1

# NON-BREEDING WATERFOWL

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# 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**

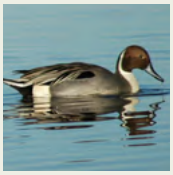
**ANNUAL WATER SUPPLIES:**
**1,360,000 ACRE-FEET**

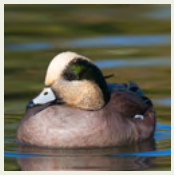
**WINTER-FLOODED RICE HABITAT:**
**341,000 ACRES**

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

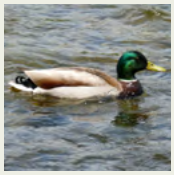
### BIRD SPECIES INCLUDE:

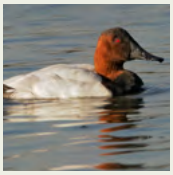
Representative waterfowl in the Central Valley in the non-breeding season

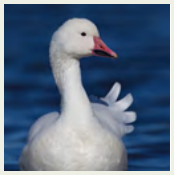

Northern pintail*

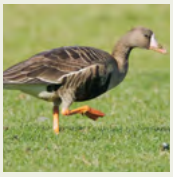

American wigeon***

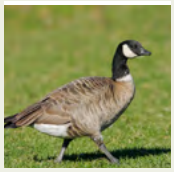

Green-winged teal**


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.

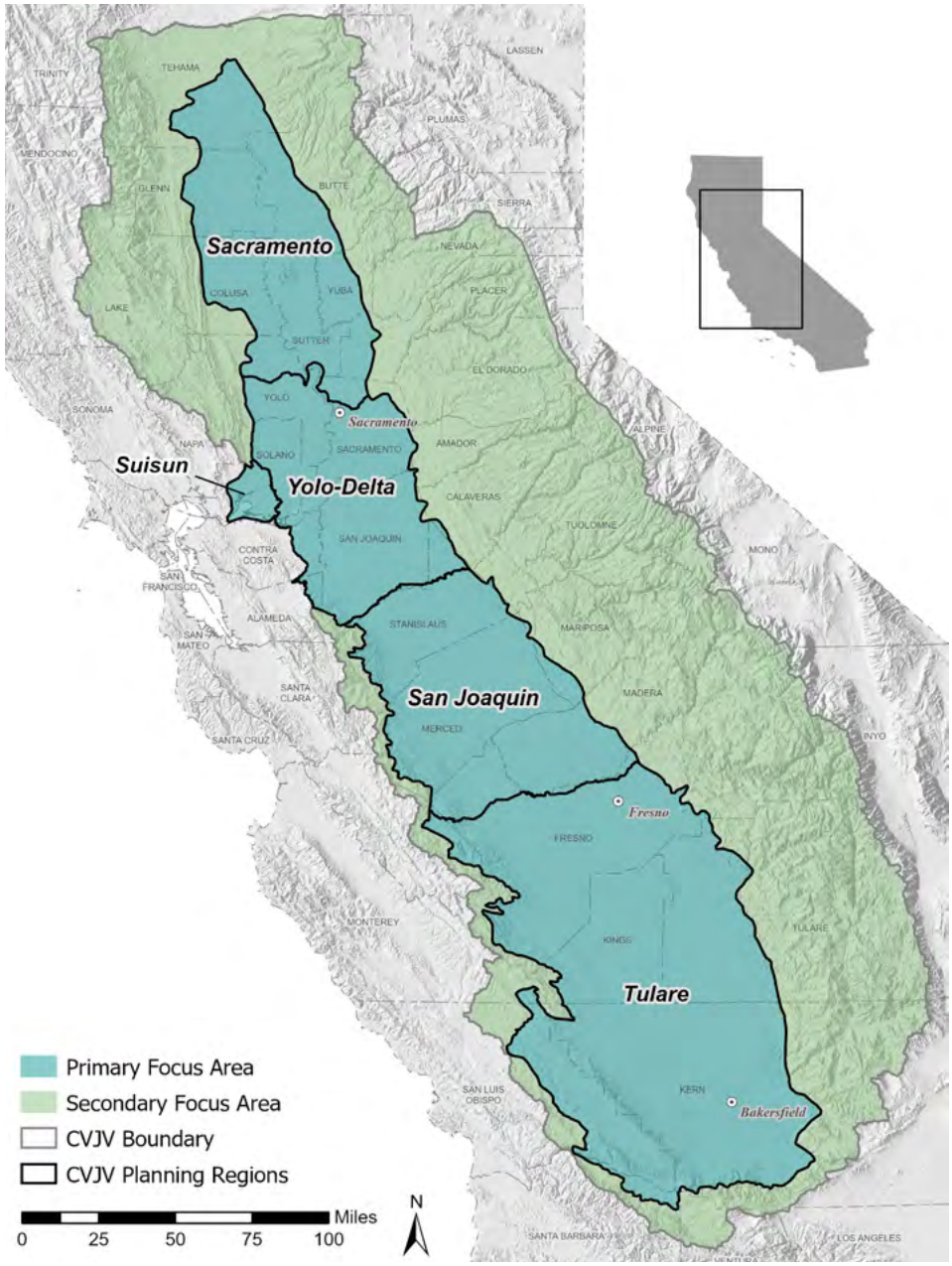



**FIGURE 7.1 Central Valley Joint Venture perimeter and Primary Focus Area, divided into five planning regions.**

### 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 nonbreeding 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.

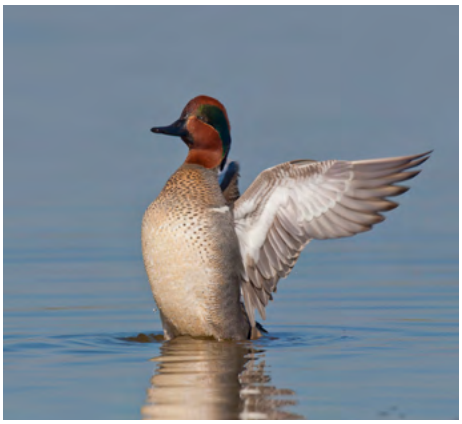
The CVJV also defined two types of wetland enhancement objectives. The first, Type I, is the acres of wetlands each year for which wetland and water conveyance infrastructure is repaired or enhanced. Based on interviews with resource managers, it was determined that this infrastructure will require some 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).

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.

| 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.**

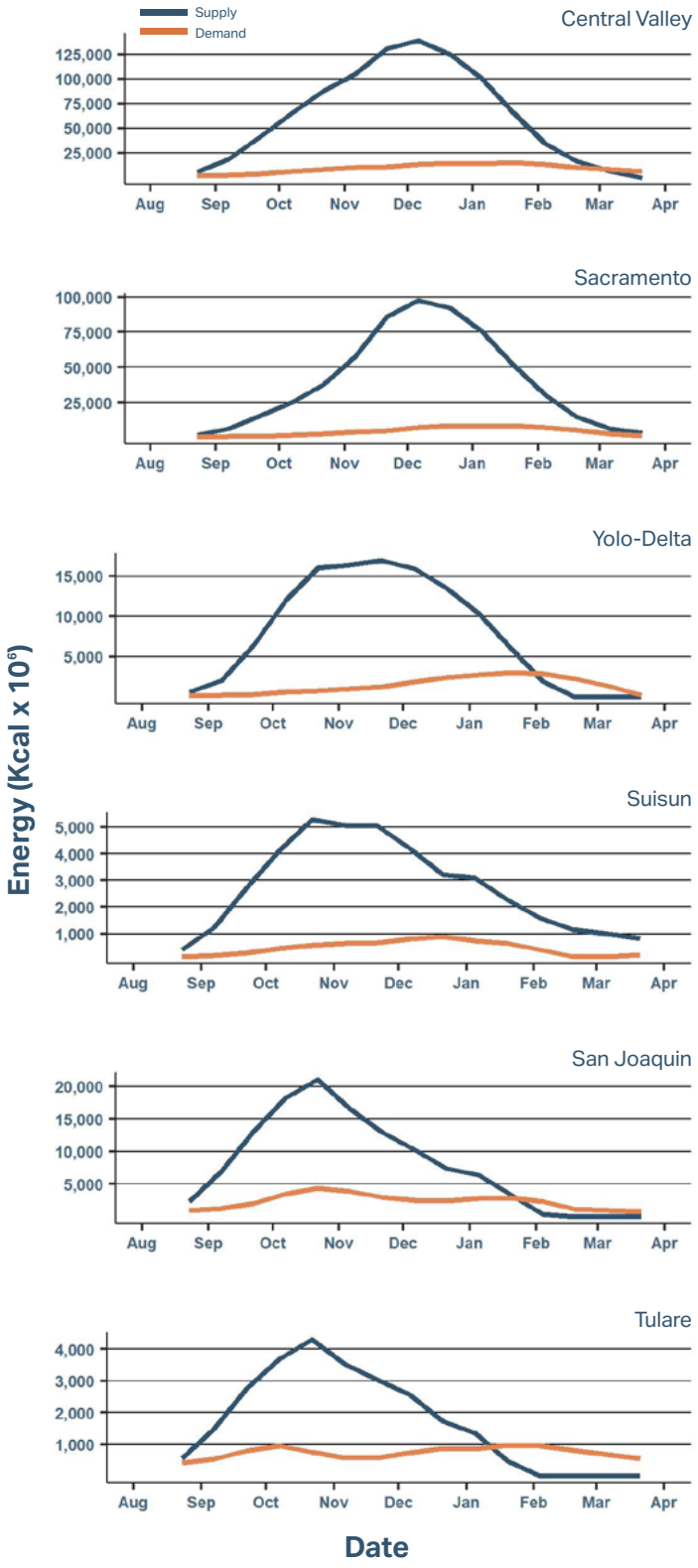



**FIGURE 7.2 Duck population energy supply (blue) vs. food energy demand (orange) (in kcal x $10^6$) for the Central Valley as a whole and for each planning region.**

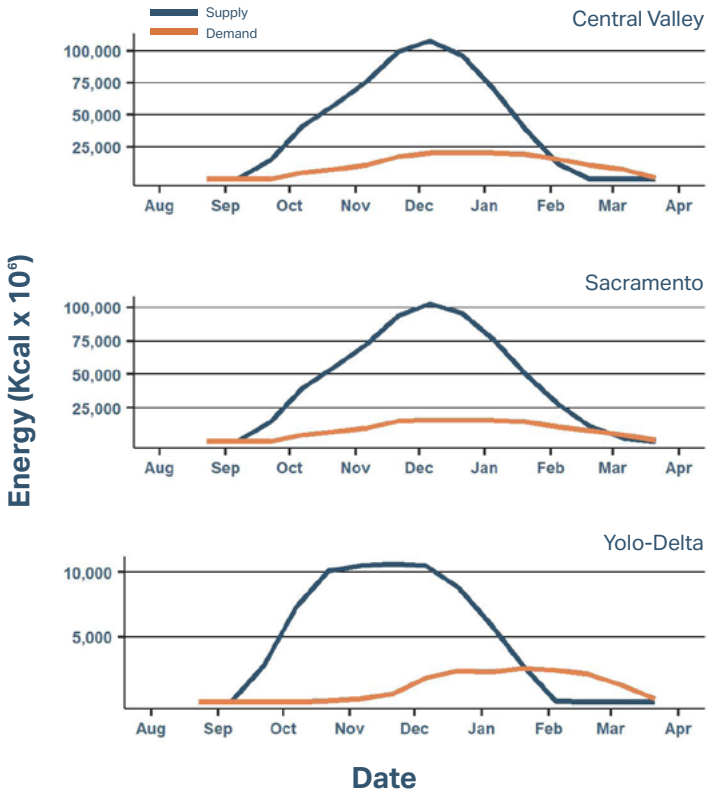



**FIGURE 7.3 Goose population energy supply (blue) vs. food energy demand (orange) (in kcal x $10^6$) for the Central Valley as a whole and for each planning region.**

## 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.**

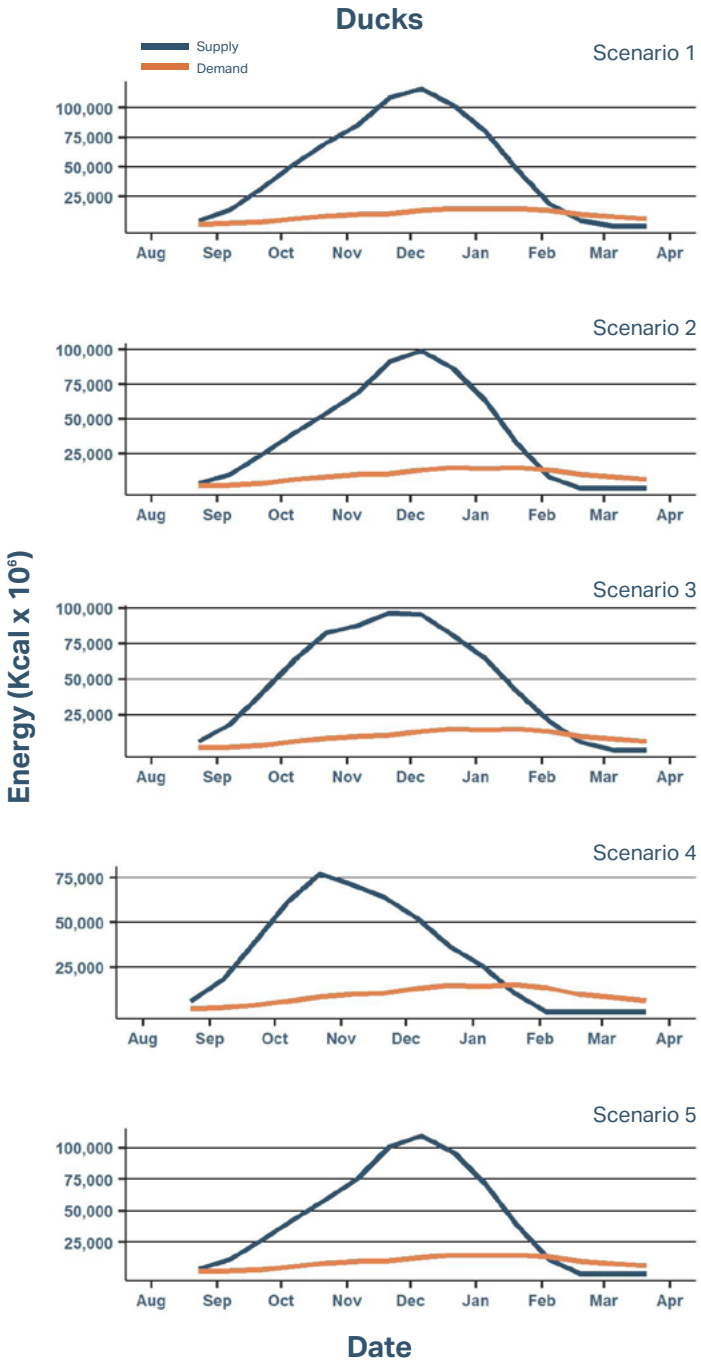



FIGURE 7.4 Duck population energy supply (blue) vs. food energy demand (orange) (in kcal x $10^6$) for the Central Valley under different model scenarios.

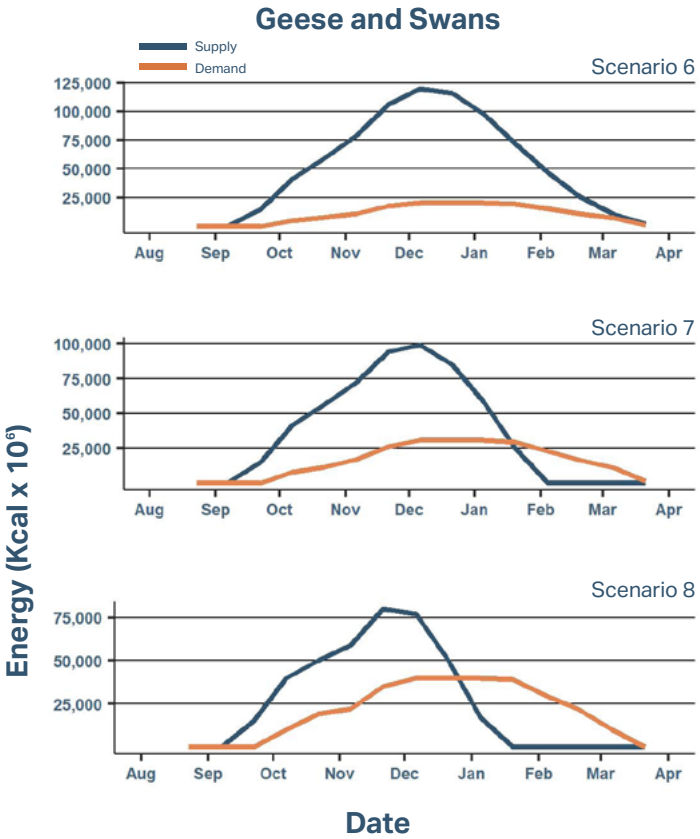



FIGURE 7.5 Goose population energy supply (blue) vs food energy demand (orange) (in kcal x $10^6$) under different model scenarios.


FIGURE 7.6 Duck population energy supply (blue) vs. food energy demand (orange) (in kcal x $10^6$) 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.**

| 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** |

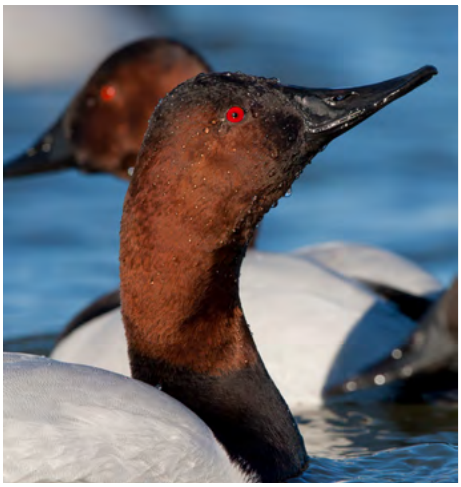
**TABLE 7.18 Water needs per month for managed seasonal wetlands in the Yolo-Delta planning region when the total wetland habitat objective of 39,954 acres is met.**

| 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.

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.



*Canvasbacks - Mike Peters*

## 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 (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** (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*

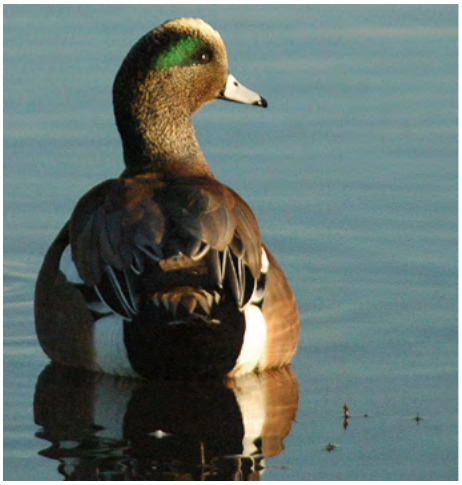
# CONSERVATION DELIVERY:
## Accomplishing the Habitat Objectives

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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# NOTES

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