangered. |
| **Strategic Habitat Conservation (SHC)** | An adaptive management framework that informs decisions about where and how to expend resources for wildlife species, or groups of species, in identified priority areas or regions (landscapes) with particular biological importance. |
| **Strategy** | A set of actions with a common focus that work together to achieve specific goals and objectives. |
| **Subtidal habitat** | Coastal wetland permanently flooded with tidal water (Mitsch and Gosselink 2000). Technically defined as the area at elevation between Mean Lower Low Water (MLLW) to 18 feet below MLLW. It is synonymous with "Estuarine Wetland - Open Water" and "Estuarine Wetland - Aquatic Bed." |
| **Suisun Resource Conservation District (SRCD)** | A 115,000-acre district, established in 1963 as a Special District of the State of California and composed primarily of privately-owned hunting clubs. |
| **Sustainable Groundwater Management Act of 2014 (SGMA)** | A state law that establishes a framework for sustainable, local groundwater management. SGMA requires groundwater-dependent regions to halt overdraft and bring basins into balanced levels of pumping and recharge. Upon passage of SGMA, the California Department of Water Resources launched the Sustainable Groundwater Management (SGM) Program to implement the law and provide ongoing support to local agencies around the state. |
| **Tailwater, agricultural** | Surface water runoff resulting from crop irrigation. |
| **Threatened species, federal** | A plant or animal species listed under the Federal Endangered Species Act of 1973, as amended, that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (USFWS 1998). |
| **Threatened species, state** | A plant or animal species listed under the California Endangered Species Act, that is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts (CDFW 2019). |

# GLOSSARY

| TERM | DEFINITION |
|---|---|
| **TRUEMET** | A bioenergetics model developed by waterfowl scientists to estimate waterfowl habitat requirements by comparing food energy needs to food energy supplies (Petrie et al. 2016). |
| **Unprotected land** | Any privately-owned land not covered by a perpetual conservation or agricultural easement. |
| **Upland or upland habitat** | An area that is not wetlands or aquatic; can include grasslands, scrub-shrub habitat, wetland-associated dry areas, and rangelands. Usually at a higher elevation than wetlands. Some diked, low-elevation or subsided areas, including former agricultural lands that were historically wetlands but are currently dry, may be classified as uplands. |
| **Vital rates** | Factors affecting population growth, such as nesting success and duckling survival rates. |
| **Western Hemisphere Shorebird Reserve Network (WHSRN)** | An organization dedicated to conserving shorebirds and their habitats through a network of key sites across the Americas. There are three categories of Sites and one of Landscapes, according to their importance for shorebirds: Sites/Landscapes of Hemispheric Importance; Sites of International Importance; and Sites of Regional Importance. |
| **Wetland stipulation** | As applied to the CVJV habitat objectives, requires a certain percentage of waterfowl diet resources in a given planning region to come from managed seasonal wetlands, rather than agricultural lands. |
| **Wetlands** | Transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water. Wetlands must have one or more of the following three attributes: 1) At least periodically, the land supports predominantly hydrophytes (plants growing in water or waterlogged soil); 2) the substrate is predominantly undrained hydric soil; and 3) the substrate is saturated with water or covered by shallow water at some time during the growing season of each year. (See also the definitions of different wetland types.) |
| **Wetlands, estuarine** | Brackish and saline wetlands associated with estuaries, where salinity due to ocean-derived salts is greater than 0.5%. Estuarine wetlands consist of three main parts: the vegetated marsh plain above the average high tide (estuarine-marsh), the area of open water during an average low tide (estuarine-open water), and the area lacking vegetation that is exposed during the average low tide (estuarine-mudflat). In addition, some estuarine wetlands have submerged aquatic vegetation, such as eel grass, that is partially exposed during the average low tide. Water regime distinguishes tidal from non-tidal wetlands in this category. |
| **Wetlands, historical** | Areas where there is evidence that a wetland once existed (USFWS 2018). Generally documented in an historical record of the wetland extent; for example, by historical maps or aerial photographs. More recently, the use of some databases (e.g., areas mapped as having wetland soil types in the soil survey) have been used in attempts to identify these wetlands. |
| **Wetlands, lacustrine** | Lacustrine systems (lakes) include wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergent vegetation, or emergent mosses or lichens with greater than 30% area coverage; and (3) total area exceeds 8 hectares (20 acres). Lacustrine waters may be tidal or nontidal, but ocean-derived salinity is less than 0.5%. |
| **Wetlands, managed** | A given area of land managed for wetland functions and where water is intentionally and actively applied annually through a managed process (USFWS 2000). These diked wetland areas are often managed by manipulating water levels specifically to benefit waterfowl and/or shorebirds. |
| **Wetlands, managed seasonal** | Flooded in the fall, with standing water maintained continuously throughout the winter until water is drawn down in the spring (Smith et al. 1994). (Also called moist-soil management areas.) |
| **Wetlands, palustrine** | Freshwater tidal wetlands or a range of freshwater nontidal, managed wetlands. The palustrine system includes all nontidal wetlands dominated by trees, shrubs, persistent emergent vegetation, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5%. Palustrine wetlands may also include wetlands lacking such vegetation. |
| **Wetlands, permanent** | Wetlands that remain flooded throughout the year; also called permanent marshes (Smith et al. 1994). |

# GLOSSARY

| TERM | DEFINITION |
|---|---|
| **Wetlands, reverse-cycle** | Reverse-cycle ponds flooded from winter or spring through summer. Also called "summer-flooded seasonal wetlands." Used by waterbirds during the breeding season for nesting, foraging, and roosting. This reverse flooding cycle establishes higher densities of invertebrates that are especially used as a duckling food source than do the typical wet winter/dry summer conditions associated with natural Central Valley flood periods (USACE and NWU 2001). |
| **Wetlands, riverine** | Includes all wetlands and deep-water habitats contained within a channel, not including wetlands dominated by trees, shrubs, persistent emergent vegetation, emergent mosses, or lichens. |
| **Wetlands, seasonal** | Non-tidal wetlands (either managed or unmanaged) that flood for extended periods, but with no surface water for parts of the year. |
| **Wetlands, semi-permanent** | Wetlands (either managed or unmanaged) that flood during the spring and summer but experience a 2- to 6-month dry period each year (Smith et al. 1994). |
| **Wetlands, tidally influenced brackish** | Wetlands influenced by the tidal action. Brackish wetlands have more salinity than freshwater, but not as much as seawater. Brackish water may be tidally influenced. |
| **Wildlife Area (WA)** | Designation given to certain lands owned or managed by the California Department of Fish and Wildlife as a way of regulating appropriate use. This designation is usually given to land with potential for multiple wildlife-dependent public uses such as waterfowl hunting, fishing or wildlife viewing (CDFW 2015). (Compare with Ecological Reserve.) |
| **Wildlife Management Area (WMA)** | A unit of the federal National Wildlife Refuge System where the primary means of protecting wildlife and their habitat is through the acquisition of conservation easements from willing sellers. |
| **Wildlife-friendly agriculture** | Agricultural crops (such as rice, corn and wheat), irrigated pasture and alfalfa that are managed to provide important habitat for waterfowl, shorebirds and waterbirds. |

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