STATE WATER RESOURCES CONTROL BOARD
PUBLIC WORKSHOPS AND REQUEST FOR INFORMATION:
COMPREHENSIVE (PHASE 2) REVIEW AND UPDATE TO THE BAY-DELTA PLAN

Workshop 3: Analytical Tools for Evaluating Water Supply, Hydrodynamic and Hydropower Effects

Written Submittal of Walter Bourez, MBK Engineers

Submitted on behalf of Northern California Water Association and Sacramento Valley Water Users

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INTRODUCTION

1. I am a civil engineer registered in the State of California (California registration no. 54794). I am a principal with the firm MBK Engineers. The focus of my practice is surface water modeling within the watersheds tributary to the Bay-Delta. I have worked extensively with the CalSim II model and its predecessors. A true and correct copy of my resume was previously submitted in this proceeding as Exhibit 1 to my written submittal for Workshop 1.

2. The State Water Board's Notice of Public Workshops dated June 22, 2012 identifies the following key issues for Workshop 3:

(a) What types of analyses should be completed to estimate the water supply, hydrodynamic and hydropower effects of potential changes to the Bay-Delta Plan?

(b) What analytical tools should be used to evaluate these effects? What are the advantages, disadvantages and limitations of these tools?

3. My presentation for Workshop 3 will be in three parts:

(a) The first portion of my presentation will describe the system-wide changes that have taken place within the Bay-Delta watershed since the SWRCB adopted the 2006 Water Quality Control Plan (WQCP), with emphasis on changes that have taken place within the Delta and the Sacramento Valley. In my opinion, it is critical that the SWRCB fully understand these changes – in particular the changes in system operations effected by the post-2006 Delta smelt and salmonid Biological Opinions (BiOps) – before it considers additional changes to the WQCP.[1]

(b) The second portion of my presentation will examine the analytical tools that the SWRCB should utilize in considering and evaluating further changes to the WQCP. Although the SWRCB is

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[1] Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project and State Water Project (Reference #81420-2008-F-1481-5) (FWS, December 2008) and the Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project (NMFS, June 2009).

familiar with the CalSim II model, an adequate evaluation of the effects of proposed changes in the WQCP will require the use, by qualified experts, of other available analytical tools as described in detail below. In my opinion, these analytical tools, taken together, constitute the current industry standard, and best available scientific and commercial information, for evaluation of the effects of proposed changes in the WQCP on beneficial uses (including public trust uses) and the environment. The SWRCB must ensure that these tools are utilized by qualified personnel in considering any changes to the 2006 WQCP.

(c) The third portion of my presentation will provide my suggested approach for the SWRCB's consideration and evaluation of possible changes in the WQCP using the example of short duration spring pulse flows in the Sacramento River. This example shows how the SWRCB can comprehensively analyze proposed revisions of the WQCP in a manner that promotes maximum benefits for all beneficial uses. As I said in my presentation during Workshop 1, the SWRCB, in considering changes in the WQCP, "should carefully consider the mutually-dependent ecosystem and water-supply benefits created by existing irrigation water use in the Sacramento Valley" and beyond.

<u>WHAT HAS CHANGED SINCE 2006?</u>

4. The chief change in the water system since the SWRCB adopted the 2006 WQCP has been the issuance and implementation of the BiOps for the operation of the Central Valley Project (CVP) and State Water Project (SWP) to protect salmon and delta smelt by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service, respectively. The BiOps contain substantial terms concerning Delta outflows and other operations. In addition to requirements for Clear Creek, Shasta, and the upper Sacramento River, the NMFS BiOp also requires the CVP to manage American River streamflows consistent with the Water Forum's 2006 flow management standard. There have also been changes in the operation of the Yuba River pursuant to the Yuba Accord and the Feather River pursuant to the water quality certification that the SWRCB issued as part of the FERC relicensing for Oroville Reservoir. The BiOps' terms concerning the Delta, however, have caused the most significant changes in system operations since adoption of the 2006 WQCP.

5. In a September 7, 2011 presentation to the California Water and Environmental Modeling Forum (CWEMF), I summarized the operational changes in the water system due to the BiOps. CWEMF is a non-profit, non-partisan organization whose mission is to increase the usefulness of models for analyzing California's water-related problems. The CWEMF, which was formed in 1994, carries out this mission by facilitating an open exchange of information on California water issues, resolving technical disagreements in a non-adversarial setting, and ensuring that technical work continues to take into account the needs of stakeholders and decision makers. My presentation regarding the effect of the BiOps can be viewed in its entirety at the CWEMF website: http://www.cwemf.org/workshops/BOWorkshop/WBourezPres.pdf.

6. Since September 2011, I have updated my analysis using the most current public version of the CalSim II model that was used by DWR to develop its 2011 SWP reliability study. This model is available for download from DWR's website at: http://baydeltaoffice.water.ca.gov/modeling/hydrology/CalSim/Downloads/CalSimDownloads/CalSim-

IIStudies/SWPReliability2011/index.cfm. For the purpose of this analysis, the "Current Conditions" model scenario as labeled on this website is used to represent how the CVP/SWP currently operates. This scenario includes reasonable and prudent alternatives ("RPAs") in the BiOps.[2] This scenario is referred to in this submittal and accompanying exhibits as the "With BiOps" Scenario.

7. To represent how the system operated prior to the implementation of the BiOps, I modified the With BiOps scenario by removing the RPAs in the salmon and smelt BiOps that are specific to governing Delta operations; this scenario is referred to as the "Without BiOps" Scenario. RPAs specific to upstream operations were not removed from the With BiOps scenario and remain in the Without BiOps modeling scenario. The reason that I did not attempt to remove the effects of RPAs specific to upstream operations is that these effects are difficult to distinguish from the effects of actions to implement section 3406(b)(2) of the Central Valley Project Improvement Act, which were already occurring in 2006. Moreover, the RPAs that are specific to Delta operations are much more important drivers of water system changes than the upstream RPAs. Therefore, the only difference in regulatory requirements between the model simulations are the Delta RPAs.[3] To determine how system operations have changed between 2006 and the present, the With BiOps scenario is compared to the Without BiOps scenario.

8. The purpose of this analysis is to demonstrate how conditions affecting the CVP, the SWP and the Sacramento Valley are changing, and are likely to change, based on implementation of the BiOps. While court orders have prevented some parts of the BiOps from being implemented in some years since those BiOps were issued, those BiOps' terms remain the best representation of how the CVP and the SWP currently operate and may operate for the foreseeable future. Modeling the BiOps' impacts over historical hydrology therefore is the best way to understand how current regulatory conditions are likely to affect both consumptive and environmental water uses in the Central Valley and in the Delta.

A comparison of the results of the Without BiOps and the With BiOps scenarios shows that the BiOps have resulted in a water system that has different characteristics than the system the SWRCB evaluated in adopting the 2006 WQCP. My analysis shows that, on average, the BiOps have resulted in approximately 1 million acre-feet/year of additional Delta outflow over the levels required in 2006. There is also an increased reliance on water stored in upstream reservoirs to satisfy Delta flow requirements and other beneficial uses of water. Increases in Delta flow requirements imposed by the BiOps have further constrained CVP and SWP operations, resulting in decreases in operational flexibility

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[2] The RPAs contained in the Delta smelt BiOp may be found at pages 329-379 of that BiOp and include six actions: (i) Adult Migration and Entrainment (First Flush), (ii) Adult Migration and Entrainment, (iii) Entrainment Protection of Larval Smelt, (iv) Estuarine Habitat During Fall, (v) Temporary Spring Head of Old River Barrier (HORB) and the Temporary Barrier Project (TBP), and (vi) Habitat Restoration. The RPAs contained in the salmon BiOp may be found at pages 587-654 of that BiOp.

[3] To be specific, there are five RPAs that have significantly modified water system operations. Those RPAs are: (i) Action IV.1.2 DCC [Delta Cross Channel] Gate Operation, which is described at pages 635-40 of the Salmonid BiOp; (ii) Action IV.2,1 San Joaquin River Inflow to Export Ratio, which is described at pages 641-45 of the Salmonid BiOp; (iii) Action 2: Adult Migration and Entrainment, which is described at pages 352-56 of the Delta smelt BiOp; (iv) Action 3: Entrainment Protection of Larval Smelt, which is described at pages 357-68 of the Delta smelt BiOp; and (v) Action 4: Estuarine Habitat During Fall, which is described at pages 369-76 of the Delta smelt BiOp.

and increases in vulnerability to adverse dry year conditions for the environment and water supply, primarily due to reduced carryover storage. In considering and evaluating possible changes in the WQCP, it is critical that the SWRCB begin with an accurate assessment of the current operational regime, and not assume that the system is being operated as was understood in 2006. What follows is a summary of more specific changes that have occurred in the CVP's and SWP's operations as a result of the BiOps' implementation.

Flow Pattern Changes

9. For both the CVP and the SWP, implementation of the BiOps has resulted in an increased reliance on upstream storage to satisfy both environmental requirements and water supply needs. Under the Without BiOps scenario, the CVP and the SWP could divert more water during periods of high flow, defined more specifically as excess conditions.[4] This ability to divert more water during periods of high flow has been reduced under the RPAs because their terms impose significantly more Delta export restrictions during late winter and spring periods when flows are typically the highest. The RPAs also result in increased reservoir releases to comply with Delta outflow requirements during the fall period when natural flows are typically the lowest. Increased Delta outflow has caused the CVP and the SWP to increase their reliance on stored water. This effect has, in turn, altered the flow regimes in upstream tributaries and changed the pattern of Delta export water diversions. Exhibit 1 depicts average monthly flow changes by water year type in the major Sacramento River Basin tributaries and the Delta.

(a) Under the With BiOps scenario, Sacramento Basin river flows are generally lower than under the Without BiOps scenario during winter and spring months, December through June, because, during those months, the CVP and SWP recover from lower storage and try to conserve water for future use.

(b) Under the With BiOps scenario, September reservoir releases and tributary flows are higher than under the Without BiOPs scenario in wet and above normal years, to satisfy the Delta smelt BiOp's Fall X2 requirement.[5] This condition also occurs in November for the Sacramento and American Rivers. For both the CVP and the SWP, the need to release additional water to meet the Fall X2 requirement causes lower carryover storage, and thus has reduced CVP and SWP carryover storage that could be used during drier years to support both fisheries and consumptive uses.

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[4] The Coordinated Operations Agreement (COA) defines "excess water conditions" as "periods when it is agreed that releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley inbasin uses, plus exports." COA, article 3, page 4.

[5] The Fall X2 requirement can be found as Action 4 in the Delta smelt BiOp and is described as: "Subject to adaptive management as described below, provide sufficient Delta outflow to maintain average X2 for September and October no greater (more eastward) than 74 km in the fall following wet years and 81 km in the fall following above normal years. The monthly average X2 must be maintained at or seaward of these values for each individual month and not averaged over the two month period. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin will be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall target. The action will be evaluated and may be modified or terminated as determined by the Service." Delta smelt BiOp, page 369. This term's implementation has been affected by court orders, but as discussed above in paragraph 8, remains the best available representation of how the CVP and the SWP currently operate and can be expected to operate in the future.

(c) Changes in tributary flows during July and August vary depending on the characteristics of each tributary. Sacramento River flows below Keswick Dam are lower for this period in the With BiOps scenario compared to the Without BiOps scenario; this reduction may result in warmer water temperature at the Sacramento River temperature compliance point located between Balls Ferry and Bend Bridge in most years. Flows in the Feather River are higher in July through September under the With BiOp scenario relative to the Without BiOp scenario to satisfy needs in the Delta. Changes in American River flows are variable depending on numerous conditions.

(d) Delta outflows are generally higher under the With BiOps scenario relative to the Without BiOps scenario; the main exception is when reservoirs refill during wet conditions to recover from the additional drawdown triggered by the BiOps.

Reservoir Storage Changes

10. Exhibit 2 depicts exceedance probability plots for key upstream CVP/SWP reservoirs for both the With BiOps and Without BiOps scenarios. For each of these reservoirs, there have been reductions in storage resulting from the RPAs. These reductions in storage have reduced water supply reliability for water users throughout the CVP/SWP system, and reduced water supply and habitat reliability for fish. The following summarizes the BiOps' effects on CVP and SWP reservoirs' storage:

(a) Trinity Reservoir average carryover storage is about 20,000 AF lower in the With BiOps scenario relative to the Without BiOps scenario; average critical year storage is about 80,000 AF lower.

(b) Shasta Reservoir average carryover storage is about 80,000 AF lower in the With BiOps scenario relative to the Without BiOps scenario; average critical year storage is about 200,000 AF lower. CalSim modeling of the BiOps' effects show Shasta storage declining to dead pool more often; this reduces the CVP's ability to comply with upstream flow and temperature requirements that have been established to support salmon in the upper Sacramento River. Because Shasta is a reservoir that has multiple years' worth of storage capacity; during extended dry conditions it can take several years to recover from these types of additional drawdown.

(c) Oroville Reservoir average carryover storage is about 350,000 AF lower in the With BiOps scenario relative to the Without BiOps scenario; average critical year storage is about 150,000 AF lower. Critical year reduction in Oroville storage is less than average year reductions because critical year effects of the BiOps are realized in SWP San Luis Reservoir, other South of Delta storage facilities, and decreases in water delivery.

(d) Folsom Reservoir average carryover storage is about 10,000 AF lower in the With BiOp scenario relative to the Without BiOp scenario; average critical year storage is about 35,000 AF lower. The characteristics of Folsom are different than other CVP and SWP reservoirs; this is primarily due to highly variable nature of its inflow and susceptibility to droughts. Because Folsom 's storage capacity (about 1,000,000 acre-feet) is small relative to its watershed's yield, it has much less ability to store water from year to year than Shasta or Oroville. Indeed, in critical years, natural flows in the American River are less than combined environmental and consumptive demands, which means that water users and fish must rely on stored water. A number of major urban water suppliers, however, depend on the

American River and Folsom and have few, if any, other water sources. As the State Water Rights Board recognized in Decision 893, these water suppliers are "naturally dependent" on the American River.[6]

Without storage in Folsom, dry year reliability in this region is a main concern and reductions in dry year reliability in Folsom storage puts American Basin urban areas at risk. The Folsom Reservoir carryover chart in Exhibit 2 shows Folsom reaching dead pool in the With BiOps scenario about 5% of years and falling below the level where urban suppliers can divert (which is at approximately 300,000 af of storage) in more than 10% of years. The reservoir levels at which existing intakes at Folsom can draw water for urban use is well above the reservoir's dead pool.

Water Supply

11. Exhibit 3 depicts a water allocation summary for CVP contractors. Water allocations in the With BiOps scenario are less than in the Without BiOps scenario for both agricultural and M&I contractors in areas north and south of the Delta. South of Delta CVP Agricultural contractors' average allocation dropped by 14% (from 63% to 49%) and north of Delta CVP Agricultural contractors' average allocation dropped by 6% (from 73% to 67%). There are years with no allocation for both north and south of Delta contractors and several additional years when deliveries are insufficient to maintain permanent crops. South of Delta CVP M&I contractors' average allocation dropped by 9% (from 89% to 80%) and north of Delta CVP M&I contractors' average allocation dropped by 2% (from 90% to 88%). Although the minimum M&I allocation in CalSim of 50% occurs in several years of the simulation, CalSim does not account for the relationship between reservoirs' elevations and the elevations of existing M&I intakes. Accordingly, CalSim overestimates deliveries to contractors that divert directly from CVP and SWP reservoirs. Those reservoirs reach dead pool in these years when CalSim depicts 50% allocations, so, in these years, a significant portion of the M&I allocation depicted by CalSim would not actually be delivered. This condition primarily occurs with CVP contractors that receive water directly from Folsom Reservoir.

12. Exhibit 4 depicts a water allocation summary for SWP contractors and for export of surplus water. SWP water allocations in the With BiOps scenario dropped by 16% (from 81% to 65%) compared to the Without BiOps scenario. In addition to this reduction in allocation, surplus water (available under Article 21 of SWP contracts) was available in about 82% of years in the Without BiOps scenario and only 25% of years in the With BiOps scenario. See Exhibit 4.

Water Transfers

13. Under the With BiOps scenario, the effects described in paragraphs 9 through 12 above cannot be significantly mitigated through water transfers. Prior to the adoption of the current BiOps, statewide water supply reliability during dry years was significantly enhanced by through-Delta water transfers. For example, during the multi-year drought that occurred in the early 1990's, the Department of Water Resources established a Drought Water Bank that successfully transferred more than one million acre-feet of water over the course of the drought.[7] A significant portion of the transfer water was made

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[6] Decision 893, p. 54.

[7] Lloyd S. Dixon *et al.*, *California's 1991 Drought Water Bank: Economic Impacts in the Selling Regions* (1993). In 1991, the Drought Water Bank purchased 821,000 af while in 1992 the Drought Water Bank purchased 193,000 af.

available through crop-idling. These types of transfers move the water across the Delta "on pattern," i.e., on the same schedule that water would be consumptively used by the crop that is idled. This water (unlike water transferred through reservoir reoperation or the substitution of groundwater for surface water) cannot be stored for later delivery; if it cannot be conveyed across the Delta at the appropriate time, it cannot later be recaptured.

14. A key difference between system operations under the Without BiOps scenario and system operations under the With BiOps scenario is that, under the Without BiOps scenario, there was export capacity in May of some years and June of most years. In dry years such capacity could be utilized to convey transfer water. Under the BiOps, there is essentially no conveyance capacity available in May or June for water transfers. The net effect is that the BiOps have significantly diminished the capacity for through-Delta water transfers. This is particularly true for transfers based on crop idling because, as mentioned above, such water must be conveyed across the Delta "on pattern." It is also true for other types of transfers, such as groundwater substitution transfers or reservoir reoperation transfers. While these types of transfers do not need to be delivered "on pattern," significant reductions in Delta pumping capacity limit their feasibility as well because Delta diversions to meet normal CVP and SWP contractual deliveries have first priority in the use of the CVP's and SWP's Delta pumping capacity, so limits on when that capacity may be used constrain water transfer capacity first and most severely.

15. In other words, the BiOps have substantially reduced the viability of a critical tool successfully used by water suppliers to meet dry year demands in previous multi-year droughts. Although available export capacity for transfers remains in critical years, available capacity in dry years is substantially reduced. Available capacity under both scenarios is depicted in Exhibit 5.

Tradeoffs

16. In essence, the smelt and salmonid BiOps compete with each other and numerous other beneficial uses of water for a limited resource. The Delta smelt BiOp results in substantially larger Delta outflows during the spring months and requires substantially higher flows during fall months. These large Delta outflows draw down the reservoir storage that the Salmonid BiOp requires in order to preserve a cold-water pool to protect salmon during the summer and fall months. As a result, there is inherent conflict between goals and requirements of the BiOps and these conflicts are most obvious during dry conditions. The BiOps, like any change in requirements and operation criteria, have altered the balance of beneficial uses of water. The tradeoff between many important system-wide benefits is affected by changes in one part of the highly connected California water system. A simple summary of some of the many trade-offs that are inherent in the BiOps is shown in Exhibit 6.

ANALYTICAL TOOLS

17. There have been tremendous advances in the analytical tools available to the SWRCB to evaluate the effects of any proposed changes in the WQCP. As an engineer who works regularly with water district managers, biologists, CVP and SWP operators, and regulatory agencies, I am familiar with many of the major tools that are currently being used to evaluate system operations. A list of the tools

that are used to evaluate water system operations is presented below. In my opinion, these analytical tools, taken together, constitute the current industry standard, and best available scientific and commercial information, for evaluation of the effects of any potential changes in the WQCP on beneficial uses (including public trust uses) and the environment. The tools listed below, though, are only a subset of tools that should be used to evaluate Delta and fishery conditions. There are numerous additional tools available to evaluate Delta water quality, turbidity, food web, fishery life cycles, fish passage, fish behavior, flood plain inundation, statistical models, and others. The SWRCB must take steps to ensure that these tools are utilized by qualified personnel in connection with the consideration and evaluation of changes to the 2006 WQCP.

Available analytical tools:

- Water operations
    - CalSim II – California Simulation Model
    - CalLite – scaled down version of CalSim II
    - CalSim III – more detailed version of CalSim II
    - Others – spreadsheets and other models
- Economics
    - LCPSIM – urban economics model
    - CVPM – agricultural economics model
    - SWAP – updated agricultural economics model
- Delta flow and salinity
    - DSM2 - 1d Delta Simulation Model
    - FDM - 1d Fischer Delta Model
    - RMA – 2d Delta simulation model
    - SELFE (DWR), Suntans (Stanford), UnTRIM - 3d Delta simulation models
- Water budget models
    - IDC – IWFM demand calculator
    - CU – Consumptive Use model
    - Urban demand models
- Water quality models
    - DSM2, RMA, FDM
    - Sediment
    - Turbidity
- Ground water model
    - IWFM – Integrated Water Flow Model
    - C2VSIM – Application of IWFM to Central Valley
    - SACFEM - Sacramento Valley Groundwater Model, application of MicroFEM
    - CVHM – Central Valley Hydrologic Model
- Temperature and salmon
    - Trinity, Whiskeytown, Shasta, Oroville, Folsom Lake models
    - Trinity, Clear Creek, Sacramento, Feather, American River models

    - Salmon mortality models
- Power generation and use
    - LTGen – CVP hydropower model
    - SWP_Power – SWP hydropower model
    - Others – upstream tributary models
- Historical data analysis and statistical models
    - Fish abundance statistical models (flow Vs. fish, others)
    - ANN, G-Model - Delta salinity models
- Numerous others
- Common sense sometimes used

18. In Workshops 1 and 2, certain parties suggested that the SWRCB include in the new WQCP so-called "first-flush flows," spring pulse flows, spring X2 flows, and fall X2 flows. Each of these types of actions can and should be evaluated using the tools identified above for hydrologic and hydraulic impacts. There are other tools (e.g., salmon lifecycle models) that the SWRCB may choose to use to evaluate biological effects. Because those models fall outside my expertise, I do not address them further here.

AN EXAMPLE OF THE USE OF ANALYTICAL TOOLS

19. The SVWU and NCWA believe that, based on the work submitted to the SWRCB by fisheries biologist Dave Vogel, there is a possibility that short duration spring pulse flows in the Sacramento River, if combined with a rain event and/or coordinated with the release of fish from the Coleman Hatchery, could have a beneficial effect on salmon returns three years later. Mr. Vogel states at page 49 of his September 14, 2012 written submittal that the SWRCB should:

> Evaluate the potential to implement short-duration pulse flows from reservoirs to enhance the outmigration of juvenile salmon to the Delta in the spring. If feasible without adversely impacting cold-water storage, water supplies, and other beneficial uses, implement and evaluate the effectiveness of pulse flows. Include Sacramento River stakeholders in this process to insure operations are well coordinated. (High Priority Study, High Priority Action).
>
> . . . . Detailed modeling studies should be conducted of the effects of any flow regimes contemplated by the SWRCB for the Bay-Delta Plan Update, in order to determine impacts to water supplies and the thermal regimes as those factors affect anadromous fish spawning, incubation, rearing, and outmigration. (High Priority Study).

Earlier in his report (at pages 26-30), Mr. Vogel offers several examples of how such short duration spring pulse flows could be implemented at relatively little water cost and at great benefit to salmon.

20. Proposed changes to the Delta and the CVP/SWP system are typically analyzed using a suite of interrelated models to evaluate operational changes and effects due to those changes. CalSim II is currently the accepted water operations model for evaluating effects of proposed actions. To evaluate system effects CalSim II is run in a mode that consists of comparing two model runs: one that contains a proposed project alternative and one that does not. Differences in certain factors, such as deliveries, river flows, and reservoir storage levels, are analyzed to determine the effects of the project alternatives on system-wide operations. All of the assumptions are the same for the No Action/No Project alternative and action alternative model runs, except for assumptions regarding the action itself, and the focus of the analysis is on the differences in the results. In comparative analysis, model biases tend to cancel out.

21. Once CalSim II is run for the No Action and Action alternatives, results for both model runs are input to a suite of models and output from these models are compared to assess changes for numerous resource areas. Resources areas that are typically assessed are Delta hydrodynamics, Delta water quality, water temperature, fisheries, hydropower, recreation, economics, and others. Exhibit 7 contains a flow chart displaying the relationship between models used to assess effects due to changes in operational criteria. Many effects are caused by changes in Project operations and the tools used to analyze the areas cited in the flowchart in Exhibit 7 are designed to work together to produce a comprehensive suite of analytical tools. For example, river flows, reservoir storage, water deliveries, and other parameters developed by the water operations model are input to models cited in Exhibit 7 to determine economic, Delta, water quality, hydropower, water temperature, fishery, and other conditions for each modeling scenario. Output from each of these models is compared for each modeling scenario to assess changes in each resource category based on changes in system conditions.

22. From my perspective as an engineer familiar with system operations, the SWRCB can and should evaluate short duration spring pulse flows in the Sacramento River in the manner described in the previous paragraph. Those models are well-developed and yield robust results. The modeled results can then be used by fisheries biologists like Mr. Vogel to determine whether, or to what extent, changes in flows can provide benefits to various fish species and the trade-offs of such benefits.

23. I agree that evaluating the effects of new water quality objectives on a very complicated system like the CVP/SWP system is a challenging task. However, as a consultant, this type of effort is now recognized as the "industry standard" for what must be done in order to analyze the effects of a proposal. In recent years, many projects have been analyzed (or are currently being analyzed) by modeling of this level of complexity. The tools listed in Paragraph 17 have been used in the manner shown by the flowchart in Exhibit 7on a large number of projects by a range of parties. Indeed, the SWRCB has recently seen such modeling in the submittals relating to the Woodland-Davis Water Supply Project and others. In my opinion it is critical that the update to the 2006 WQCP meet this same standard of analysis.

Exhibit 1- Changes in Key River Flows (With BiOps minus Without BiOps)

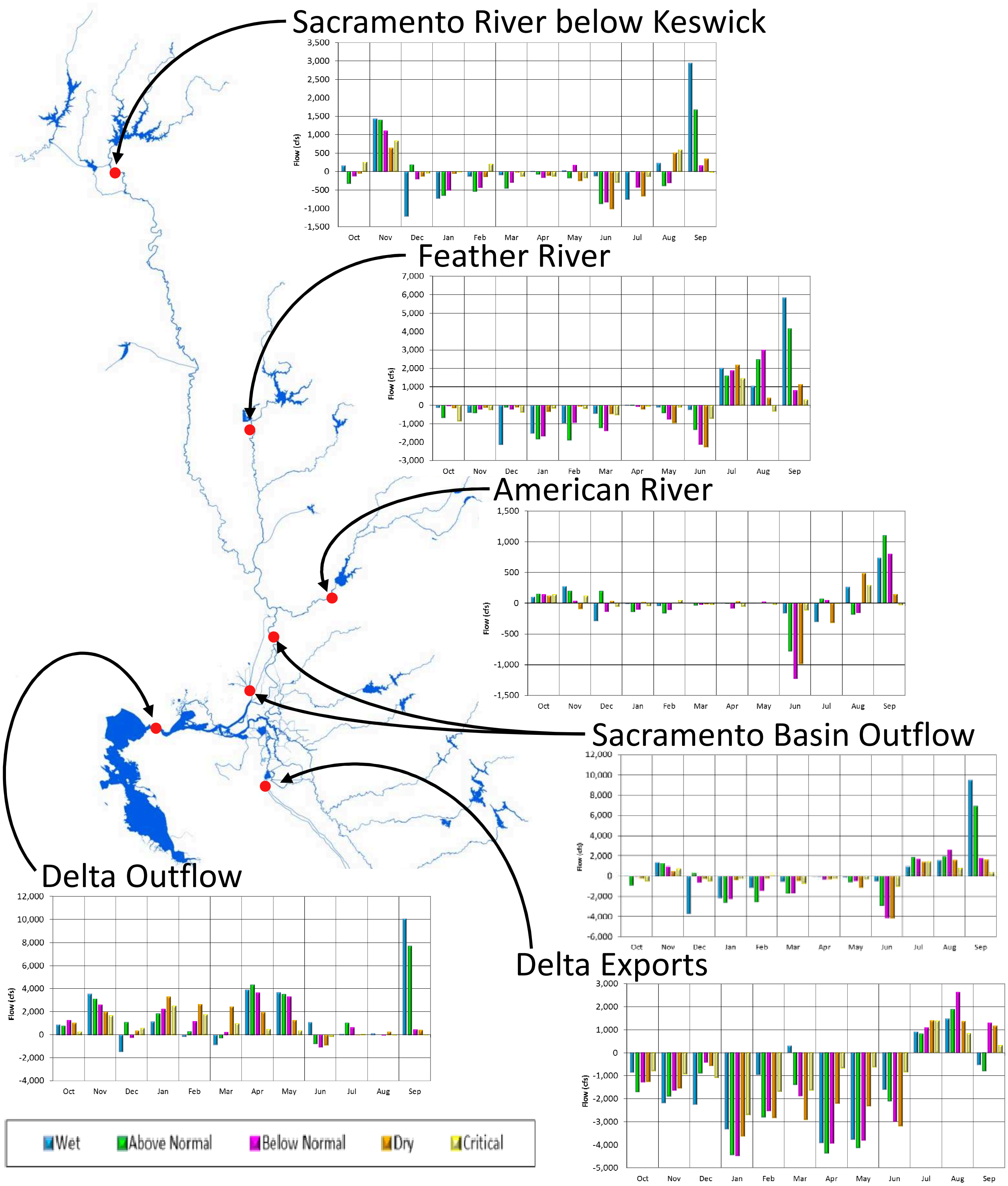


Exhibit 2- Project Reservoir Carryover Storage

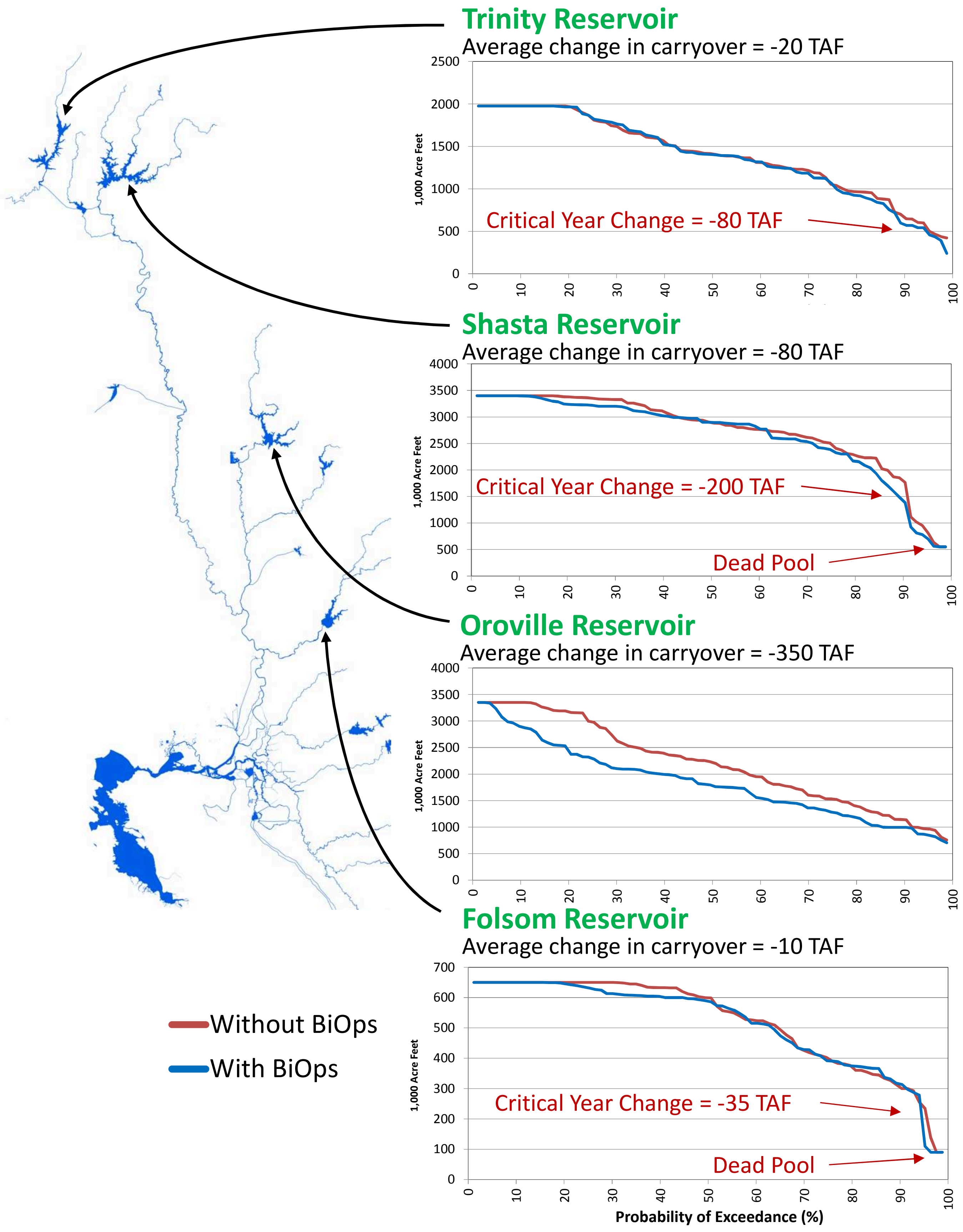
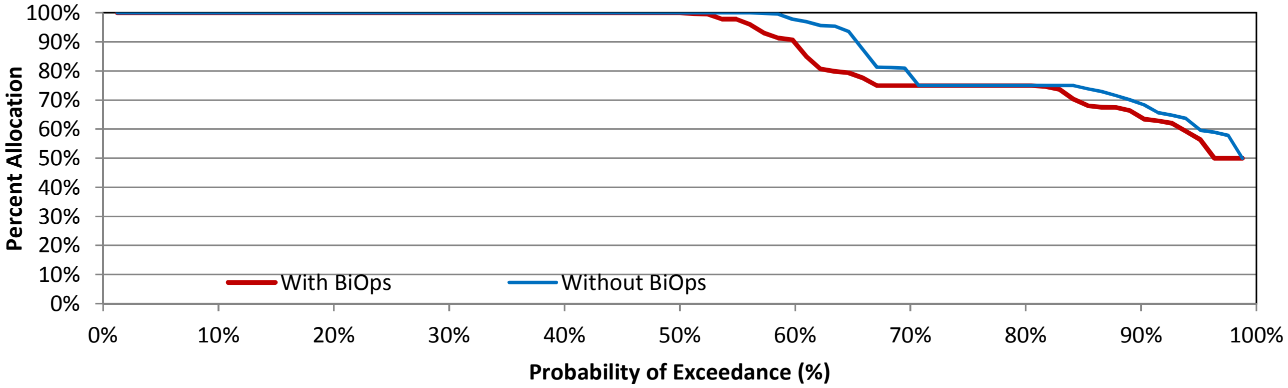
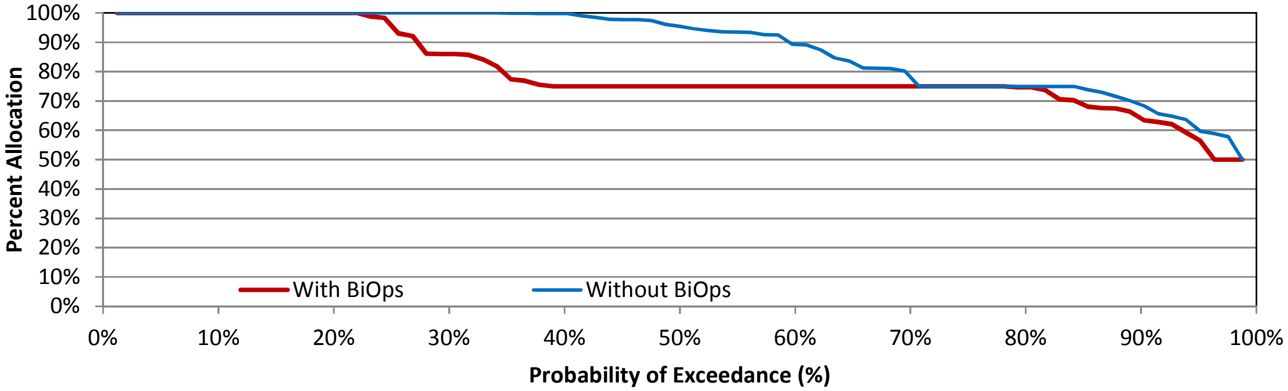
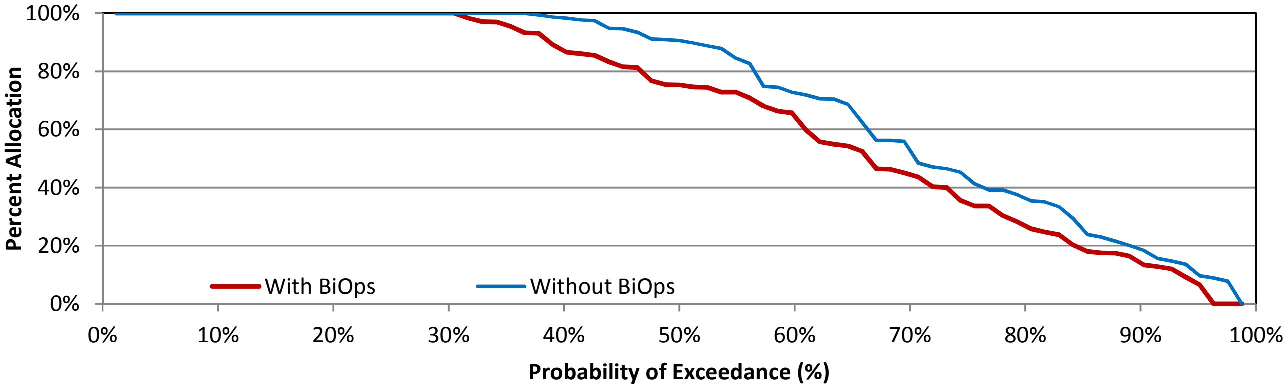


Exhibit 3 - CVP Water Allocation Summary


CVP North of Delta M&I Contract Allocation


CVP South of Delta M&I Contract Allocation


CVP North of Delta Agricultural Service Contract Allocation

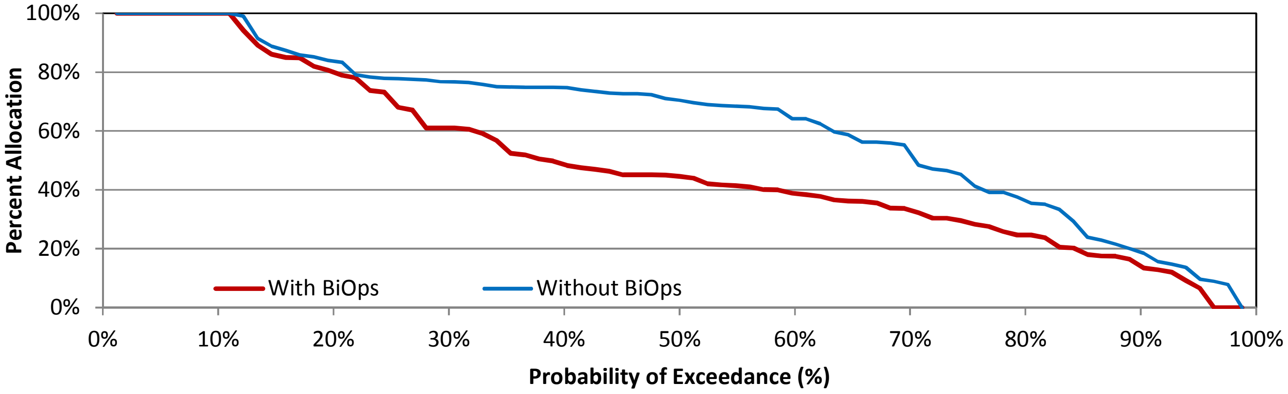
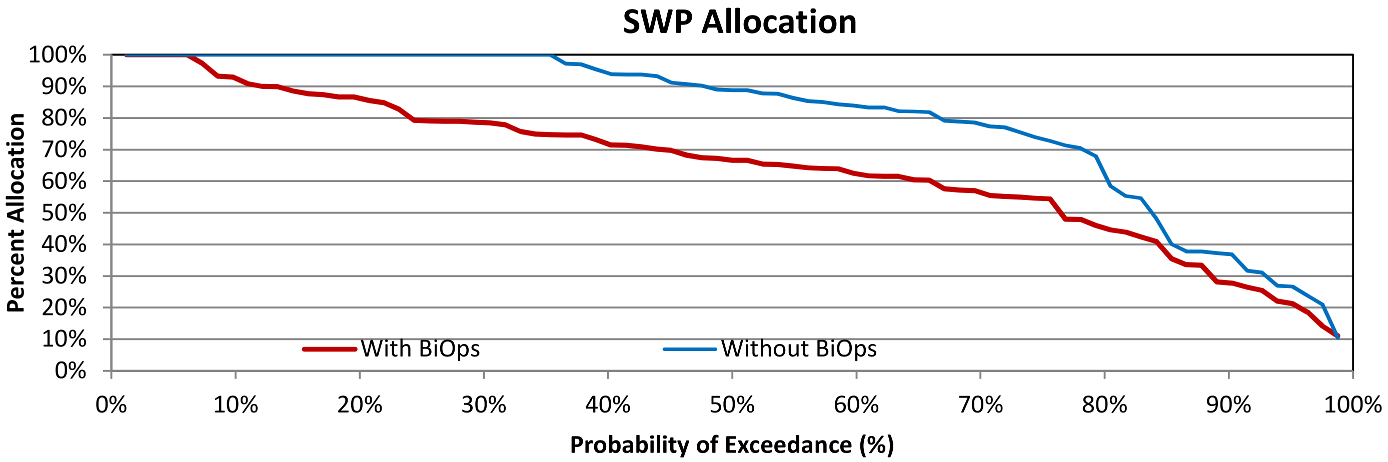

CVP South of Delta Agricultural Service Contract Allocation

Exhibit 4 - SWP Water Allocation Summary



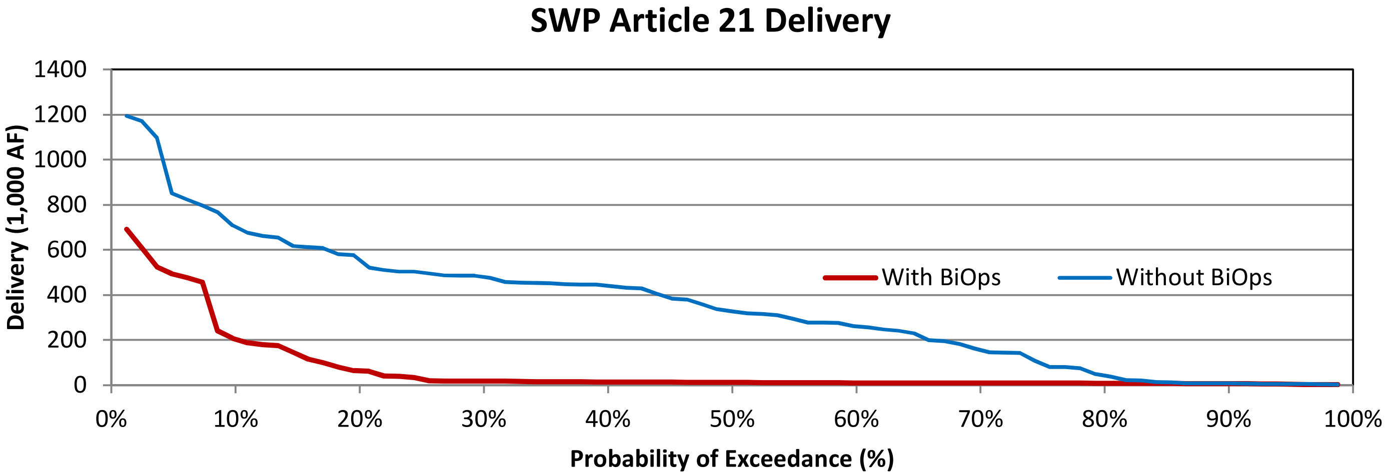
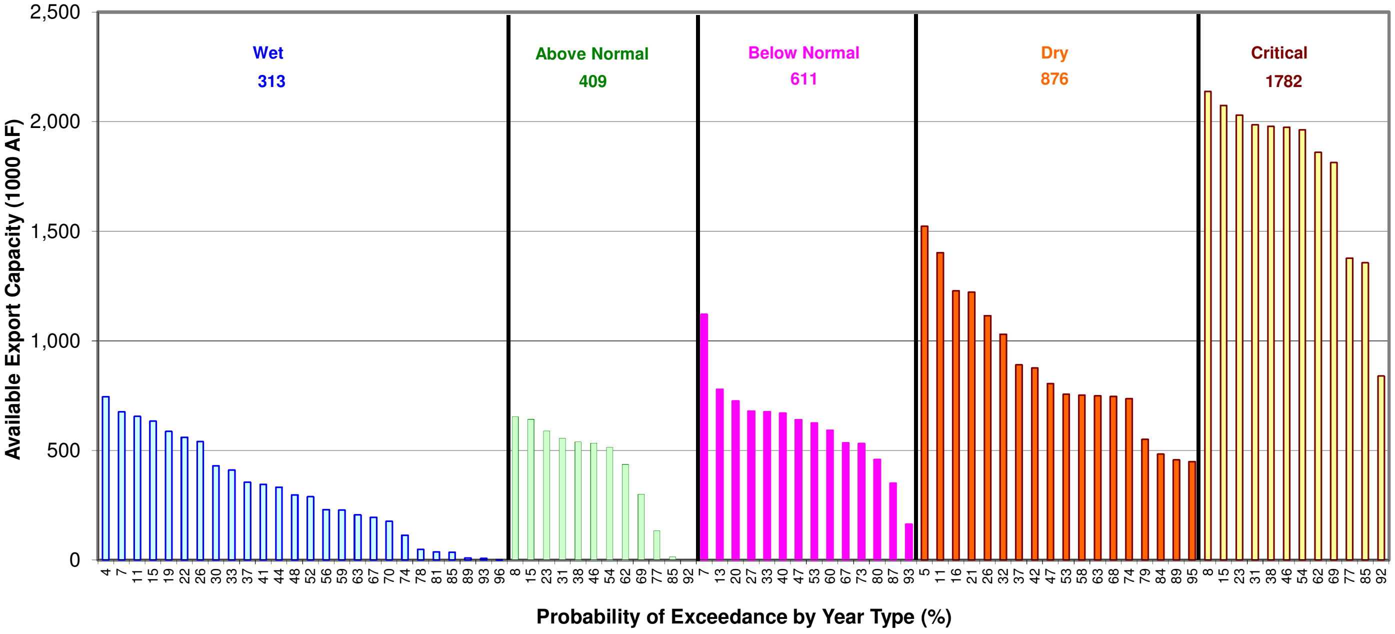


Exhibit 5- Delta Export Capacity Available from June Through September for Water Transfer

Available June Through September Delta Export Capacity based on Without BiOps Operating Conditions



Available June Through September Delta Export Capacity based on With BiOps Operating Conditions

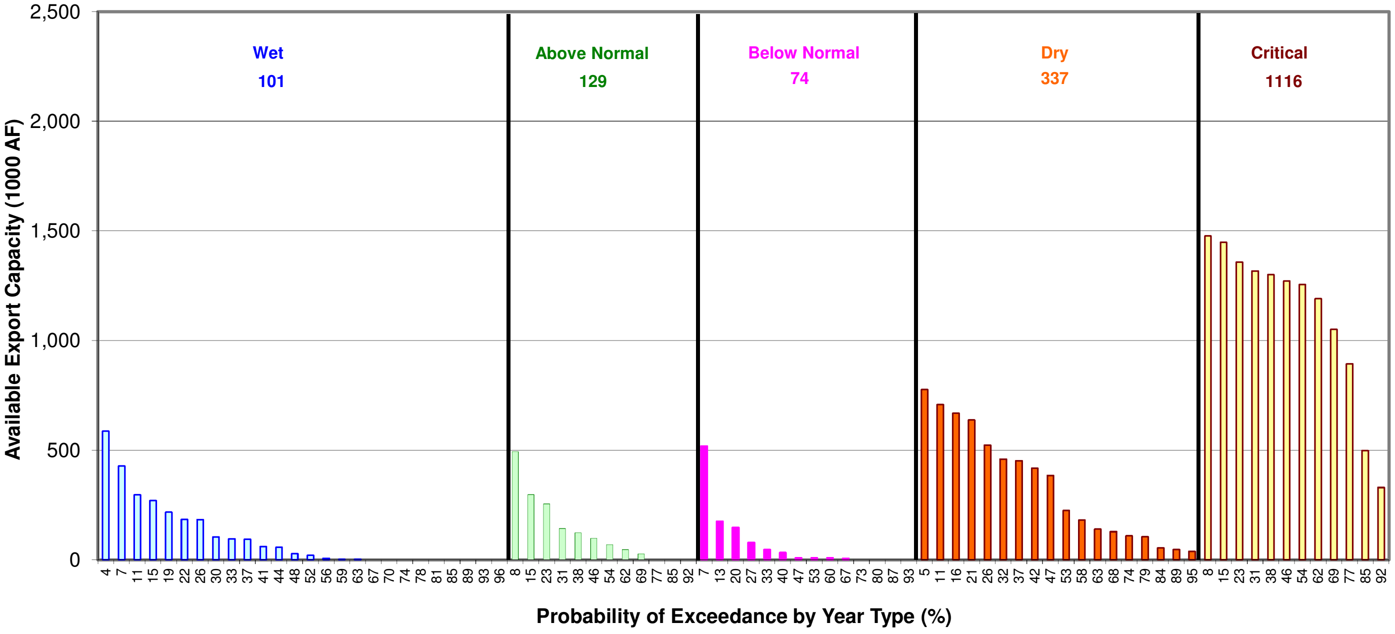
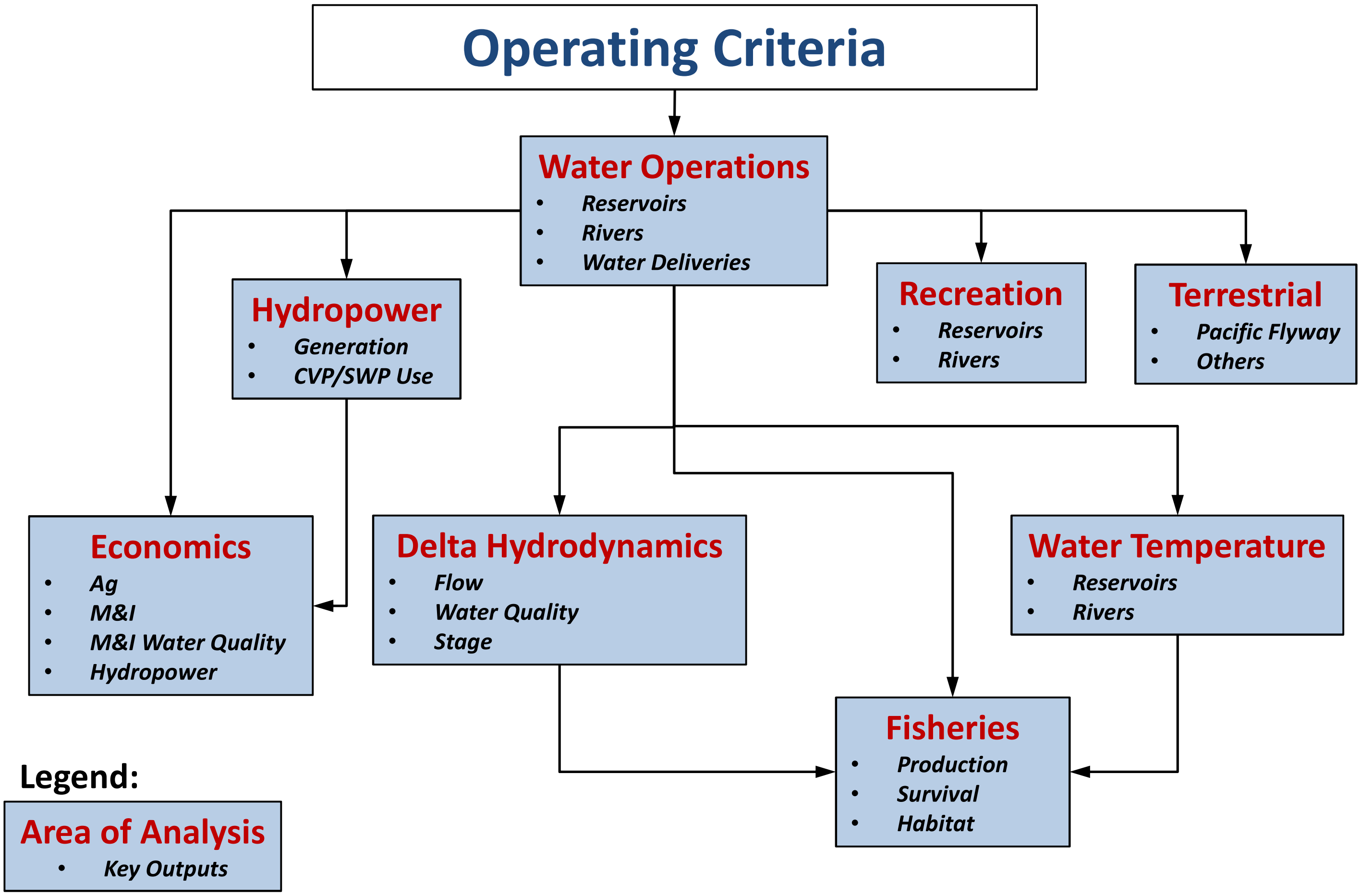


Exhibit 6 - Tradeoffs Made by Imposition of Operating Criteria

Water Deliveries	Delta Outflow
Delta Flow Requirements	Upstream Environmental Benefit
CVP North of Delta Delivery	CVP South of Delta Delivery
Shasta Storage	Folsom Storage
Oroville Storage	SWP SOD Storage
Urban water supply	Agricultural water supply
North of Delta Storage	South of Delta Storage
Stream Temperature	Stream Habitat
Stream Temperature	Spring Flows
Power	Water Supply
Power	Spring time releases
Species A	Species B
Salmon Habitat	Delta Smelt Flow Criteria
American River Fisheries	Sacramento River Fisheries
Fall period flows	Spring time flows
Average annual water supply	Dry year water supply reliability

Exhibit7 - Analytical Tools Used to Evaluate Effects Due to Changes in Operations Criteria



CALIFORNIA
natural
resources
AGENCY

EDMUND G. BROWN JR., *Governor*
JOHN LAIRD, *Secretary for Natural Resources*

October 26, 2011

Erik Vink, Management Board Chairman
Central Valley Joint Venture
2800 Cottage Way, Suite W-1916
Sacramento CA 95825

Dear Erik;

Secretary Laird asked me to reply to your letter of September 30 for both of us. Your concern about possible impacts of changes in water operations due to the implementation of BDCP is understandable.

We discussed with the State Water Resources Control Board the alternative they wanted us to consider, and reduced the target outflows by 25-50% due to concern about possible impacts on the cold water pool in upstream reservoirs, and possible impacts on local water supplies and groundwater. We believe that with these changes, any impact on refuge or other waterfowl water supplies can be avoided.

We are now undertaking the effects analysis of the conservation measures contemplated in BDCP. These analyses will consider the effects of our conservation measures on waterfowl habitat. At the moment, there are two projects which appear to have possible impacts. They are the Yolo Bypass and South Delta habitat improvement. We are working directly with CWA and DU to evaluate the Yolo Bypass project, and we are still very early in the development of the South Delta project, which does have the potential of increasing floodplain and tidal marsh habitat.

The State Board letter looks to the longer term with respect to revisions of the Bay Delta Plan. In hearings on that plan, impacts of additional outflow and other water rights changes on waterfowl habitat will have to be fully considered.

If you would like to further discuss the concerns you expressed in your letter, please contact Beth and I would be happy to meet you and others from the Joint Venture.

Best regards,

Jerry

Jerry Meral

cc. John Laird, Secretary

1416 Ninth Street, Suite 1311, Sacramento, CA 95814 Ph. 916.653.5656 Fax 916.653.8102 http://resources.ca.gov

Baldwin Hills Conservancy • California Coastal Commission • California Coastal Conservancy • California Conservation Corps • California Tahoe Conservancy
Coachella Valley Mountains Conservancy • Colorado River Board of California • Delta Protection Commission • Delta Stewardship Council • Department of Boating & Waterways • Department of Conservation
Department of Fish & Game • Department of Forestry & Fire Protection • Department of Parks & Recreation • Department of Resources Recycling and Recovery • Department of Water Resources
Energy Resources, Conservation & Development Commission • Native American Heritage Commission • Sacramento-San Joaquin Delta Conservancy • San Diego River Conservancy
San Francisco Bay Conservation & Development Commission • San Gabriel & Lower Los Angeles Rivers & Mountains Conservancy • San Joaquin River Conservancy
Santa Monica Mountains Conservancy • Sierra Nevada Conservancy • State Lands Commission • Wildlife Conservation Board

CENTRAL VALLEY JOINT VENTURE

Conserving Bird Habitat in California's Central Valley

September 23, 2011

Mr. Phil Isenberg, Chair
Delta Stewardship Council
980 Ninth Street, Suite 1500
Sacramento, CA 95814

RE: Analysis of Delta Plan Impacts on Pacific Flyway Habitat in the Delta, Sacramento and San Joaquin Valleys

Dear Chairman Isenberg:

California contains considerable areas of land that provide habitat for species migrating along the Pacific Flyway in the Delta, the Sacramento Valley and the San Joaquin Valley. These lands, which include National Wildlife Refuges, State Wildlife Areas, managed wetlands and rice lands, also provide valuable habitat for resident terrestrial species including several listed species under the federal Endangered Species Act and the California Endangered Species Act. We are committed to the protection of these lands and the habitat they provide. If the lands do not receive water of adequate quantity and quality, their habitat values will be lost.

As work progresses on the Environmental Impact Report (EIR) for the Delta Plan, we are keenly interested in how the Delta Stewardship Council plans to include analysis of impacts on water diversions and water availability, both within and outside of the Delta, necessary for refuge water supply, managed wetlands and other land uses that provide valuable habitat for both migrating and resident species. As you know, these areas are of international significance to the migrating birds traveling to and from other countries.

It is our hope that the Delta Plan and related EIR will include analysis of the impact policies and recommendations contained in the Plan will have on the water supplies necessary to maintain these valuable habitat lands. The habitat values these water supplies facilitate are described in greater detail in the Central Valley Joint Venture 2006 Implementation Plan (http://www.centralvalleyjointventure.org/science). We would expect this analysis would include the impacts of policies and recommendations contained in Chapter 4, A More Reliable Water Supply for California (including the recommendation to “Update Delta Flow Requirements”) as well as Chapter 5, Restore the Delta Ecosystem.

For decades, considerable time and resources have been dedicated to the protection and enhancement of habitat in the Delta and the Sacramento and San Joaquin Valleys for birds and other terrestrial species. We are concerned that all of these efforts could be negatively impacted by some actions being discussed to address ecosystem problems in the Delta. This is more likely to occur if the Delta Plan and EIR do not include analysis of the potential impacts of policies and recommendations on the availability of water supplies for these important lands in the Central Valley.

The staff of our Joint Venture together with many of our non-governmental partners offers our help to you in this effort.

Sincerely,

Erik Vink
Management Board Chairman

cc: Central Valley Joint Venture Management Board
Randy Fiorini
Gloria D. Gray
Patrick Johnston
Felicia Marcus
Hank Nordhoff
Don Nottoli
Joe Grindstaff
Terry Macaulay

CENTRAL VALLEY JOINT VENTURE

Conserving Bird Habitat in California's Central Valley

September 30, 2011

Mr. John Laird
Secretary
California Natural Resources Agency
1416 Ninth Street, Suite. 1311
Sacramento, CA 95814

Gerald H. Meral, Ph.D.
Deputy Secretary
Bay Delta Conservation Plan
California Natural Resources Agency
1416 Ninth Street, Suite. 1311
Sacramento, CA 95814

RE: Analysis of Bay Delta Conservation Plan Impacts on Pacific Flyway Habitat in the Sacramento and San Joaquin Valleys

Dear Secretary Laird and Dr. Meral:

California contains considerable areas of land that provide habitat for species migrating along the Pacific Flyway. These lands, which include National Wildlife Refuges, State Wildlife Areas, managed wetlands and rice lands, also provide valuable habitat for resident terrestrial species such as the giant garter snake. We are committed to the protection of these lands and land uses and the habitat they provide. If the lands do not receive reliable supplies of water, their habitat values will be lost.

It was with great interest that we read the April 19, 2011 correspondence from State Water Resources Control Board (SWRCB) Executive Director Thomas Howard regarding the "Environmental Analyses in Support of the Bay Delta Conservation Plan (BDCP)." In the letter, Mr. Howard notes that, "any environmental analysis associated with changes to the Bay-Delta Plan must evaluate the significant environmental impact of any such changes and identify a reasonable range of potentially feasible alternatives to such changes."

The letter goes on to recommend that changes be made to the operational criteria being evaluated for one or more of the alternatives being considered by the BDCP to incorporate two summary determinations contained in the SWRCB's Delta Flow Criteria Report established pursuant to the Sacramento-San Joaquin Delta Reform Act of 2009: "1) provide additional spring Delta outflow in all years to promote increased abundance and improved productivity for longfin smelt and other estuarine species; and 2) provide flows that promote a more natural hydrograph at all times." According to the letter, SWRCB staff suggests that modeling conducted reflecting these changes use "as a starting point…adding 1.5 million acre-fee per year to Delta outflow."

It is our hope that the evaluation of the "significant environmental impact" of these proposed changes include analysis of the impact these changes would have on water diversions necessary for refuge water supply, managed wetlands and wildlife compatible agriculture that provide essential habitat for migrating waterfowl and raptors utilizing the Pacific Flyway, as well as wintering shorebirds and resident terrestrial species such as the giant garter snake. The habitat values these water supplies facilitate are described in greater detail in the Central Valley Joint Venture 2006 Implementation Plan (http://www.centralvalleyjointventure.org/science).

For decades, considerable time and resources have been dedicated to the protection and enhancement of habitat in the Sacramento Valley for birds and other terrestrial species. We are concerned that restored habitat could be negatively impacted by the efforts to address problems in the Delta. This is more likely to occur if the BDCP environmental analyses do not include evaluation of the potential impacts on the availability of water supplies for these important lands upstream from the Delta. That being said the sustainability of water supplies that support significant waterbird values in the Delta and the San Joaquin Valley will depend on a balanced and fully mitigated approach to meeting the legislative and regulatory mandates that you are working to produce in the BDCP process. The Joint Venture and our member organizations stand ready to help provide information and expertise to help achieve this important outcome.

Please let us know how the Bay Delta Conservation Plan will include this analysis in the evaluation of the "significant environmental impact" of these proposed changes.

Sincerely,

Erik Vink
Management Board Chairman

cc: Mr. Thomas Howard, State Water Resources Control Board
Central Valley Joint Venture Management Board

CENTRAL VALLEY JOINT VENTURE

Conserving Bird Habitat in California's Central Valley

Conservation Organizations

Audubon California

California Waterfowl Association

Defenders of Wildlife

Ducks Unlimited, Inc.

PRBO Conservation Science

River Partners

The Nature Conservancy

Trust for Public Land

July 23, 2012

Dr. Jerry Meral, Deputy Secretary
California Natural Resources Agency
1416 9th St, Suite 1311
Sacramento, CA 95814

Dear Dr. Meral:

On behalf of the Central Valley Joint Venture (CVJV) Management Board, we are writing to clarify the habitat needs of migratory birds in the Sacramento-San Joaquin Delta to help insure they are adequately considered in the Bay Delta Conservation Plan (BDCP), the Delta Plan, and other associated planning efforts in the region.

The CVJV is a partnership of 21 public and private entities comprised of government agencies, science and conservation organizations, and one corporation. Our mission is to work collaboratively to protect, restore, and enhance habitats for birds, in accordance with conservation actions identified in the CVJV Implementation Plan[1] (Plan). The Plan provides a cohesive vision for bird conservation in the Central Valley within the context of the entire Pacific Flyway and in association with four international bird conservation initiatives. The Plan is based on the best available science and sets quantitative habitat and population objectives to meet the needs of migrant and resident birds.

We fully support wetland restoration in the Delta and urge that restoration planning take into account the needs of the entire ecosystem rather than focus on a particular species or community. Plans that influence the future of the Delta have the obligation to fully recognize, protect and where feasible enhance the migratory bird values of the region. The potential for restoring ecological conditions favorable for native fish species is clearly important, but should be additive to, rather than at the expense of, existing avian and other terrestrial values. The CVJV partners have accomplished, at great public and private expense, an incredible amount of wetland restoration that should be accounted for as assets in these planning efforts.

Background: As you know, the amount of all wetland types in California has been severely reduced and degraded over the last 200 years. California has lost more than 95% of its historic wetlands, largely due to urbanization, flood control and agriculture. As a result, many wetland-associated species

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[1] CVJV 2006 Implementation Plan- http://www.centralvalleyjointventure.org/science

have declined from historic levels and are increasingly dependent on the last remaining wetlands. Despite these tremendous losses, California remains the most important wintering and migratory stopover area for waterfowl and shorebirds in the Pacific Flyway. In addition, many year-round resident bird species rely completely on our state's wetlands.

The importance of wetland habitat in California is widely recognized and "no net loss" policies have been established at the state and federal levels to promote conservation of existing wetlands and restoration of additional wetland acres. In 2009, the State Legislature passed the Delta Reform Act (SBX7 1) which, among other things, amended the Water Code to insure the Delta Plan included restoring habitat necessary to avoid a net loss of migratory bird habitat and, where feasible, increase migratory bird habitat to promote viable populations of migratory birds *(Water Code §85302).*

The CVJV has supported these policies, and our Plan provides a bird conservation blueprint by identifying specific goals and objectives for wetland, riparian and agricultural habitats. The CVJV has also promoted and helped implement non-traditional management solutions to fulfill the needs of waterbirds by working extensively with private wetland managers and agriculture. This is critical, because there is insufficient wetland habitat in public ownership to support current migratory bird populations. In addition to conventional restoration and protection, the CVJV also emphasizes active management and enhancement of existing wetlands and agriculture to maximize the benefits to waterbirds. Few wetlands with natural hydrology remain in the Central Valley due to reclamation and flood control projects. Most wetlands are intensively managed and artificially flooded during the winter as surrogate habitat to replace lost natural wetlands. Seasonal wetlands are flooded in fall to coincide with waterbird migration, and water depth is manipulated to attract target species. Water is drawn down in spring to expose the soil and stimulate growth of beneficial food plants. Prescriptive water control includes subsequent irrigation during the growing season to improve food production and availability for birds the following fall and winter. Enhancing agriculture for waterbirds involves applying water to certain crops to provide supplemental foraging habitat to meet the energetic needs not provided by the Central Valley's limited natural or managed wetlands.

The Plan defines specific habitat goals and objectives, by basin, for several avian groups deemed of ecological or economic value in the Central Valley. The basins approach provides a distributional component to the Plan strategy, which requires that all of the habitat needs not be located in one or few isolated (and therefore vulnerable) locations, but rather be spread throughout the length and breadth of the Central Valley. Three of these basins (Suisun, Delta, and Yolo) are within the BDCP planning area. Specific objectives for the three basins are included as an appendix to this letter.

Status: Habitat in the Delta region has become considerably more hospitable to avian species as a result of CVJV activities largely due to conservation efforts in the Yolo Basin (e.g., expansion and restoration at the Yolo Bypass Wildlife Area). However, funding and permit restrictions have limited our enhancement efforts in the Suisun Basin.

Recommendation: We respectfully recommend that all Delta-related planning efforts including BDCP and the work of the Delta Stewardship Council incorporate the following goal, principles and objectives:

> **GOAL**: Contribute to the attainment of the acreage, water, and bird population goals set forth by the Central Valley Joint Venture Implementation Plan.
>
> **PRINCIPLE 1: Avoid Detrimental Impacts to Wetland Water Supply.** Ensure that BDCP activities: 1) enhance, and do not directly or indirectly compromise the ability to

provide full Level 4 and Level 2 water deliveries to federal refuges, state wildlife areas and private wetlands identified in the Central Valley Project Improvement Act *(Public Law 102-575)* and aid in meeting this existing statutory obligation; and 2) do not negatively impact the water supplies of private and public wetlands, including agricultural wetlands, in the Sacramento and San Joaquin Valleys.

- Action 1.1: Within BDCP's NEPA/CEQA processes, analyze water transfer activities that are within the scope of BDCP specifically for potential adverse impacts to CVPIA refuge water supplies and ensure full mitigation for these impacts.

PRINCIPLE 2: Mitigate for Impacts to Brackish and Freshwater Wetland-associated Birds and Bird Habitat. BDCP actions that result in losses of brackish and freshwater wetlands (including seasonal, permanent, and managed wetlands, mud flats, and winter flooded corn and rice areas meeting CVJV Plan criteria) should be fully mitigated consistent with the Natural Communities Conservation Planning Act of 2003 *(Fish and Game Code 2800 et seq*). Mitigation actions should:

- Action 2.1: Place mitigation wetlands within the Delta on site and in kind to the maximum extent possible but otherwise within the Central Valley.
- Action 2.2: Plan and construct mitigation wetlands near existing wetland complexes whenever possible[2].
- Action 2.3: Fund conservation easements for bird-compatible agriculture that contributes to meeting the CVJV goals.
- Action 2.4: Enhance existing wetlands and agriculture to improve their productivity and quality for birds.

PRINCIPLE 3: Use Adaptive Management to Improve Mitigation Outcomes. Implement a monitoring and assessment program at all wetland mitigation sites and at regional scales to assess the effectiveness of mitigation actions. Mitigation actions should include clear and measurable goals and objectives.

- Action 3.1: Establish an independent science advisory panel to assess the effectiveness of wetland mitigation actions. Include representation from the CVJV. This panel could be part of the Delta Stewardship Council's Independent Science Board.
- Action 3.2: Develop site level mitigation monitoring and assessment for shorebirds, waterfowl and their habitats using established monitoring protocols so that data generated are compatible with existing monitoring programs (e.g. Pacific Flyway Shorebird Survey[3], Mid-winter Waterfowl Survey).
- Action 3.3: Develop and/or support maintenance plans that contain performance standards to ensure long term sustainability of sites.
- Action 3.4: If mitigation outcomes are deemed by the advisory panel to be insufficient, make sure there is capacity to adapt the mitigation program to meet the objectives.

Through hard work and significant investment, conditions are better today for migratory birds in the Delta than they were twenty years ago. Yet, the CVJV has not fulfilled our wetland habitat conservation goals in the three Delta basins, and our partners continue to look for opportunities there. It is very evident that the physical, economic and political landscapes have changed considerably in the Central Valley since the CVJV began its work, and a reevaluation of migratory bird needs in light of these changes is paramount to improve conservation planning and

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[2] Reiter et al. in prep. Local and Landscape Factors Influence Shorebird Use of Managed Wetlands.

[3] Pacific Flyway Shorebird Survey- http://data.prbo.org/apps/pfss/

delivery. This is especially true in the Delta region, where BDCP could have an immediate and lasting impact on the migratory bird resource. BDCP must include habitat restoration planning that considers the needs of all species and that emphasizes restoring high-quality habitat in the places that have the highest potential for success. Restoring 65,000 acres of tidal marsh, 10,000 acres of flood plain, and the enhancement of existing flood plains (e.g., the Yolo Bypass area), as proposed in the BDCP, could reduce habitat for certain species of migratory birds depending on the strategy and location of these efforts.

That said, a comprehensive and integrated BDCP has the potential to improve wetland and agriculture habitats important to birds, fish, and terrestrial wildlife. It must be thoroughly evaluated in regards to impacts on migratory birds and impacts avoided, reduced or mitigated to ensure consistency with the Delta Reform Act.

Our partner organizations have staff with considerable scientific expertise in avian and wetland ecology and are willing to provide input during the development of the BDCP and the evaluation of its effects. We look forward to engaging with your agency and others involved in Delta and Suisun planning to insure that ecosystem restoration includes all important habitat types and considers important terrestrial species such as migratory birds.

Sincerely,

Ellie Cohen
Management Board Chair

cc: Central Valley Joint Venture Management Board

Attachment: Avian Habitat Needs in the Delta. The habitat needs for birds and the conservation objectives designed to achieve those needs are found in the CVJV Implementation Plan. They are summarized below.

Suisun Basin - **32,232 acres of highly functioning seasonal wetlands**

The CVJV Implementation Plan identifies a number of means (described as "Objectives" in the Plan) designed to achieve the above requirement, as follows:

- *Wetland protection objectives* - There are no wetland protection objectives for this basin, as the entire 58,000-acre marsh (32,232 wetlands) was considered protected by the Suisun Marsh Protection Act of 1977 when the 2006 Plan was published.
- *Wetland restoration objectives* – There are no wetland restoration objectives, because existing managed wetlands were considered adequate to support desired waterfowl populations. However, reductions in wetland values as a result of conversion to tidal or other means would require an equal amount restored to managed wetlands to maintain migratory bird values.
- *Annual enhancement objective for existing wetlands* – 2,686 acres/year
- *Wetland water supply objectives*- 153,102 acre/feet/year

Yolo Basin **- 11,558 acres of highly functioning seasonal wetlands**
11,000 acres of winter flooded (or otherwise enhanced) small grain agriculture

The CVJV Implementation Plan identifies a number of means (described as "Objectives" in the Plan) designed to achieve the above requirement, as follows:

- *Wetland protection objective* – 5,000 acres
- *Wetland restoration objective* – 3,000 acres
- *Annual enhancement objective for existing wetlands* - 963 acres/year
- *Riparian habitat restoration objective*- 675 acres
- *Wetland water supply objective* – 57,790 acre/feet/year

Delta Basin **- 25,349 acres of highly functioning seasonal wetlands**
23,000 acres of winter flooded (or otherwise enhanced small grain

The CVJV Implementation Plan identifies a number of means (described as "Objectives" in the Plan) designed to achieve the above requirement, as follows:

- *Wetland protection objective* – 3,000 acres
- *Wetland restoration objective* - 19,000 acres
- *Annual enhancement objective for existing wetlands* - 529 acres/year
- *Riparian restoration objective* – 2,500 acres (Cosumnes and Mokelumne rivers)
- *Wetland water supply objectives* – 120,408 acre/feet/year

CENTRAL VALLEY JOINT VENTURE

Conserving Bird Habitat in California's Central Valley

October 15, 2010

California Department of Fish and Game
Attn: Mr. Chad Dibble
Water Branch
1416 9th St. 12th Floor
Sacramento, CA 95814

Subject: Comments on DFG Delta Flow Report

Dear Mr. Dibble:

On behalf of the Central Valley Joint Venture (CVJV), a public-private partnership working to conserve habitats in California's Central Valley for the benefit of migratory birds, we write to comment on the recent draft advisory report entitled "Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta" (Draft Report). We also acknowledge and appreciate the amount of work that has gone into complying with the Legislature's mandate to quantify water needs for Delta species of concern (Water Code, Section 85084.5).

The Draft Report summarizes its recommended flow criteria for aquatic species in Table 16 (pgs. 104-106), but we would like to emphasize the preceding Section 9.3 which notes that these recommendations are only one factor in the development of specific flow criteria and managing the Delta:

Before any specific criteria are implemented, the following should be considered:

1. Balancing of the need to protect the Delta's aquatic and terrestrial ecosystem with the need for reliable water supply.
2. The proposed project description as presented in the context of the available scientific understanding provided in this document.
3. New research and monitoring not available when this report was completed that may better protect species of concern (Draft Report, p. 103).

Going forward, the additional information identified in Section 9.3, as well as consideration for upstream impacts to biological resources, will be critical to inform the development of any flow criteria standards by the State Water Resources Control Board (SWRCB), Bay-Delta Conservation Plan, Delta Stewardship Council, or any other entity or planning process.

In addition, the CVJV appreciates the Draft Report's acknowledgement of the *CVJV 2006 Implementation Plan* (Draft Report, p. 9). Among other things, the *2006 Implementation Plan* identifies water needs for wetlands, harvested rice, and other habitats to meet the energetic needs of waterfowl, shorebirds, waterbirds, and riparian songbirds. If such information is not taken into account in the development of flow criteria standards, we fear numerous adverse impacts to migratory birds will result.

Finally, we encourage the Department of Fish & Game to build upon the substantial work and analysis embodied in the draft report and support its encouragement to SWRCB "to ensure impacts on beneficial uses of the Delta are comprehensively addressed when balancing environmental protection and water supply reliability" (Executive Summary, page *v*).

The Central Valley Joint Venture appreciates the opportunity to provide comments. Thank you for your time and consideration.

Sincerely,

Erik Vink
Management Board Chairman

cc: Central Valley Joint Venture Management Board
Mr. Phil Isenberg, Chair, Delta Stewardship Council
Mr. Charles Hoppin, Chair, State Water Resources Control Board

CENTRAL VALLEY

JOINT VENTURE

CONSERVING BIRD HABITAT

2006 IMPLEMENTATION PLAN

CENTRAL VALLEY
JOINT VENTURE
CONSERVING BIRD HABITAT

2006 IMPLEMENTATION PLAN

When referring to this document, please use the following:
Central Valley Joint Venture, 2006.
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat.
U.S. Fish and Wildlife Service, Sacramento, CA.
Cover photos: Northern pintails, Bob McLandress, CWA; Faith Ranch, Lake Marie, Gary Zahm

ACKNOWLEDGEMENTS

This plan has been several years in the making and could not have been completed without the extensive input of individuals from numerous Joint Venture organizations and agencies, the agricultural and water communities, and the private sector. Their participation was an essential component of the efficacy of this plan. On behalf of the Central Valley Joint Venture partnership, I would like to thank those who gave their time and expertise so generously.

Bob Shaffer

Bob Shaffer
Coordinator
Central Valley Joint Venture

Special Recognition Goes To:

- Former Central Valley Joint Venture Coordinators, Gary Kramer and Dave Paullin, for developing the 1990 Implementation Plan and establishing the foundation for a successful and enduring partnership.
- Mark Petrie, Ducks Unlimited, Inc., who was the Project Manager and combined his unique planning and modeling skills with technical expertise and writing ability to prepare a number of chapters including: Accomplishments, Basin Characteristics, Breeding Waterfowl, Wintering Waterfowl, Wintering Shorebirds, and Summary.
- Geoff Geupel, Catherine Hickey, and Diana Stralberg, PRBO Conservation Science for their work on the Riparian Songbirds and Breeding Shorebirds chapters.
- Dale Garrison, Fish and Wildlife Service, Joel Miller, Joel Miller Environmental Consulting, and Dave Widell, Ducks Unlimited, Inc. for their work on the Wetland Water Supplies chapter.
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- Dave Feliz, California Department of Fish and Game, Dale Garrison, Fish and Wildlife Service, Brian Gilmore, Bob McLandress, California Waterfowl Association, Jill Shirley, Central Vally Joint Venture, Carley Sweet, TRC Essex, and Gary Zahm for the use of their photographs throughout the Plan.
- Kevin Petrik and Xiangyue Wei, Ducks Unlimited, Inc., for producing the maps in this report (unless otherwise noted).
- JV staff members Rob Holbrook, Ruth Ostroff, and Jill Shirley, who dedicated hundreds of staff hours writing and editing the Plan.

Plan Contributors:

Organizations

Audubon California – Julia Levin, Glenn Olson, Vance Russell, Dan Taylor

California Association of Resource Conservation Districts – Tacy Currey

California Rice Commission – Paul Buttner

California Waterfowl Association – Ed Burns, Rob Capriola, Bill Gaines, Mark Hennelly, Dan Loughman, Bob McLandress, Jake Messerli, Dennis Orthmeyer, Jason Rhine, Chadd Santerre, Greg Yarris

Colusa Basin Drainage District – Anjanette Martin

Conaway Conservancy – Mike Hall

Defenders of Wildlife – Kim Delfino

Delta Protection Commission – Margit Aramburu

Ducks Unlimited Inc. – Theresa Allen-Hurst, Mark Biddlecomb, Dan Connelly, Mike Eichholz, Dan Fehringer, Jay Dee Garr, Virginia Getz, Greg Green, Chris Hildebrandt, Luke Naylor, Mark Petrie, Kevin Petrik, Fritz Reid, Ruth Spell, Xiangyue Wei, Dave Widell, Olen Zirkle

Grassland Water District – Scott Lower, Don Marciochi, Bob Nardi, Tim Pool

PRBO Conservation Science – Ann Chrisney, Ellie Cohen, Geoff Geupel, Jeanne Hammond, Catherine Hickey, Chrissy Howell, Kim Kreitinger Gary Page, Dave Shuford, Hilde Spautz, Diana Stralberg, Julian Wood

River Partners – John Carlon, Tom Griggs

Suisun Resource Conservation District – Steve Chappell, Kristin Garrison, Craig Haffner, Bruce Wickland

The Nature Conservancy – Mike Conner, Mike Eaton, Greg Golet, Sam Lawson, Ryan Luster, Ramona Swanson, Chris Unkel, Dawit Zeleke

Trust for Public Land – Nelson Mathews, Erik Vink

Tulare Basin Wetland Association – Bob Bowman, Jeff Thomson, Jack Thomson, Fran Burgess

Tulare Basin Wildlife Partners – Carole Combs, Rob Hanson, Dick Moss

University California Davis – Josh Ackerman, John Eadie, Shaun Oldenburger

University Nevada Reno – Jim Sedinger

State Agencies

California Department of Fish and Game – John Anderson, Andy Atkinson, John Beam, Ryan Broddrick, Brad Burkholder, Bill Cook, Dave Feliz, Paul Forsberg, Steve Juarez, Dean Kwasny, Bill Loudermilk, Carol Oz, Ed Penny, Glenn Rollins, Jeff Single, Dave Smith, Carl Wilcox, Dan Yparraguirre, Dave Zezulak

California Department of Water Resources – Dale Hoffman-Floerke, Jim Martin, Kent Nelson, Michael Perrone

California Resources Agency – Jay Chamberlin

California State Parks – Ruth Coleman, Nina Gordon

California Wildlife Conservation Board – Marilyn Cundiff, Peter Perrine

Federal Agencies

Army Corps of Engineers – Miki Fujitsubo, Mario Parker

Bureau of Land Management – Rick Cooper, Tony Danna, Steve Laymon, Larry Saslaw, Jim Weigand

Bureau of Reclamation – Frank Michny, Carl Dealy, Georgiana Gregory, Ned Gruenhagen, Mike Heaton, Pamela Hodapp, Jon Jay, Myrnie Mayville, Dan Meier, Michael Monroe, Sonya Nechanicky, Nigel Quinn, Patricia Rivera, John Thomson, Basia Trout

Environmental Protection Agency – Carolyn Yale

Fish and Wildlife Service – Brad Bortner, Lorna Daskalu, Steve Dyer, John Engbring, Kim Forrest, Scott Frazer, Dale Garrison, Michael Green, Matt Hamman, Dave Hardt, Tom Harvey, Craig Isola, Rob Holbrook, Tom McCabe, Ken McDermond, Greg Mensik, Shawn Milar, Maura Naughton, Ruth Ostroff, Dave Paullin, Mark Pelz, Loren Rupport, Bob Shaffer, Debra Schlafmann, Mike Wolder, Dennis Woolington, Bea Treiterer, Tara Zimmerman

Natural Resources Conservation Service – Alan Forkey, Tom Moore, Larry Norris, Malia Ortiz

U.S. Geological Survey – Mike Casazza, Joe Fleskes, Mike Miller

Others

Central Valley Bird Club – John Sterling

Ghostwriters – Jean Duncan

Greenfield Management Strategies – Bob Greenfield

Hedgerow Farms – John Anderson

Joel Miller Environmental Consulting – Joel Miller

North American Waterfowl Management Plan Committee – Eldridge “Red” Hunt

Wildlife Consultants – Gary Ivey, John McCaull

Department of Water Resources, State of California

California Waterfowl Association

Ducks Unlimited

United States Environmental Protection Agency

River Partners

CENTRAL VALLEY JOINT VENTURE

PARTNERS

The mission of the Central Valley Joint Venture is to work collaboratively through diverse partnerships to protect, restore, and enhance wetlands and associated habitats for waterfowl, shorebirds, waterbirds, and riparian songbirds, in accordance with conservation actions identified in the Joint Venture's Implementation Plan.

The Trust for Public Land California

U.S. Fish & Wildlife Service, Department of the Interior

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

Defenders of Wildlife

State of California resources agency

WCB State of California Wildlife Conservation Board

Audubon California

U.S. Department of the Interior Bureau of Land Management

US Army Corps of Engineers
Sacramento District

NRCS Natural Resources Conservation Service

U.S. Department of the Interior Bureau of Reclamation

California State Parks Since 1864

prbo
PRBO Conservation Science

Resources Agency California Department of Fish & Game

California Association of Resource Conservation Districts

CENTRAL VALLEY JOINT VENTURE TENETS

The Central Valley Joint Venture (CVJV) Management Board is comprised of representatives from the agencies and organizations that form the joint venture partnership. Their purpose is to provide overall leadership, guidance, resources and support for bird habitat conservation within the CVJV administrative boundary. Each member is responsible for ensuring that their agency or organization contributes to the overall goals of the CVJV.

The following provides a general framework for accomplishing the CVJV mission. The CVJV focuses on waterfowl, but integrates the needs of other bird groups, as outlined in its Implementation Plan. The focus will broaden, subject to future funding opportunities, to implement bird conservation strategies consistent with the CVJV mission statement.

Land Use Principles:

The CVJV will accomplish its habitat goals by means of land protection, restoration, and enhancement. Terms are defined as follows:

- Protection – the removal of a threat to land via fee title acquisition, perpetual conservation easement or perpetual agricultural easement from willing sellers. This action does not result in a gain in habitat acreage. Unprotected is defined as any privately owned land not covered by perpetual easement.
- Restoration – the physical manipulation of a former wetland or upland site with the goal of mimicking natural/historic functions. Only restoration under long-term protection will be counted as acreage gained.
- Enhancement – the physical manipulation of a wetland or upland site to repair or improve natural/historic functions or to manipulate successional stages of vegetation for the benefit of wildlife. Any manipulations for wildlife habitat improvements on lands protected less than perpetually will be counted as enhancement. This action does not result in a habitat acreage gain.
- The CVJV strongly encourages the assurance of adequate long-term water supplies with all wetland protection, restoration, and enhancement projects.
- The CVJV encourages land conservation through fee title acquisition or perpetual conservation easements. The CVJV will also support non-perpetual conservation programs. However, they will not count towards the JV's protection objectives.
- Habitat objective accomplishments do not transfer from one basin to another.
- The CVJV encourages non-regulatory actions prior to mitigation whenever possible.
- The CVJV seeks at least 50% of the energetic requirement for waterfowl from wetlands in each basin.

Biological Principles:

- The basis of the CVJV biological principles is to provide habitat for six bird groups, as addressed in the Implementation Plan. These bird groups include the following: breeding and non-breeding waterfowl, breeding and non-breeding shorebirds, riparian dependent songbirds, and waterbirds.
- The CVJV Implementation Plan objectives will not be implemented at the expense of other native/sensitive habitats such as vernal pools, remnant native grasslands, etc.

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Northern pintails
Photo: Bob McLandress, CWA

Central Valley Joint Venture 2006 Implementation Plan

EXECUTIVE SUMMARY

Plan Background

The 2006 *Central Valley Joint Venture Implementation Plan* (2006 Plan) allows the Central Valley Joint Venture (JV) and its individual partners to examine the habitat needs of various bird groups in the nine basins within the Central Valley, and to formulate and prioritize activities to meet those needs. The 2006 Plan updates the 1990 *Central Valley Habitat Joint Venture Implementation Plan* (1990 Plan; USFWS 1990), the original guiding document for wetland habitat conservation in the Central Valley of California. The 2006 Plan will direct the efforts of the JV for the next five years.

The 2006 Plan brings together research, monitoring data and evaluation from many sources, and represents the combined expertise of a wide range of professionals from conservation organizations, State and Federal agencies, and the private sector. Their knowledge and experience comprise the foundation for this plan.

The 2006 Plan brings together research, monitoring data and evaluation from many sources, and represents the combined expertise of a wide range of professionals from conservation organizations, State and Federal agencies, and the private sector.

Historical and Current Conditions of the Central Valley

The Central Valley stretches 450 miles down the center of California. It totals approximately 10 million acres, or 10% of the state, and includes portions of 19 counties. The 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.

In the 1800s, the Central Valley contained more than 4 million acres of wetland habitats, supporting an estimated 20 to 40 million waterfowl annually. Grassland and riparian habitats once bordered most of these wetlands. Since then, agricultural and urban development have destroyed or modified more than 95% of the historic wetlands and over 90% of all riparian habitats. Today, just over 205,000 acres of managed wetlands remain in the Central Valley, and of those, two thirds are in private ownership.

Origins of the Central Valley Joint Venture

In 1986, United States and Canadian wildlife agencies developed the North American Waterfowl Management Plan (NAWMP). The NAWMP recognized that wide-ranging degradations to wetlands and associated uplands across the continent required a comprehensive response to improve landscapes using public policies, wildlife friendly agriculture, and traditional habitat restoration programs. The purpose of the plan was, and remains, to sustain abundant waterfowl populations by conserving landscapes, through self-directed partnerships (joint ventures) guided by sound science.

The Central Valley Habitat Joint Venture was formally organized in 1988 and was one of the original six priority joint ventures formed under the NAWMP. Renamed the Central Valley Joint Venture in 2004, the Management Board has expanded from nine to twenty conservation organizations, and State and Federal agencies. With this growth, the JV has broadened its focus from exclusively waterfowl to include the conservation of habitats for other birds, consistent with major national and international bird conservation plans, and the North American Bird Conservation Initiative.

Organization and Content

The 2006 Plan incorporates new information and broadens the scope of conservation activities to include objectives for breeding waterfowl, breeding and non-breeding shorebirds, waterbirds, and riparian-dependent songbirds. It has identified specific goals and objectives for these species, stepped down to each of the Valley's nine basins. The 2006 Plan relies on both quantitative and qualitative approaches for establishing bird-group conservation objectives, and considers both biological and non-biological factors.

Chapter 1 explains the origin and purposes of the JV, the background for this updated implementation plan, and the historical and current conditions of the Central Valley.

Chapter 2 identifies the conservation objectives provided in the 1990 Plan, and summarizes accomplishments both Valley-wide and by basin for each objective. It also describes challenges faced in meeting certain objectives.

Chapter 3 provides a description of significant basin characteristics within the JV. The Central Valley is divided into nine basins that reflect regional differences in drainage patterns, and these serve as conservation planning units in the 2006 Plan for most bird groups.

Chapter 4 identifies the conservation objectives for wintering waterfowl, defined as non-breeding migrating or wintering ducks, geese, and swans using the Central Valley between August and March.

Chapter 5 discusses the habitat needs and corresponding limiting factors associated with the conservation of breeding waterfowl for basins in the Central Valley.

Chapter 6 addresses the needs of wintering shorebirds, defined as non-breeding shorebirds that occupy the Central Valley between July and May, each year.

Chapter 7 addresses the needs of seven species of shorebirds that breed within the Central Valley.

Chapter 8 addresses conservation needs within the Central Valley for waterbirds, a large and diverse group that includes seabirds, coastal waterbirds, wading birds and marshbirds that rely on aquatic habitats.

Chapter 9 addresses the conservation needs and strategies associated with breeding riparian songbirds in the Central Valley and is based on a suite of focal bird species that breed primarily in riparian habitat.

Chapter 10 outlines the need for water supplies for Central Valley wetlands and alternatives for obtaining needed water supplies to meet the 2006 Plan objectives. It summarizes the history of wetland water supplies and includes a topical summary of the most current and pressing water related issues within each basin.

Chapter 11 collates conservation objectives by habitat, and by basin or regional planning unit, for all bird groups addressed in this Plan. Table 11-1 lists these objectives by habitat type as follows:

Table S-1. Central Valley-wide conservation objectives and strategies combined across all bird groups for all basins.

Central Valley-wide objectives by habitat type		
Habitat type	*Strategy*	*Objective*
Seasonal wetlands	Protection	Protect all unprotected wetlands with fee or conservation easements
Seasonal wetlands	Restoration	108,527 acres
Seasonal wetlands	Enhancement	23,884 acres annually[a]
Semi-permanent wetlands	Restoration	12,500 acres
Riparian areas	Restoration	10,000 acres
Rice cropland	Enhancement[b]	170,000 acres
Agricultural cropland	Protection using Type I[c] and Type II[d] Agricultural Easements	Recommended for specific basins[c,d]
Agricultural cropland	Enhancement to benefit waterfowl	307,000 acres

[a] *Annual enhancement needs when restoration goals have been met.*

[b] *Post-harvest (winter flooding) of rice cropland.*

[c] *Type I agricultural easements: easements that protect waterfowl food sources, focused in the American, Butte, and Sutter Basins.*

[d] *Type II agricultural easements: easements that buffer existing wetlands from urban and residential development, focused in the American, Butte, Sutter, Delta, and San Joaquin Basins.*

The JV has made considerable progress toward achieving the goals of its 1990 Plan. This success has been due to the efforts of many partners and a wide range of habitat programs. In addition, JV partners have invested in research to evaluate biological assumptions on which the 1990 Plan was based. This investment has considerably strengthened the biological foundation of the 2006 Plan.

The JV's efforts to protect, restore and enhance wetlands have significantly increased wildlife habitat resources in the Central Valley, not only for waterfowl, but for numerous other wetland dependent species as well. These benefits have also included improved water quality, flood control, and increased recreational opportunities. Using a collaborative, non-regulatory approach, and guided by the 2006 Plan, the JV will work together to insure that those benefits continue to expand for wildlife and the general public.


Snow geese
Photo: Ducks Unlimited

Chapter One: INTRODUCTION

This chapter explains the origin and purposes of the Central Valley Joint Venture (JV), the background for this updated implementation plan, and the historical and current conditions of the Central Valley.

The mission of the Central Valley Joint Venture is to work collaboratively through diverse partnerships to protect, restore, and enhance wetlands and associated habitats for waterfowl, shorebirds, waterbirds, and riparian songbirds, in accordance with conservation actions identified in the Joint Venture's Implementation Plan.

Through these biologically based actions, the JV will advance in achieving its vision of providing a diversity of habitats necessary to sustain migratory bird populations in perpetuity for the benefit of those species, resident wildlife, and the public.

Origins of the Central Valley Joint Venture

The JV has its origins in the North American Waterfowl Management Plan (NAWMP), an international treaty signed on May 14, 1986 by the Canadian Minister of the Environment and the United States Secretary of the Interior. Mexico became a signatory to the plan during the 1994 NAWMP Update. The NAWMP was initiated in response to declining numbers of North American waterfowl. It established population goals for key waterfowl species, and identified a framework for recovering these populations through habitat enhancement, restoration and protection. Although the goals of the NAWMP were continental in scope, its success ultimately depended on regional efforts to increase waterfowl habitat. The joint venture concept of merging the efforts of government agencies, non-profit organizations, corporations, tribes, and individuals was ideally suited to the task of meeting waterfowl needs at regional scales. As a result, joint ventures were eventually formed in all of North America's key waterfowl areas to meet NAWMP goals.

Central Valley Joint Venture Partners

Audubon California

CA Association of Resource Conservation Districts

California Waterfowl Association

Defenders of Wildlife

Ducks Unlimited, Inc.

PRBO Conservation Science

River Partners

The Nature Conservancy

The Trust for Public Land

CA Dept. of Fish and Game

CA Dept. of Water Resources

CA Resources Agency

CA State Parks

CA Wildlife Conservation Board

U.S. Army Corps of Engineers

U.S. Bureau of Land Management

U.S. Bureau of Reclamation

U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service

U.S. Natural Resources Conservation Service


Cache Creek Nature Preserve
Photo: Brian Gilmore

The Central Valley Habitat Joint Venture (CVHJV) was formally organized in 1988 and was one of the original six priority joint ventures formed under the NAWMP. California Waterfowl Association, Defenders of Wildlife, Ducks Unlimited Inc., National Audubon Society, The Nature Conservancy, Trust for Public Land, Waterfowl Habitat Owners Alliance, CA Department of Fish and Game, and U.S. Fish and Wildlife Service (USFWS) were the nine founding partners and comprised the CVHJV's first Management Board (Board). Renamed the Central Valley Joint Venture in 2004, the Board now enjoys the membership of twenty conservation organizations, state and federal agencies. The partners have combined their efforts to cooperatively meet the habitat needs of migrating and resident bird species in the Central Valley of California associated with four international bird conservation initiatives.

In 1990, the CVHJV partnership developed its first strategic plan to deliver partnership-based waterfowl habitat conservation, the *Central Valley Habitat Joint Venture Implementation Plan* (1990 Plan). This *2006 Central Valley Joint Venture Implementation Plan* (2006 Plan) incorporates new information and broadens the scope of conservation activities to include objectives for shorebirds, waterbirds, and riparian songbirds.

The USFWS provides guidance for the establishment and organization of migratory bird joint ventures: "A joint venture is a self-directed partnership of agencies, organizations, corporations, tribes, or individuals that has formally accepted the responsibility of implementing national or international bird conservation plans within a specific geographic area or for a specific taxonomic group, and has received general acceptance in the bird conservation community for such responsibility" (U.S. Fish and Wildlife Service 2005).

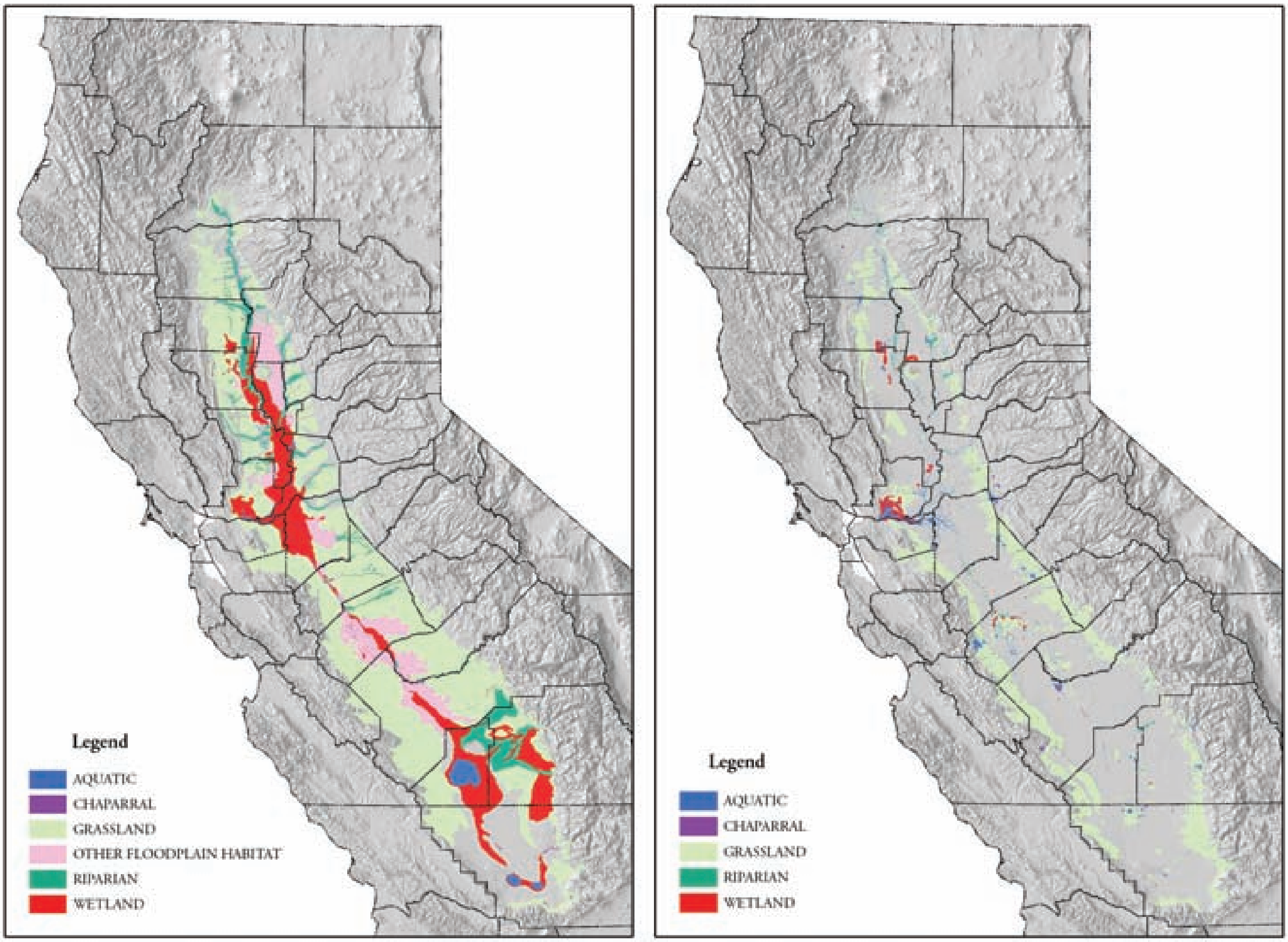
The JV is currently administered through a coordination office within the USFWS, and is guided by a Management Board that receives input and recommendations from a variety of working committees.

The Central Valley: Historical and Current Conditions

The Central Valley averages 40 miles wide and stretches 450 miles from north to south. It is bordered by the foothills of the Coast Range on its west and the Sierra Nevada on its east. The valley consists of two lesser valleys drained by California's two largest rivers, the Sacramento in the north and the San Joaquin in the south. These rivers flow from opposite directions and converge 40 miles southwest of Sacramento in a maze of channels, marshes and islands known as the Sacramento-San Joaquin Delta. These waters eventually reach the San Francisco Bay and empty into the Pacific Ocean.

The Central Valley totals about 10 million acres, or 10% of the State, and includes portions of 19 counties. Prior to the Gold Rush of the mid-1800s, the valley contained more than 4 million acres of wetland habitat. Most of these wetlands were bordered by grassland and riparian habitats. 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. Estimates from the 1800s suggest these habitats supported between 20 million and 40 million waterfowl annually. By the 1970s waterfowl numbers were estimated to be between 6 to 7 million, but declined significantly by the late 1980s (Heitmeyer 1989). Unfortunately, loss of these habitats has been dramatic. More than 95% of historic wetlands and 98% of all riparian habitats have been destroyed or modified. The remnant intensively managed wetlands and associated agricultural habitats now support an average of 5.5 million waterfowl annually. Few places on earth have greater concentrations of wintering waterfowl than the Central Valley.

Today, just over 205,000 acres of managed wetlands remain in the Central Valley (Figure 1-1), and of these, two thirds are in private ownership. The over-bank flooding that once characterized the valley is essentially gone. Dams, levees, and flood bypasses confine these historic flows to controlled pathways.



Data Sources: GIC Central Valley Historic Mapping Project, Chico State USGS 3-Arc Second Digital Elevation Model

Figure 1-1. Changes in Central Valley wetlands and associated habitats from 1900 (left) to 1990 (right).

Threats to wildlife habitat in the Central Valley continue to grow. Most of the valley's wetlands now rely on the application of water through managed systems. The long term reliability and affordability of water supplies for these wetlands is uncertain, as other water users compete for this limited resource. Water shortages in California are expected to grow as urban demand for water increases. The likely result is that water supplies needed for wetland management will become increasingly expensive, or worse yet, unavailable. According to the California Department of Finance, there are currently more than 34 million people in the state. This number is projected to reach 59 million by 2040, with an increase in the Central Valley from 5.4 million to 15.6 million. California's Central Valley ranks number one among the nation's twenty most threatened farming regions (American Farmland Trust 1997). The state's projected population increase will be accompanied by a loss of nearly one million acres of irrigated farmland within the valley (American Farmland Trust 1995), some of which contributes to meeting the needs of waterfowl and other wetland dependent wildlife.

Snow geese, white-fronted geese, northern pintails
Photo: Bob McLandress, CWA

Figure 1-2. Central Valley Joint Venture basins.

Focus of the 1990 Plan

In 1990, the JV developed its first planning document, the *Central Valley Habitat Joint Venture Implementation Plan*. The 1990 Plan primarily focused on the needs of wintering waterfowl (herein defined as non-breeding waterfowl that rely on the Central Valley floor during August-March). Breeding waterfowl needs were also addressed, although to a lesser degree. Waterfowl population objectives were generally linked to the NAWMP. Six conservation objectives were established to meet the habitat needs of Central Valley waterfowl:

1. Protect 80,000 additional acres of existing wetlands through acquisition of fee-title or perpetual conservation easements.
2. Secure an incremental, firm 402,450 acre-foot water supply that is of suitable quality and is delivered in a timely manner for use by National Wildlife Refuges (NWR), State Wildlife Areas (WA), and the Grasslands Resource Conservation District (GRCD).
3. Secure Central Valley Project power for NWRs, WAs and GRCD, and other public and private lands dedicated to wetland management.
4. Increase wetland acres by 120,000 acres and protect these wetlands in perpetuity by acquisition of fee-title or conservation easement.
5. Enhance wetland habitats on 291,555 acres of public and private lands.
6. Enhance waterfowl habitat on 443,000 acres of agricultural lands.

Each of these objectives was based mainly on the foraging habitat needs of wintering waterfowl, and also on enhancement of upland cover for breeding waterfowl in the Central Valley. The objectives were then stepped down to the valley's nine basins, based on historic waterfowl distribution. These basins served as planning units in the 1990 Plan (Figure 1-2).

The JV has made considerable progress toward achieving the goals of its 1990 Plan, and these accomplishments are detailed in Chapter 2. During the past 15 years, Joint Venture partners have invested in research to evaluate biological assumptions on which the 1990 Plan was based. This investment has considerably strengthened the biological foundation of the 2006 Plan.

Focus of the 2006 Plan

As previously stated, the 1990 Plan focused mainly on the needs of wintering waterfowl. Although meeting waterfowl needs remains central to the JV's purpose, the 2006 Plan has been expanded to include multiple bird groups.

In 1999, the North American Bird Conservation Initiative (NABCI) was formed to advance integrated bird conservation by capitalizing on partnership opportunities, promoting all-bird planning, and developing nation-wide Bird Conservation Regions. Joint ventures offer an existing structure for achieving the NABCI vision of integrating the goals of the various bird conservation plans. The USFWS encourages joint ventures to develop the capacity to deliver partnership based migratory bird habitat conservation (U.S. Fish and Wildlife Service 2005), although to date this direction has not come with additional funding sources to accomplish the task. The JV has consequently expanded its planning efforts to include six bird groups. Information for some bird groups is lacking compared to migrating and wintering waterfowl. However, the 2006 Plan is a first step in developing sound conservation objectives for each of the following:

- Wintering Waterfowl
- Breeding Waterfowl
- Non-breeding Shorebirds
- Breeding Shorebirds
- Waterbirds
- Breeding Riparian Songbirds

As part of its expanded responsibility to provide habitat for shorebirds, waterbirds and riparian birds along with waterfowl, the JV has increased its boundaries to include most of the Central Valley watershed, and has identified secondary and tertiary areas of focus within this expanded area. (Figure 1-3). Although the 2006 Plan continues to focus on the nine basins identified in the 1990 Plan, future planning efforts by the JV will reflect habitat needs within the expanded boundaries.

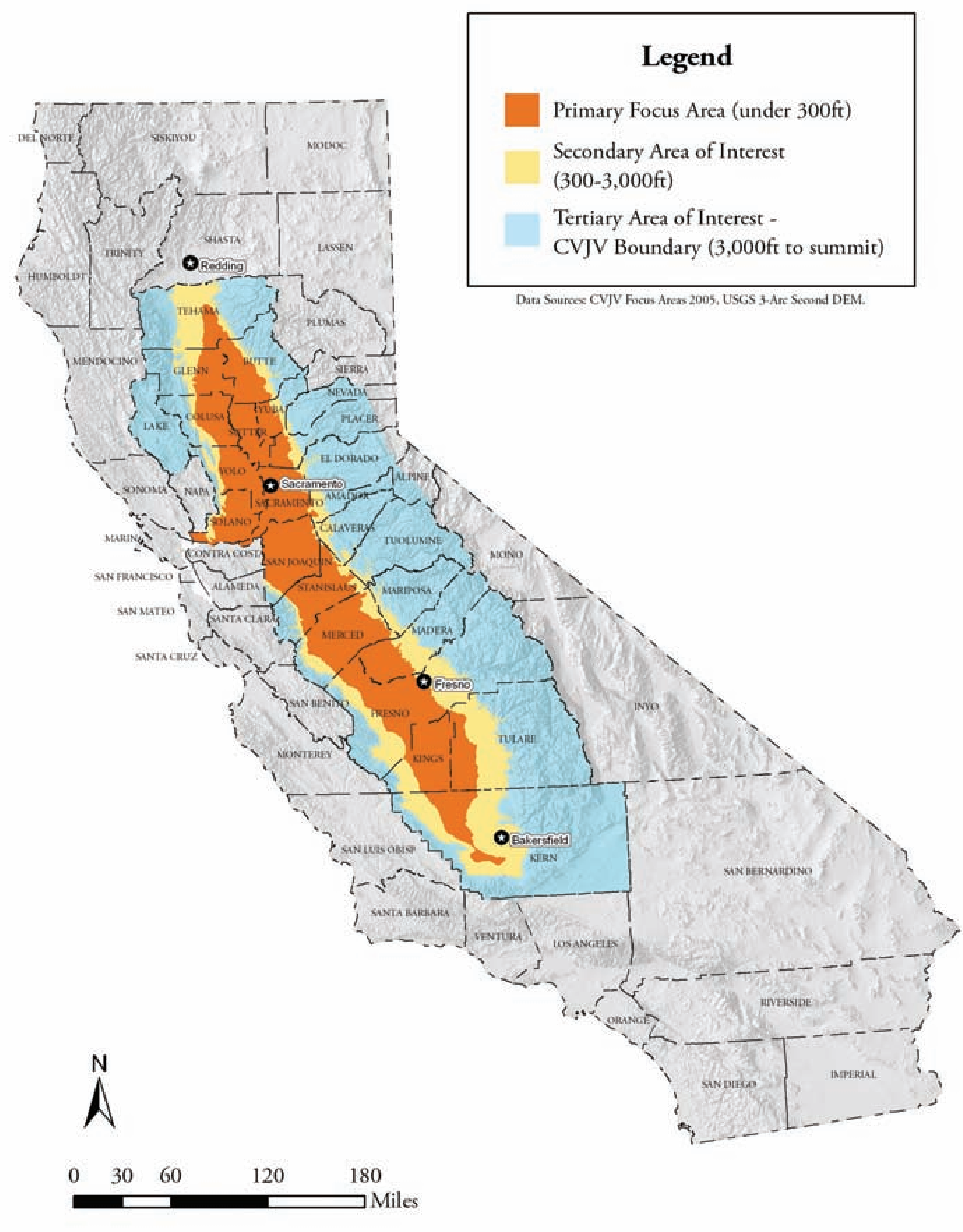


Figure 1-3. Central Valley Joint Venture boundary and focus areas.

Gray Lodge Wildlife Area
Photo: Brian Gilmore

While this 2006 Plan addresess the needs of multiple bird groups, wintering waterfowl remain a key focus of the JV's conservation activities. The *2004 NAWMP Strategic Guidance* document emphasizes a strengthening of the biological foundations of waterfowl conservation in North America. The JV has responded to this call by clearly linking waterfowl objectives for the Central Valley to continental population objectives established under the NAWMP. The 2006 Plan identifies the landscape conditions needed in the Central Valley to sustain waterfowl populations at NAWMP goals. Linking landscape conditions in the valley to continental population goals for waterfowl reflects the spirit of the 2004 NAWMP, which also acknowledged the need to integrate habitat objectives for waterfowl with those of other wetland dependent bird groups.

The 2006 Plan relies on both quantitative and qualitative approaches for establishing bird-group conservation objectives. Where possible, the Plan seeks a direct relationship between bird population objectives and habitat needs when establishing bird-group conservation objectives, because it allows these objectives to be expressed quantitatively (e.g., acres). In contrast, some bird groups lack population objectives or lack a clear link between population objectives and habitat needs. In those cases, conservation objectives reflect present understanding of breeding or non-breeding ecology but are not linked to a population objective.

Regardless of the approach, the 2006 Plan also considers non-biological factors when establishing conservation objectives. Human population growth, changing land use, and competition for limited water supplies all present real challenges to bird conservation efforts in the Central Valley. By taking into consideration biological factors, socio-economic forecasts, potential changes in agricultural practices, and an increasingly competitive water market, habitat programs can anticipate and to some degree mitigate landscape changes that are otherwise detrimental to birds.

The remainder of the 2006 Plan includes ten chapters. Chapter 2 describes JV accomplishments since 1990. Chapter 3 provides an overview of habitat conditions in each of the Central Valley's nine basins, as well as important socio-economic factors that characterize these regional planning units. Chapters 4 through 9 establish conservation objectives for each of the six bird groups. Chapter 10 examines water issues in the Central Valley and identifies the water needs and challenges faced by the JV to secure reliable and affordable supplies now and in the future. Chapter 11 provides integrated conservation objectives for all bird groups.

There are several locally-driven conservation efforts underway in areas such as the Tulare and American Basins which may identify conservation needs that are beyond the scope of the 2006 Plan, in terms of the amount and types of habitats to be protected, restored and enhanced. The JV fully supports these efforts, as many of its partners are participating in such scoping and planning activities. Future updates to this plan will reflect the accomplishments of these regional efforts.

Ducks in a Seasonal Wetland
Photo: Dale Garrison, USFWS

Chapter Two:
JOINT VENTURE ACCOMPLISHMENTS

This chapter identifies the conservation objectives provided in the 1990 *Central Valley Habitat Joint Venture Implementation Plan*, and summarizes accomplishments both valley-wide and by basin for each objective. It also describes challenges faced in meeting certain objectives.

Introduction

The Central Valley Joint Venture partnership (JV) has an impressive record of accomplishment since its inception in 1988, and has made excellent progress towards meeting the objectives adopted in the 1990 Central Valley Habitat Joint Venture Implementation Plan (1990 Plan). The 1990 Plan established conservation objectives outlined in Chapter 1 and are summarized below:

- Wetland Protection: Protect in perpetuity 80,000 acres of existing wetland habitats.
- Wetland Water Supplies: Secure adequate power and water supplies for wetland management.
- Wetland Restoration: Restore and protect in perpetuity 120,000 acres of former wetlands.
- Wetland Enhancement: Enhance all existing wetlands.
- Agricultural Land Enhancement: Enhance waterfowl habitat on 443,000 acres of agricultural lands.

> "The Central Valley Joint Venture is internationally recognized as an outstanding model of cooperative conservation, where partnerships working collectively toward common goals have protected, enhanced and restored thousands of acres of wetland, riparian, and associated upland habitat in the Central Valley for the benefit of migratory birds, resident wildlife and the public."
>
> **David Paullin**
> *Coordinator*
> *National Joint Venture*
> *Assessment Team*

Summary of Central Valley-wide Accomplishments

The JV has reached 71% of the Wetland Protection objective through the purchase or donation of fee title and conservation easements from willing sellers. Significant progress has been made toward the Water Supply objective through the passage of the Central Valley Project Improvement Act (CVPIA) Title 34 of Public law 102-575, passed by Congress on October 30, 1992. The purpose of the CVPIA was to achieve optimum water supplies for all public wetlands and private wetlands within the GCRD.The CVPIA provided for 72% of the wetland water supply needs identified by the JV. Fifty-nine percent of the Wetland Restoration objective has been met. Since the Wetland Enhancement objective involves annual habitat enhancements of 50,000 to 75,000 acres per year, it is not expressed here as an accomplishment percentage. Agricultural Enhancement objectives for wintering waterfowl are 119% of the 1990 goal due to tremendous increases in winter-flooded rice.

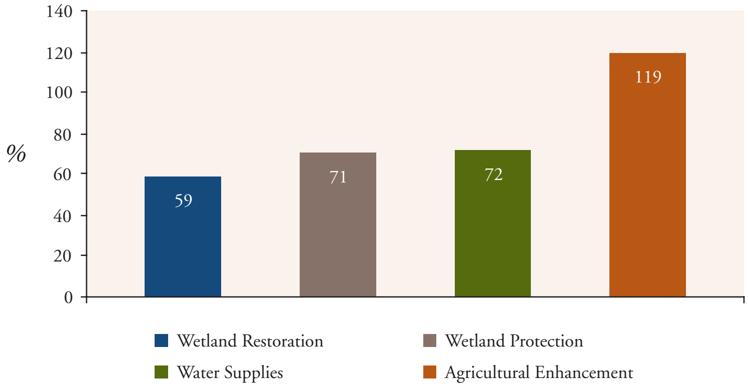


Figure 2-1. Progress in meeting conservation objectives as a percentage of objectives identified in the 1990 Plan.

The JV's efforts to protect, restore, and enhance wetlands have significantly increased wildlife habitat resources in the Central Valley (Figure 2-1), not only for waterfowl, but numerous other wetland dependent species as well. These benefits have also included improved water quality, flood control, and increased recreational opportunities.

Accomplishments by Basin

Wetland Protection

Protect In Perpetuity 80,000 Acres of Existing Wetland Habitats

The 1990 Plan had a stated objective of protecting 80,000 acres of existing privately owned wetlands through acquisition of fee-title or perpetual conservation easements. The 1990 Plan assumed 291,555 acres of wetlands were present in the Central Valley and that fifty nine percent of these wetlands (172,665 acres) were already protected through fee-title acquisition, perpetual easements or legislative actions. Accordingly, this left 118,810 acres of unprotected wetlands in the Central Valley.

Although the JV preferred that all wetlands receive protection, it recognized that many private wetland owners would be unwilling sellers or would not wish to enlist their properties in easement programs. Therefore, the JV adopted a wetland protection objective of 80,000 acres, which represented 67% of all remaining unprotected wetlands. This objective was seen as feasible, challenging, and large enough to make a significant difference to

Table 2-1. 1990 Wetland Protection objectives by basin. Basins are listed in priority based on the percent of wetlands in 1990 that were unprotected.

Basin	*Unprotected Wetlands (acres)*	*JV Protection Objective[a] (acres)*
Yolo	8,700	5,000
American	3,150	2,000
San Joaquin	67,000	52,500
Tulare	19,560	5,000
Butte	12,200	10,000
Delta	4,300	3,000
Colusa	3,400	2,000
Suisun	0[b]	no objective
Sutter	500	500
Total	**118,810**	**80,000**

[a] These acres reflect two thirds of the estimated unprotected wetlands in the Central Valley in 1990, and was considered to be a reasonable and achievable objective for the JV at that time.

[b] The entire 58,000 acre Suisun Marsh was assumed to be protected by the Suisun Marsh Protection Act of 1977.

waterfowl in the Central Valley. This 80,000-acre objective was divided among the nine basins. Basins were listed in order of priority based on the percent of existing wetlands that remained unprotected (Table 2-1).

Tracking of wetland protection efforts indicates that 56,778 acres of wetlands were protected between 1990 and 2003. To better understand how wetland protection was distributed among basins, and how this related to the JV's priorities (Table 2-1), wetland protection accomplishments between 1990 and 2003 are reported by basin (Table 2-2). There were some inconsistencies in actual protection efforts relative to how basins were prioritized. For example, efforts to protect wetlands were highest in the Butte Basin, although it ranked fifth in priority (effort to protect wetlands is defined as 1990 protection objectives divided by actual acres protected between 1990 and 2003). In contrast, efforts to protect wetlands in American Basin ranked seventh, despite being identified as the second highest priority basin. Alternatively, efforts to protect wetlands in the San Joaquin Basin nearly matched the basin's 1990 priority rank. Those inconsistencies may be explained by the presence or absence of local interest and/or opportunity for protection actions in individual basins.

Table 2-2. 1990 Wetland Protection objectives vs. accomplishments. Basins are listed in priority based on the percent of existing wetlands that were unprotected in 1990.

Basin	*JV Protection Objective (acres)*	*Wetlands Protected 1990–2003 (acres)*
Yolo	5,000	2,935
American	2,000	318
San Joaquin	52,500	40,138
Tulare	5,000	54
Butte	10,000	10,690
Delta	3,000	1,704
Colusa	2,000	794
Sutter	500	145
Total	80,000	56,778

Wetland Power and Water Supplies

Secure Adequate Power and Water Supplies for Wetland Management

Power Supplies

Procuring low-cost rates for power necessary to supply water to Central Valley National Wildlife Refuges (NWR), State Wildlife Areas (WA) and the Grassland Resource Conservation District (GRCD) wetlands has been an elusive endeavor for many years. JV partners have had limited success in attaining these rates due to a variety of complicated factors including, but not limited to: (1) the unwillingness of Pacific Gas and Electric Company (PG&E) to deliver power from other power distribution sources (e.g., Western Area Power Administration); (2) lack of dedicated capacity in major transmission facilities; (3) PG&E's requirement for minimum amounts of energy delivered to a single distribution point; the requirement of paying for stand-by power when electricity is not being used; (3) the high cost of maintenance of power lines and distribution facilities; and (4) current policy interpretations by the Bureau of Reclamation as to what existing or proposed pumping facilities qualify or don't qualify for Central Valley Project Use power, which is the lowest cost rate available.


White-faced ibis
Photo: Dave Feliz, CDFG

The JV recognizes that affordable power must be included in the formula to provide reliable water supplies to Central Valley wetlands. This is particularly true in areas such as the Tulare Basin where pumped groundwater is the primary water source and in the Suisun Marsh where pumping is necessary to drain diked, managed wetlands for leaching and habitat management. A JV Power Committee organized to reengage in these issues may develop acceptable solutions in the near future.

Water Supplies

The passage of the CVPIA significantly increased the reliability of water supplies for public wetlands and for private wetlands in the GRCD. The 1990 Plan had a stated objective of securing a 402,450 acre-foot water supply that is of "suitable quality and is delivered in a timely manner" for optimum management of wetlands on NWRs, WAs, and in the GRCD. The GRCD includes most private wetlands in the San Joaquin Basin, with the San Joaquin Basin itself containing 38% of all private wetlands in the Central Valley (see Chapter 3). Thus, the JV's water objectives targeted a significant fraction of privately managed wetlands in the valley, as well as all existing publicly-owned wetlands.

Water objectives in the 1990 Plan for NWRs, WAs, and the GRCD are presented in Table 2-3. Level 1 supply equaled reliable water supplies that were available by 1990, while Level 2 supplies equaled the average delivery of water to public habitats and the GRCD prior to the 1990 Plan. Of the 363,000 acre-feet annually delivered to public habitats and the GRCD by 1990, only 95,200 acre-feet were considered reliable (Table 2-3). Level 3 water supplies in the 1990 Plan equaled the amount of water needed for optimum management of existing wetland habitats, while Level 4 equaled the amount of water needed to permit full habitat development on public wetland areas and the GRCD.

Passage of the CVPIA automatically guaranteed Level 2 water supplies for NWRs, WAs, and the GRCD. The CVPIA also stipulated that Level 4 water supplies would be achieved in 10% increments between 1993 and 2002. This would include securing reliable water through annual water purchases, and the necessary construction of conveyance facilities to refuges not yet in place but needed to carry these water supplies. Although the intent of the CVPIA was to reach reliable Level 4 supplies through incremental gains over a ten-year period, this has not been achieved because of chronic funding shortages and ongoing competition with other CVPIA programs for limited funds. Mendota WA, as well as Kern and Pixley NWRs, also lack the facilities to convey Level 4 supplies. Gray Lodge WA conveyance facilities were only recently completed in 2005. The result is that water purchases for public habitats and the GRCD remain unreliable.

Water acquisition to achieve Level 4 supplies relies upon spot market purchases by the Bureau of Reclamation from willing sellers every year. The escalating cost of water makes these purchases increasingly expensive. For example, average costs for water have increased from $50 per acre-foot to $125 per acre-foot during the last five years, despite normal rainfall amounts. An extended drought in California could make future water purchases prohibitively expensive. Chapter 10 discusses the challenges and issues that will most likely affect the JV's ability to secure water for wetlands in the near future.

Table 2-3. Water supply needs (acre-feet) identified in the 1989 *Report on Refuge Water Supply Investigations, Central Valley Hydrologic Basin, California.*

Area	*Level 1*[a]	*Level 2*[b]	*Level 3*[c]	*Level 4*[d]	*Objective*[e]
SACRAMENTO NWR	0	46,400	50,000	50,000	50,000
DELEVAN NWR	0	20,950	25,000	30,000	30,000
COLUSA NWR	0	25,000	25,000	25,000	25,000
SUTTER NWR	0	23,500	30,000	30,000	30,000
GRAY LODGE WA	8,000	35,400	41,000	44,000	36,000
GRASSLAND RCD	50,000	125,000	180,000	180,000	130,000
VOLTA WA	10,000	10,000	13,000	16,000	6,000
LOS BANOS WA	6,200	16,670	22,500	25,000	18,800
KESTERSON NWR	3,500	3,500	10,000	10,000	6,500
SAN LUIS NWR	0	13,350	19,000	19,000	19,000
MERCED NWR	0	13,500	16,000	16,000	16,000
MENDOTA WA	25,500	18,500	24,000	29,650	4,150
PIXLEY NWR	0	1,280	3,000	6,000	6,000
KERN NWR	0	9,950	15,050	25,000	25,000
TOTAL	**103,200**	**353,050**	**473,550**	**505,650**	**402,450**

[a] *Existing firm water supply in 1990*
[b] *Average annual water deliveries prior to 1990 Plan*
[c] *Full use of existing development (as it existed in 1990)*
[d] *Water needed to permit full habitat development*
[e] *Additional firm water needs identified in the 1990 Plan (Level 4 minus Level 1)*

Wetland Restoration

Restore and Protect In Perpetuity 120,000 Acres of Former Wetlands

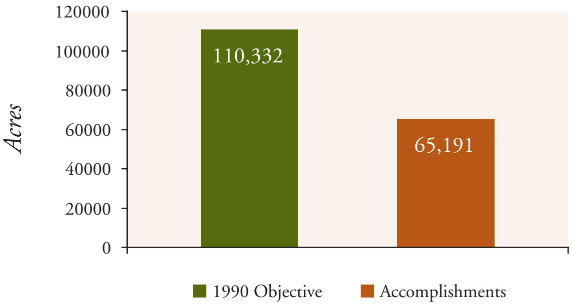


Figure 2-2. 1990 Wetland restoration objectives (acres) vs. wetlands restored between 1990 and 2003 for the entire Central Valley.

The 1990 Plan had a stated objective of restoring 120,000 acres of wetland habitat. Restoration of 9,668 acres of wetlands in the Central Valley between 1986 and 1989 was applied towards this conservation objective, leaving an actual restoration objective of 110,332 acres.

The 1990 Plan identified 291,555 acres of existing wetlands in the Central Valley, but this number actually included a significant number of upland acres on federal, state, and private lands. Improved wetland inventory capabilities have shown that this initial number of wetland acres was an overestimation, and it has been revised in the 2006 Plan to 140,363 acres, in order to more accurately reflect the actual number of Central Valley wetlands that existed in 1990.

As of April 1, 2003 managed wetlands in the Central Valley totaled 205,554 acres. This represents a gain of 65,191 acres of wetland habitat, or 59% of the 1990 revised wetland acres (Figure 2-2). It also represents a 46% increase in the acres of managed wetlands that were present in 1990.

Wetland restoration objectives and accomplishments are presented by basin in Table 2-4. While significant progress has been made in meeting the 1990 wetland restoration objective for the entire Central Valley, there is disparity among basins. JV progress in meeting 1990 wetland restoration objectives for the American, Delta, and Sutter Basins lags well behind the overall figure of 59% for the Central Valley. In contrast 1990 wetland restoration objective for the San Joaquin Basin has been exceeded.

Yolo Basin Wildlife Area wetland restoration
Photo: Jill Shirley, CVJV

Wetland restoration, San Joaquin Valley
Photo: Ducks Unlimited

Table 2-4. Wetland restoration objectives (acres) and accomplishments in the Central Valley by basin 1990 to 2003.

Basin	*1990 Objective*	*Wetlands Restored 1990-2003*	*Percent of Objective*
American	9,517	2,658	28%
Butte	28,080	17,793	63%
Colusa	12,990	6,079	47%
Delta	19,060	4,226	22%
San Joaquin	19,980	22,742	114%
Suisun	No Objective[a]	234	N/A
Sutter	10,960	760	7%
Tulare	No Objective[b]	6,445	N/A
Yolo	9,745	4,254	44%
Total	**110,332**	**65,191**	**59%**

[a] *The entire 58,000 acre Suisun Marsh was assumed to be already in wetlands, therefore, no wetland restoration objective was established for this basin. Tidal restoration was not considered in the 1990 Plan, due to limited waterfowl benefits.*

[b] *No restoration was proposed in the 1990 Plan, but this did not preclude future restoration efforts by public or private interests.*

Wetland Enhancement

Enhance All Existing Wetlands

The 1990 Plan had a stated objective of enhancing all acres of existing public and privately managed wetlands. Although wetland enhancement in the Central Valley has proven difficult to track. Wetland enhancement has been redefined for the 2006 Plan (see Chapter 4), and the JV has developed a new web-based system to track accomplishments. This system will allow the JV to better measure progress in meeting enhancement objectives.

Agricultural Land Enhancement

Enhance Waterfowl Habitat On 443,000 Acres of Agricultural Lands Annually

The JV has made great strides towards its 1990 objective by enhancing over 384,000 acres of agricultural lands (J.D. Garr, Ducks Unlimited, Inc., personal communication). The 1990 Plan had a stated objective of annually enhancing waterfowl habitat on 443,000 acres of agricultural land. This conservation objective was broadly divided into two categories:

1. Enhancement of 332,290 acres of grain fields to help meet the food energy needs of wintering waterfowl, and
2. Enhancement of 110,800 acres of upland habitat to ensure adequate nest success for breeding waterfowl.

Enhancement of grain fields for wintering waterfowl was further divided into 83,075 acres of deferred tillage and 249,215 acres of winter flooding.

Table 2-5. Agricultural enhancement objectives and accomplishments for wintering waterfowl by basin.

Basin	*1990 Winter Flooding Goal*[a]	*Current Winter Flooding*	*1990 Deferred Tillage Goal*	*Current Deferred Tillage*	*1990 Basin Total Goal*[b]	*Current Basin Total*[c]
American	11,140	72,049	3,713	0	14,853	72,049
Butte	72,151	99,494	24,050	0	96,201	99,494
Colusa	63,268	141,895	21,093	0	84,361	141,895
Delta	39,078	30,495	13,026	0	52,104	30,495
San Joaquin	0	0	0	0	0	0
Suisun	0	0	0	0	0	0
Sutter	33,845	33,168	11,282	0	45,127	33,168
Tulare	14,854	Unknown	4,951	0	19,805	Unknown
Yolo	14,879	7,020	4,960	0	19,839	7,020
Total	**249,215**	**384,121**	**83,075**	**0**	**332,290**	**384,121**

[a] *Winter flooding refers exclusively to winter flooding of rice habitat with the exception of the Delta Basin where 29,488 acres of winter flooded corn and 1007 acres of winter flooded rice are estimated. Winter flooded acres in Tulare Basin are unknown but not believed to be large.*

[b] *Sum of Winter Flooding and Deferred Tillage goals in the 1990 Plan.*

[c] *Estimated sum of current Winter Flooding and Deferred Tillage acres as of 2003. Current Deferred Tillage is zero in all basins.*

Deferred tillage increases the amount of waste grain available to waterfowl by not deep plowing fields immediately after harvest, while winter flooding increases bird access to agricultural food resources. Although agricultural enhancement objectives were developed to provide additional habitat for breeding waterfowl, no upland programs for nesting waterfowl have been developed since 1990. Instead, efforts to meet the agricultural enhancement objectives in the 1990 Plan have largely focused on improving waterfowl access to agricultural foods during migration and winter.

Winter flooding, particularly of rice lands, has proved to be so widespread since 1990 that the conservation objective was achieved without relying on other approaches. Winter flooding of agricultural habitats in the Central Valley is now estimated at over 384,000 acres, with over ninety percent of this habitat being rice (information on how winter flooding was estimated is provided in Chapter 3). This estimate exceeds the 1990 objective for winter flooding by 135,000 acres (Figure 2-3). Although a pilot program to encourage deferred tillage was initiated in 1989, the JV partners did not actively pursue this program. Winter flooding alone now exceeds the 1990 objective of enhancing 332,000 acres of agricultural habitat. Therefore, the lack of a deferred tillage program has not prevented the JV from meeting its overall conservation objectives for farmed lands. If winter flooding declines and post-harvest disking becomes more common, the JV may need to revisit the issue of deferred tillage.

Figure 2-3. Winter flooding objectives vs. accomplishments from 1990 through 2003.

The overall objective of enhancing 332,000 acres of grain fields to help meet the food energy needs of wintering waterfowl was divided among the American, Butte, Colusa, Delta, Sutter, and Yolo Basins. No agricultural enhancement objectives for wintering waterfowl were developed for the San Joaquin, Tulare, and Suisun Marsh Basins (Table 2-5). Agricultural enhancement objectives have been exceeded for the American, Butte, and Colusa Basins. Current estimates of winter flooding in the Yolo Basin are less than half of the 1990 objective. While winter flooding objectives for this basin exceed 14,000 acres, rice production averaged only 9,750 acres in Yolo Basin between 1997 and 2001. Therefore, this objective was unlikely to be met. Although the Delta and Sutter Basins each approached their goals for winter flooding, the overall objective for agricultural enhancement (winter flooding + deferred tillage) was not met for either basin (Table 2-5).

Summary

The JV has reached 71% of the Wetland Protection objective through the purchase or donation of fee title and conservation easements from willing sellers. Significant progress has been made toward the Water Supply objective through the passage of the Central Valley Project Improvement Act (CVPIA). The CVPIA provided for 72% of the wetland water supply needs identified by the JV. Fifty-nine percent of the Wetland Restoration objective has been met. Every year 50,000 to 70,000 acres of wetlands are enhanced. Agricultural Enhancement objectives for wintering waterfowl are 119% of the 1990 goal due to tremendous increases in winter-flooded rice.

The JV's efforts to protect, restore, and enhance wetlands have significantly increased wildlife habitat resources in the Central Valley, not only for waterfowl, but numerous other wetland dependent species as well. These benefits have also included improved water quality, flood control, and increased recreational opportunities.


Suisun Basin
Photo: Bob McLandress, CWA

Chapter Three: BASIN CHARACTERISTICS

This chapter provides a description of important basin characteristics within the JV. The Central Valley is divided into nine basins that reflect regional differences in drainage patterns (Figure 3-1), and these serve as conservation planning units in the 2006 Plan for most bird groups. The first section describes each basin, its general location, size, and hydrology. The second provides a summary of habitat conditions in each basin including a description of wetland, agricultural and associated habitat resources that are important to specific bird groups. The final section of this chapter discusses anticipated human population growth and associated changes in land use.

Basin Description, Hydrology, and Other Features

Butte Basin

The Butte Basin encompasses 1,100 square miles and extends 75 miles from Red Bluff south to the Sutter Buttes. The basin is bordered by the Sacramento River on its west, and the Sierra Nevada foothills and Feather River on its east (Figure 3-2). 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 are now protected by levees and have

"Each of the nine Central Valley hydrologic basins is unique, providing its own set of biological values for wintering and breeding birds. The JV has been adept at working directly with those individuals, agencies and organizations with the greatest local knowledge, effectively gathering the best information available to develop landscape-level habitat objectives for all of the major bird groups."

Peter Perrine
Wetlands Program Manager
California Wildlife
Conservation Board

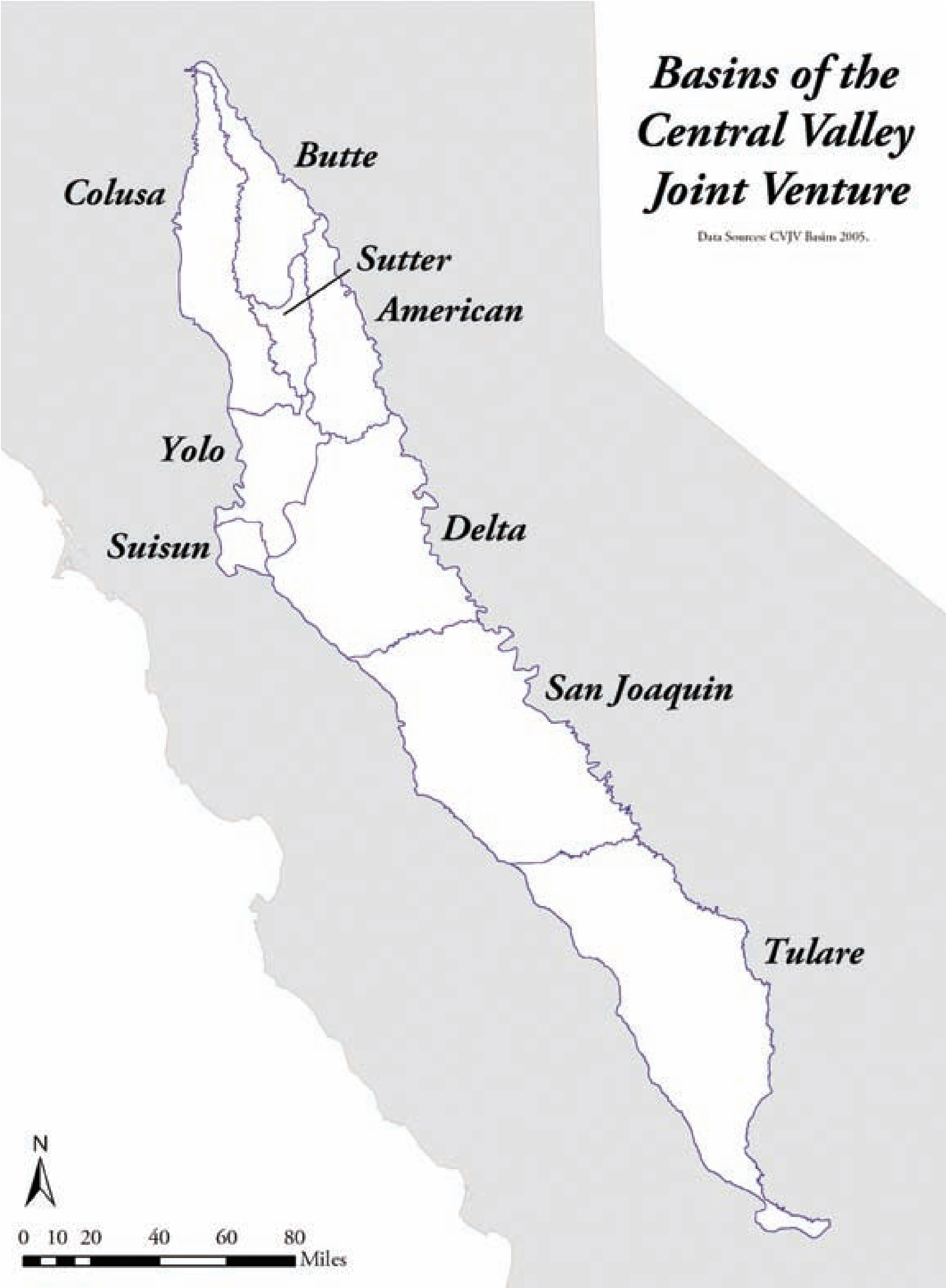
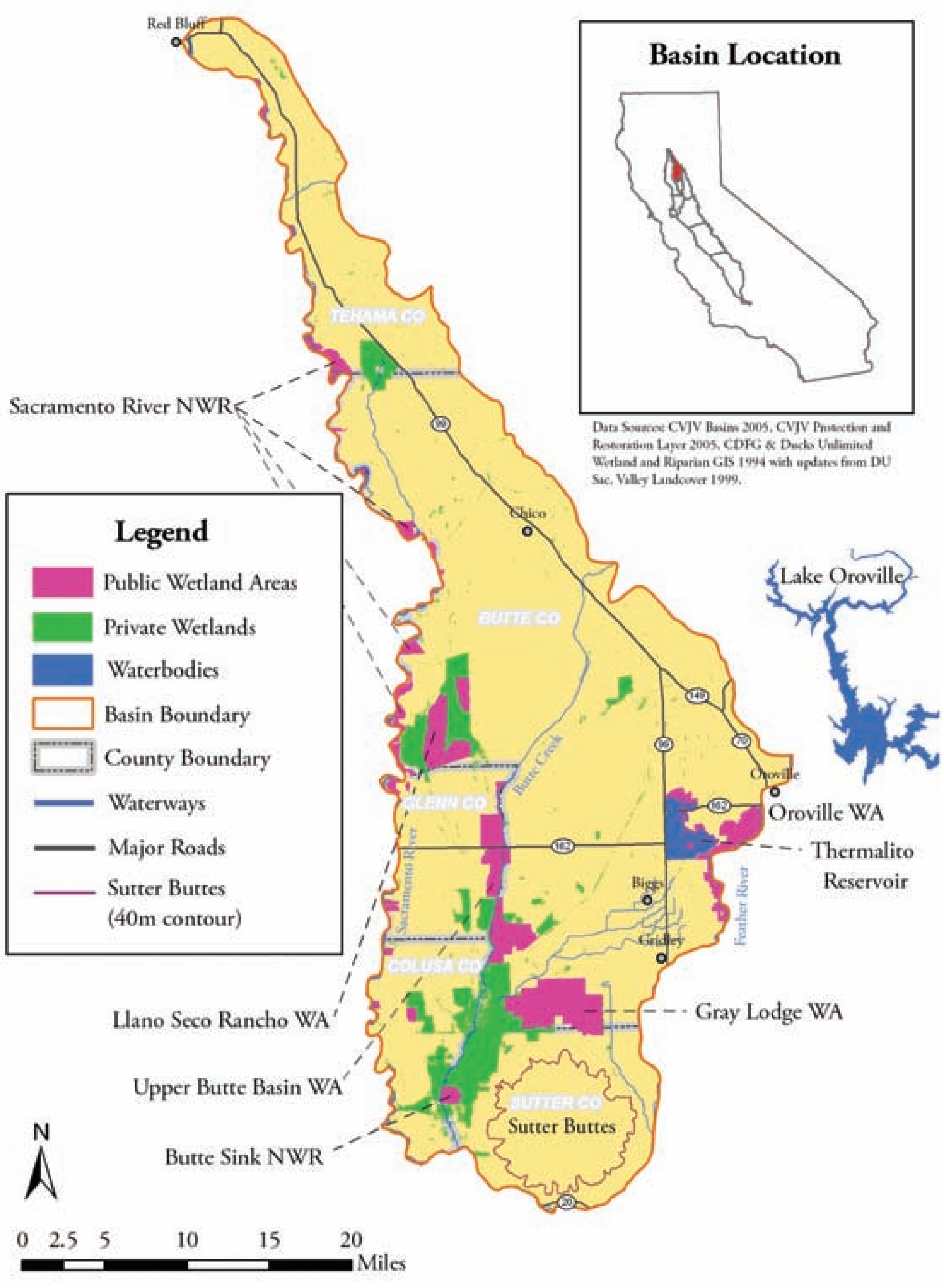


Figure 3-1. Central Valley Joint Venture basin boundaries.

been developed for urban and agricultural use. Below Chico, over-bank flooding from Butte Creek and the Sacramento River 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 as well. The southwestern part of the basin is now managed by the Sacramento River Flood Control District to convey flood flows into the Sutter Bypass.

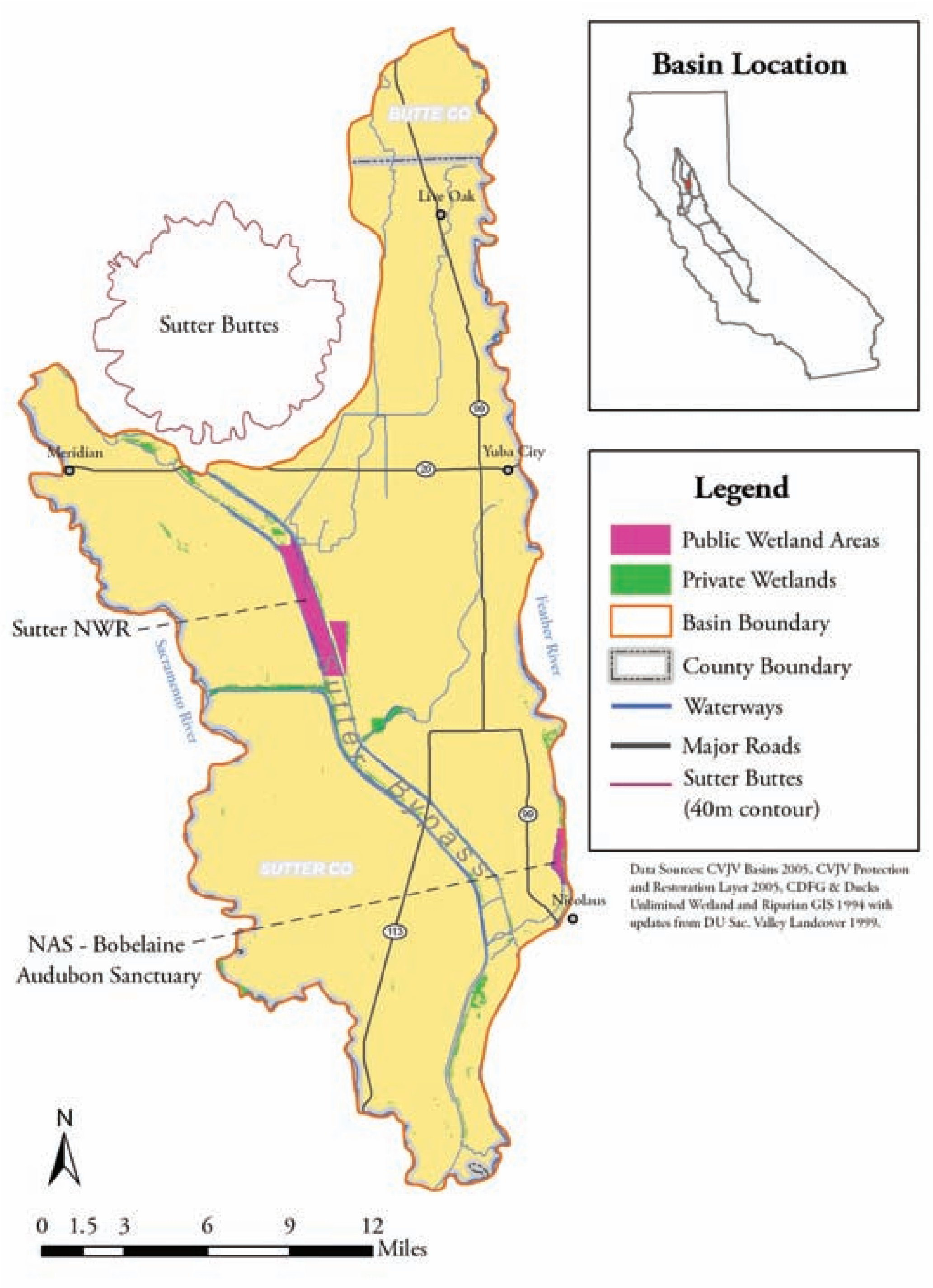


Data Source: CVJV Basins 2005, CVJV Protection and Restoration Layer 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 3-2. Map of the Butte Basin

Sutter Basin

The Sutter Basin totals 350 square miles and extends south from the Sutter Buttes to the confluence of the Feather and Sacramento Rivers. These rivers also border the basin to its east and west (Figure 3-3). Overflow from the Sacramento and Feather Rivers and the Butte Sink historically flooded 40,000 to 50,000 acres of wetlands. 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.

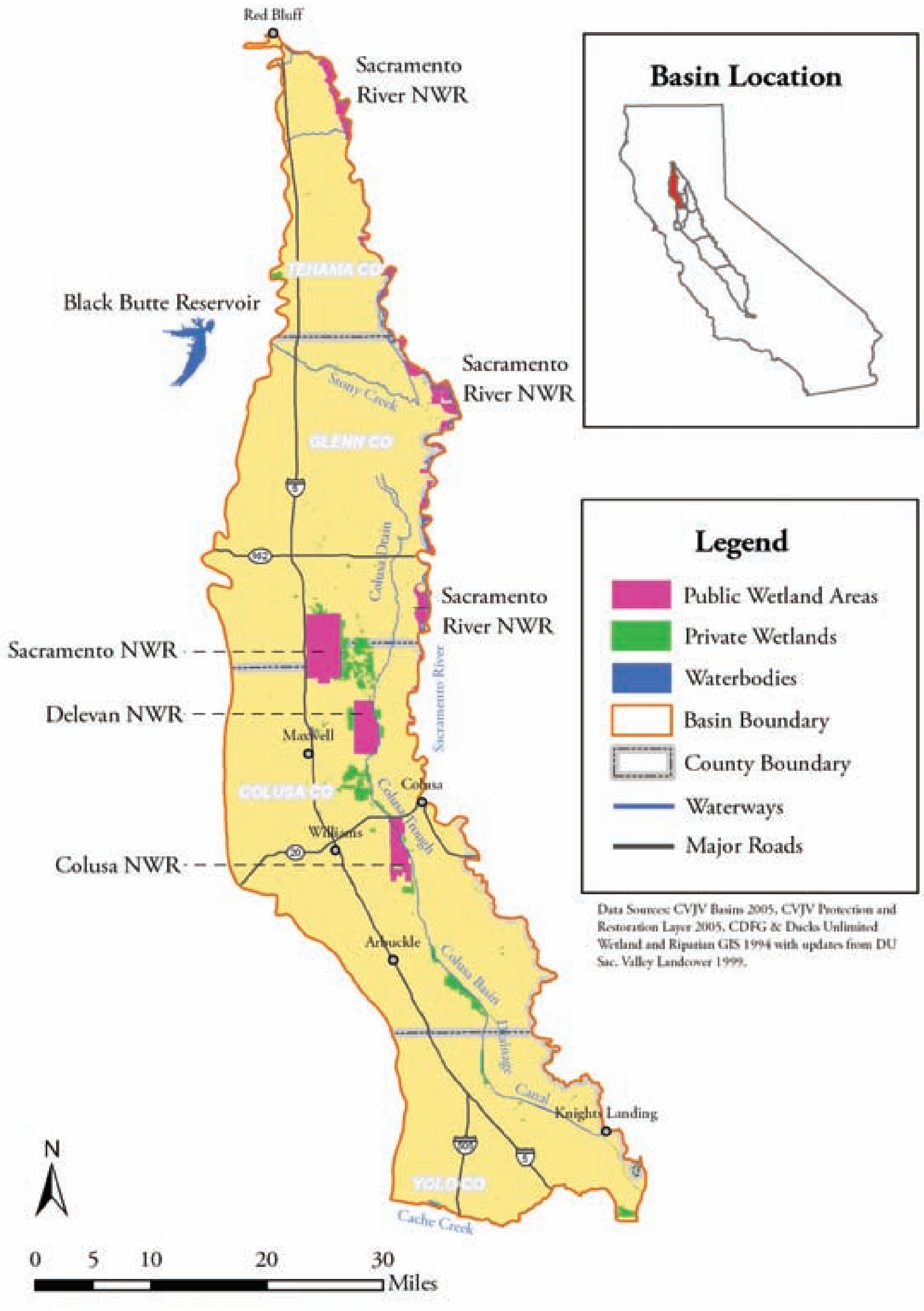


Data Sources: CVJV Basins 2005, CVJV Protection and Restoration Layer 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 3-3. Map of the Sutter Basin

Colusa Basin

The Colusa Basin extends 106 miles from Red Bluff south to Cache Creek and is bordered on the east by the Sacramento River and on the west by the Coast Range. The basin totals 1,600 square miles, though most wetland habitat is located south of the Stony Creek drainage (Figure 3-4). Colusa Trough, a naturally formed depression that enters the Sacramento River near Knight's Landing, drains the basin. 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.

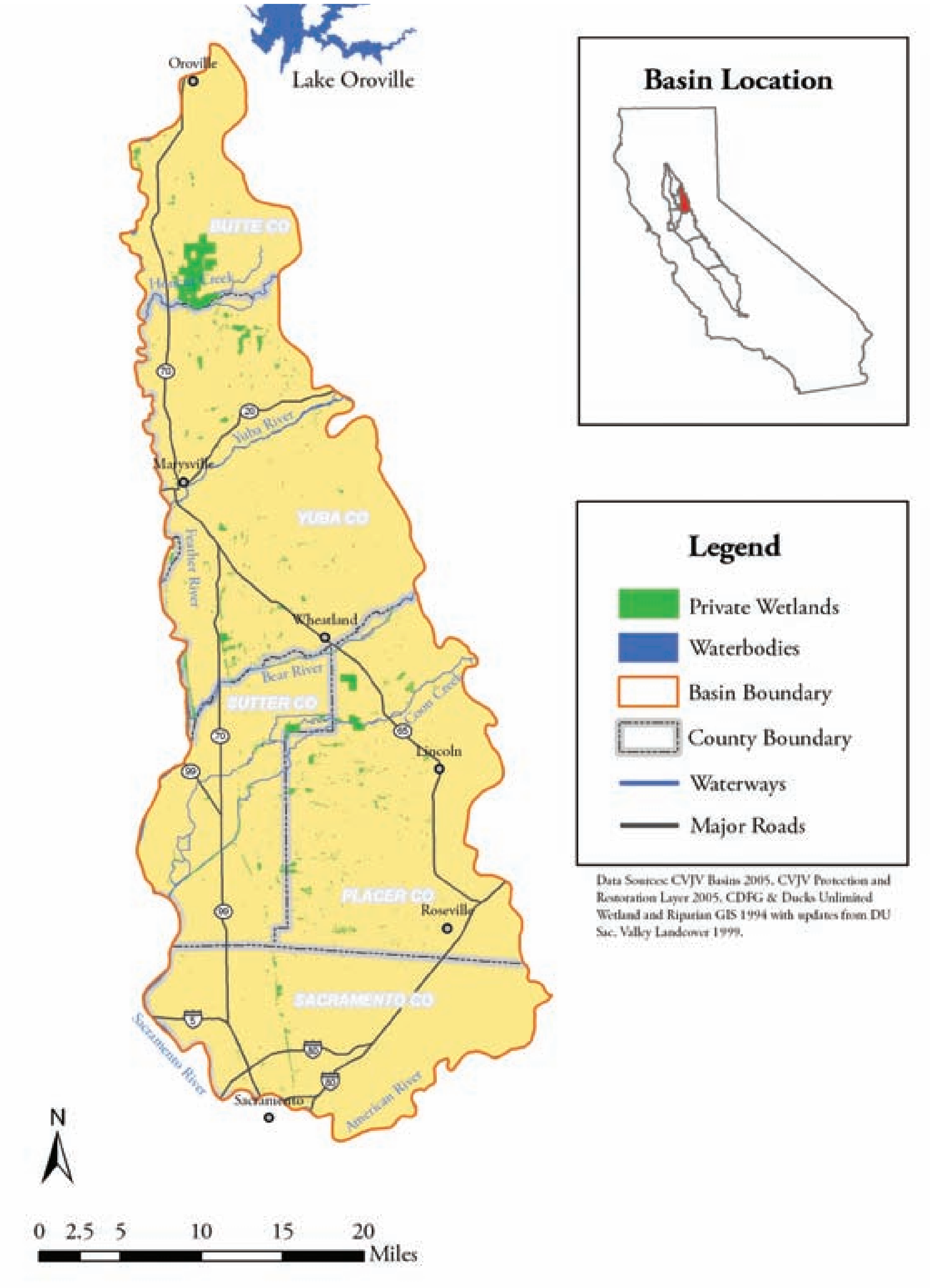


Data Sources: CVJV Basins 2005, CVJV Protection and Restoration Layer 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 3-4. Map of the Colusa Basin

American Basin

The American Basin lies east of the Sacramento and Feather Rivers and west of the Sierra Nevada foothills from Oroville in the north to the American River in the south. The basin totals about 860 square miles (Figure 3-5). Historically, water from the American, Yuba, Feather, Sacramento, and Bear Rivers flooded this area. This basin includes the District 10 and Honcut Creek areas, which constitutes a large block of privately owned wetlands. Construction of flood control reservoirs, levees, and dams at Folsom, Oroville, and Bullards Bar, have eliminated most of this over-bank flooding.



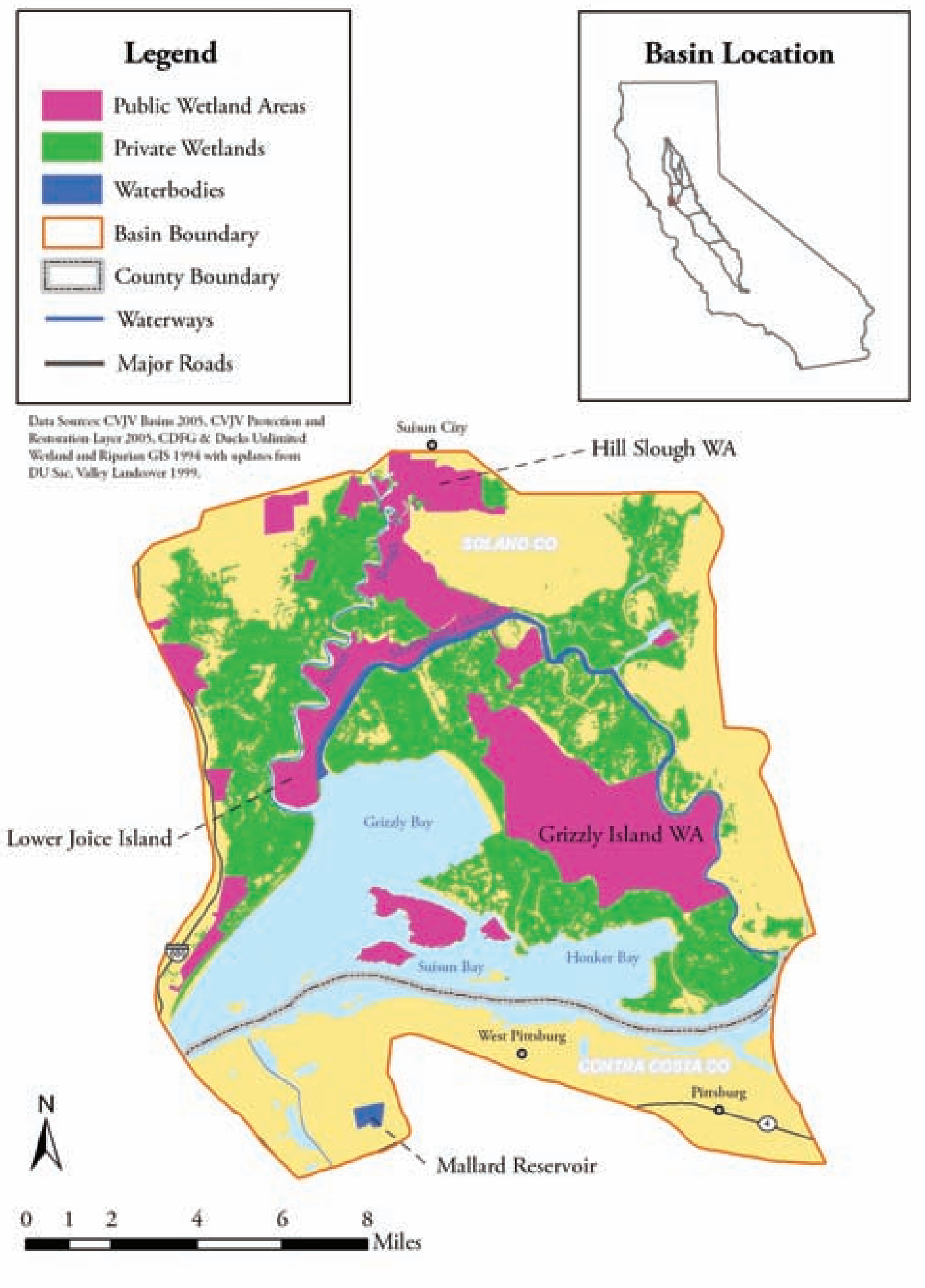
Data Sources: CVJV Basins 2005, CVJV Protection and Restoration Layer 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 3-5. Map of the American Basin

Suisun Basin

The Suisun Basin encompasses 170 square miles in southern Solano County and is bordered on the east by the Sacramento-San Joaquin Delta and on the west by the Carquinez Strait (Figure 3-6). Suisun Marsh dominates the basin, and is the largest brackish (diked, managed) wetland remaining in California. In 1963 landowners created the 116,000-acre Suisun Resource Conservation District (Suisun RCD), which includes a complex of managed and unmanaged wetlands as well as upland habitat. There are 158 privately owned wetlands in the Suisun Basin. There are also 15,000 acres owned by the California Department of Fish and Game in the Grizzly Island Wildlife Area complex. Landowners must meet standards for wetland habitat and water quality set by the Suisun Marsh Preservation Act of 1977, enacted by the State of California.

Historically, the Suisun Marsh was a tidally influenced basin that totaled 74,000 acres. Large portions of the marsh were submerged daily until levee construction in the 1850s restricted tidal flows. Tide gates and levees currently protect most of the Marsh from flooding, however salinities have gradually increased because of freshwater diversions from the San Joaquin and Sacramento Rivers. Vegetation communities in the marsh reflect this increase in salinity, as many common plant species are salt tolerant (Heitmeyer et al. 1989).

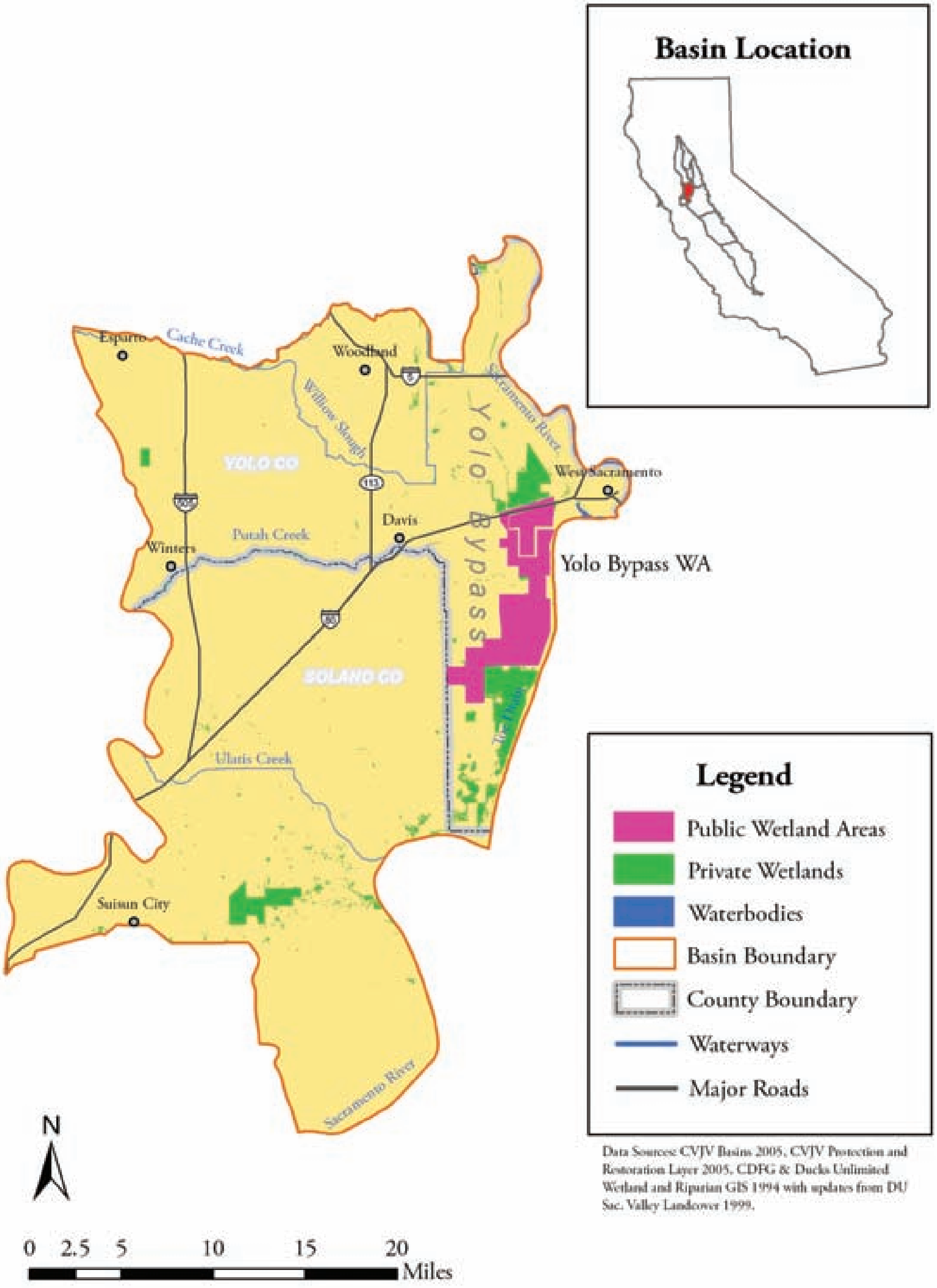


Data Sources: CVJV Basins 2005, CVJV Protection and Restoration Layer 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 3-6. Map of the Suisun Basin

Yolo Basin

The Yolo Basin lies west of the Sacramento River between Cache Creek to the north and the Montezuma Hills and the Delta Basin to the south, and totals about 800 square miles (Figure 3-7). The basin historically received overflow waters from the Sacramento River as well as Cache, Putah, and Ulatis Creeks. Low lying areas near the 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, and provides flood protection for adjacent lands when flows in the Sacramento River are high.



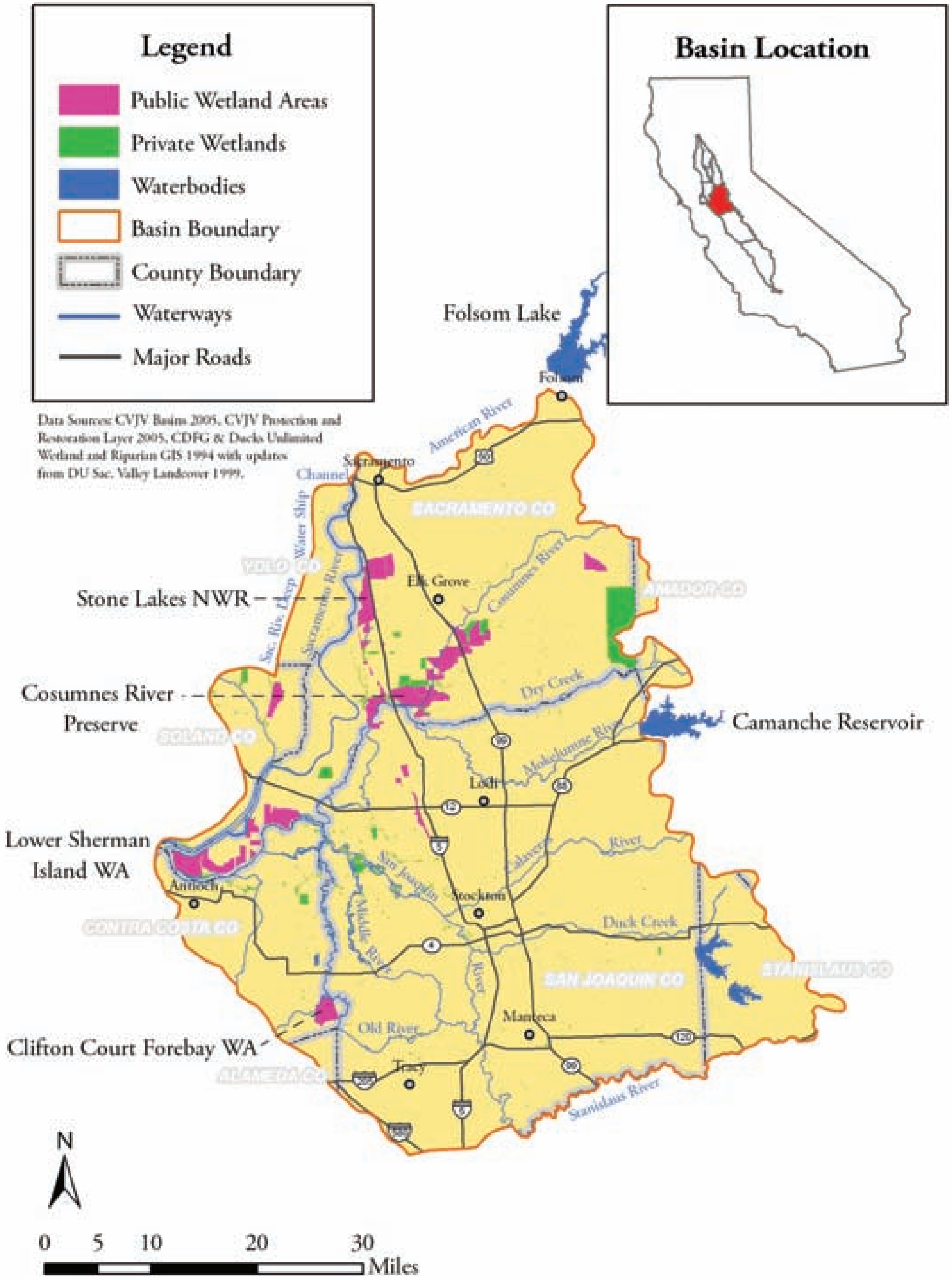
Data Sources: CVJV Basins 2005, CVJV Protection and Restoration Layer 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 3-7. Map of the Yolo Basin

Delta Basin

The Delta Basin totals 2,100 square miles and extends from the American River in the north, to the Stanislaus River in the south. Other borders are the Sierra Nevada foothills to the east, the Sacramento River to the northwest, and the Coast Range to the southwest (Figure 3-8). Prior to the mid-1800s, the Delta Basin was tidally influenced and part of a larger estuary that included Suisun Marsh and the 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 basin is formed by the convergence of the Sacramento, San Joaquin, Cosumnes, Mokelumne, and Calaveras Rivers. 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 sixty former wetland islands in the Delta. These islands are intensively farmed and some are managed as duck hunting clubs after crop harvest.



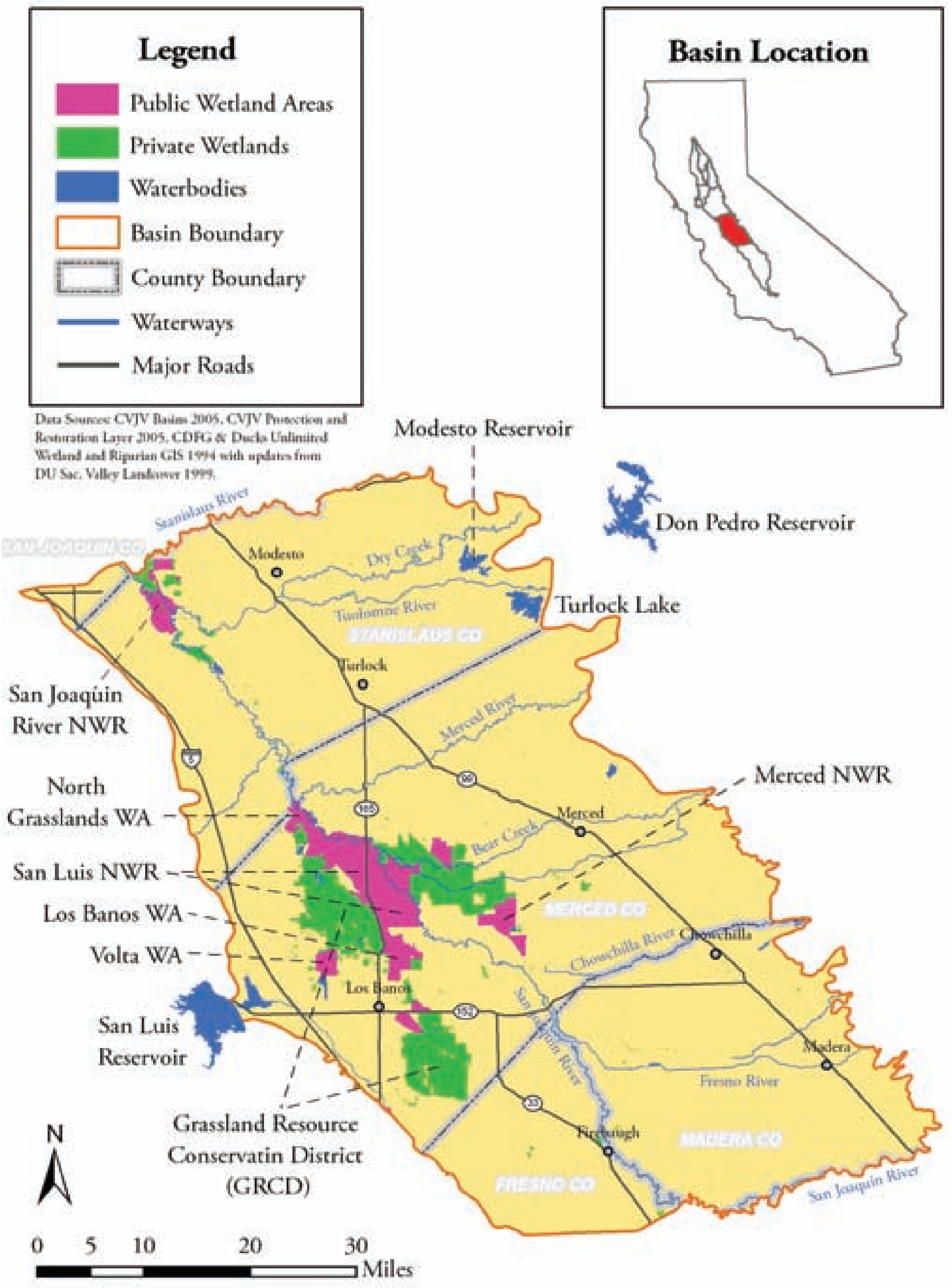
Data Sources: CVJV Basins 2005, CVJV Protection and Restoration Layer 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 3-8. Map of the Delta Basin.

San Joaquin Basin

The San Joaquin Basin totals 2,900 square miles, extending from the Stanislaus River in the north, to the San Joaquin River in the south. The 80-mile-long basin is bordered on its west by the California Aqueduct, and on its east by the foothills of the Sierra Nevada (Figure 3-9). Major tributaries to the San Joaquin River include the Chowchilla, Merced, and Tuolumne Rivers.

Most private wetlands as well as several federal and state areas in the San Joaquin Basin are located in the Grassland Resource Conservation District (GRCD) on the western edge of the basin. Many of these private wetlands have been permanently protected by U.S. Fish and Wildlife Service conservation easements. Wetland areas in existence in 1991 have been guaranteed average annual (Level 2) water supplies as a result of the Central Valley Project Improvement Act (CVPIA) of 1992. Soils on the western side of the San Joaquin Basin are derived from marine sediments that are high in salts and trace elements. Post-harvest 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 and consequently, use of this water has been greatly restricted.



Data Sources: CVJV Basins 2005, CVJV Protection and Restoration Layer 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

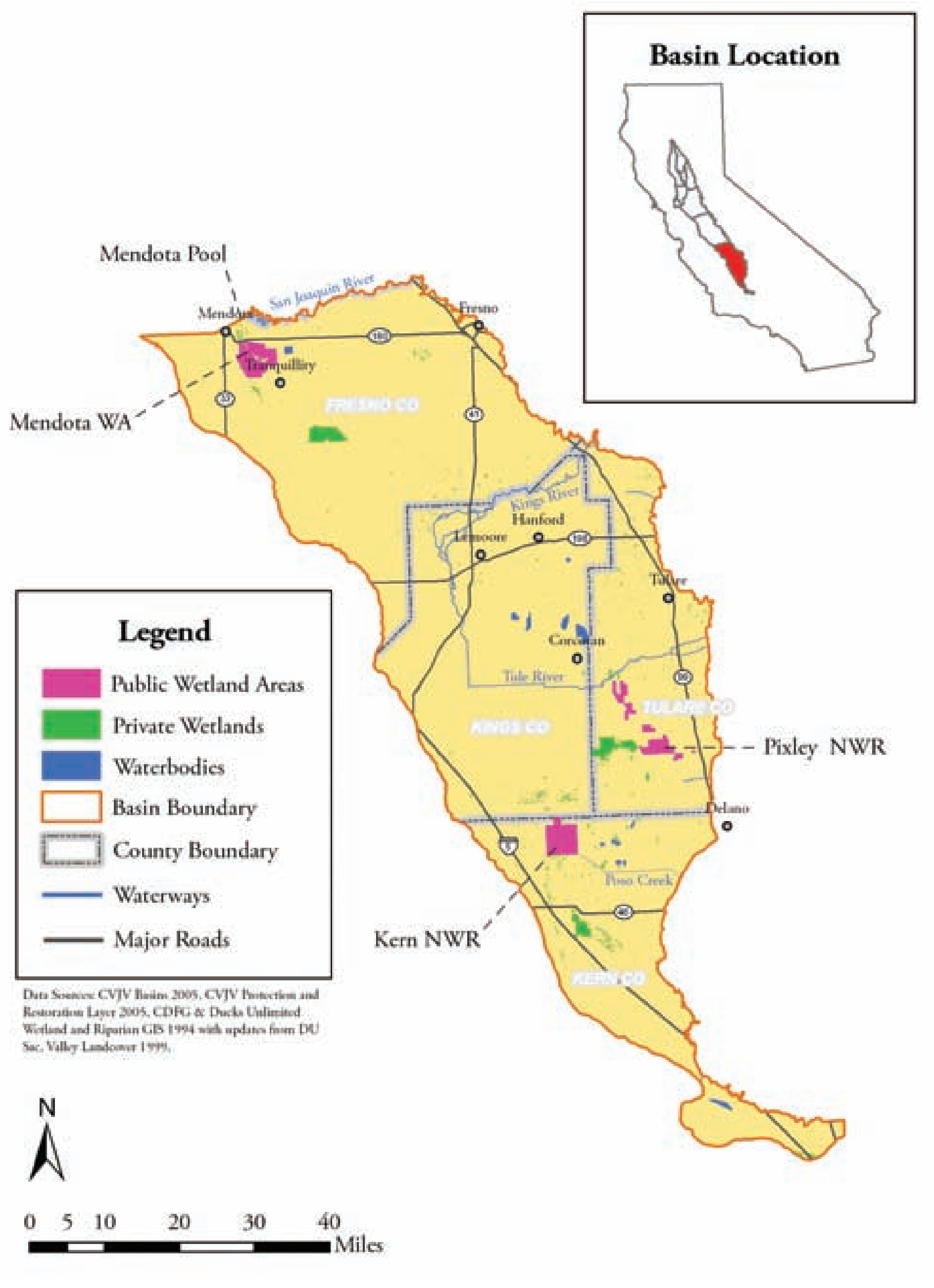
Figure 3-9. Map of the San Joaquin Basin

Tulare Basin

Tulare Basin is the largest basin in the Central Valley and totals 5,600 square miles. This basin is 135 miles long and is bordered to the west by the Coast Range, and to the east by the southern Sierra Nevada foothills (Figure 3-10). The San Joaquin River divides the Tulare and San Joaquin Basins.

Despite being the driest region of the Central Valley, the Tulare Basin once contained the largest single block of wetland habitat in California and 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 streams including the Kern, Kings, and Tule Rivers, into a series of shallow lake basins within the sink. These lakes provided habitat for millions of migrant waterfowl and shorebirds. 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 historic levels. Although agriculture dominates the basin, surface water supplies are not sufficient to meet crop needs. As a result, agricultural producers rely heavily on groundwater to augment supplies. The end result is that surface water supplies for private wetland management are virtually non-existent in many parts of the basin, and landowners are forced to rely on groundwater. Many private wetland owners are unable to afford the high pumping costs for groundwater, resulting in a loss of nearly half of the wetlands over the past two decades. Although the Tulare Basin poses significant challenges for the JV, the area sees tremendous waterbird use during wet years. This use testifies to the historical and continuing importance of the basin within the Central Valley.



Data Sources: CVJV Basins 2005, CVJV Protection and Restoration Layer 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 3-10. Map of the Tulare Basin

Habitat Types and Locations

Wetlands

Managed wetlands in the Central Valley are broadly categorized as seasonal, semi-permanent or permanent. Seasonal wetlands are typically flooded in the fall, with drawdown occurring between March and May. Semi-permanent wetlands are usually flooded from early fall through early July, while permanent wetlands are flooded year round. Since the majority of these non-seasonal wetland habitats are semi-permanent, for planning purposes, semi-permanent and permanent wetlands are combined.

Butte Sink wetlands
Photo: Bob McLandress, CWA

Refined estimates of managed wetlands indicate that wetland acreage was overestimated in the 1990 plan. The 2000 *Central Valley Wetland Water Supply Investigations, CVPIA 3406 (d)(6)(A,B), A Report to Congress* (Water Report; USFWS 2000) stated that there were 165,834 acres of managed wetland acres as of November 1996. The Water Report relied on satellite imagery to estimate wetland acres during winter 1993-1994, and JV accomplishments from 1993-1994 to November 1996 were added. Wetland acreage estimates were updated from the Water Report by adding JV accomplishments from December 1, 1997 to April 1, 2003. To date, 205,554 acres of managed wetlands are estimated for the Central Valley. Wetland acres by type and ownership are presented for each basin in Table 3-1.

About two thirds of all managed wetlands in the Central Valley are privately owned, while nearly 90% of all wetlands are managed on a seasonal basis. Seventy-seven percent of all wetlands are located in four basins: Butte, Colusa, Suisun, and San Joaquin. The San Joaquin Basin alone contains a third of all wetlands in the Valley, most within the Grassland Resource Conservation District (GRCD). The overall distribution of wetlands in the Central Valley is depicted in Figure 3-11.

Table 3-1. Acres of managed seasonal wetlands (SW) and semi-permanent wetlands (SPW) in the Central Valley.[a]

Basin	*Private SW*	*Public SW*	*Private SPW*	*Public SPW*	*Total SW*	*Total SPW*	*Total Wetlands*
American	3,187	0	562	0	3,187	562	3,749
Butte	16,170	7,170	2,853	1,266	23,340	4,119	27,459
Colusa	11,086	11,304	1,956	1,995	22,390	3,951	26,341
Delta	3,741	2,608	661	460	6,349	1,121	7,470
San Joaquin	46,857	14,156	5,206	1,573	61,013	6,779	67,792
Suisun	25,364	6,868	4,476	1,212	32,232	5,688	37,920
Sutter	247	1,704	43	301	1,951	344	2,295
Tulare	6,718	13,494	746	1,499	20,212	2,245	22,457
Yolo	5,803	2,755	1,027	485	8,558	1,512	10,070
Total	**119,173**	**60,059**	**17,530**	**8,792**	**179,232**	**26,322**	**205,554**

Data Sources: CVJV Basins 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 3-11. Distribution of wetlands in the Central Valley in 2005.

Figure 3-12. Distribution of riparian habitat in the Central Valley in 2005.

Riparian

Current and historical acre estimates for the extent of riparian habitat are presented for each basin in Table 3-2. Riparian habitat is defined as plant communities supporting woody vegetation along rivers, creeks, and streams. Riparian habitat estimates were obtained using multiple GIS layers, as there is no single riparian data layer for the Central Valley (D. Stralberg, PRBO Conservation Science, personal communication). The overall distribution of riparian habitat in the Central Valley is presented in Figure 3-12.

Table 3-2. Current and historical acres of riparian habitat.

Basin	*Current Acres*	*Historic Acres*
American	16,370	67,520
Butte	32,535	105,452
Colusa	19,798	171,013
Delta	Unavailable	Unavailable
San Joaquin	12,245	48,755
Suisun	Unavailable	Unavailable
Sutter	3,641	20,338
Tulare	7,195	272,158
Yolo	3,569	48,320
Total	**107,813**	**733,556**

Upland

Upland areas that may serve as waterfowl nesting habitat in the Central Valley include grain and hay crops, grasslands, and pasture (McLandress et al. 1996). The distribution of these three cover types was mapped using data from the California Department of Water Resources (Figure 3-13). Acres of each habitat by basin are presented in Table 3-3.

Table 3-3. Acres of upland habitat among Central Valley basins.

Basin	*Grassland*	*Pasture*	*Grain & Hay*
American	170,649	30,026	19,042
Butte	174,539	20,423	19,636
Colusa	330,681	81,802	116,942
Delta	206,300	167,611	112,138
San Joaquin	357,244	279,516	74,528
Suisun	21,235	517	983
Sutter	8,750	3,387	11,626
Tulare	452,355	318,573	239,177
Yolo	121,633	57,973	90,657
Total	**1,843,386**	**959,828**	**684,729**

Agriculture

Rice

U.S. Department of Agriculture (USDA) statistics indicate that planted rice in the Central Valley averaged 502,600 acres between 1997 and 2002, and varied between 460,000 and 550,000 acres during this 5-year period (Figure 3-14).

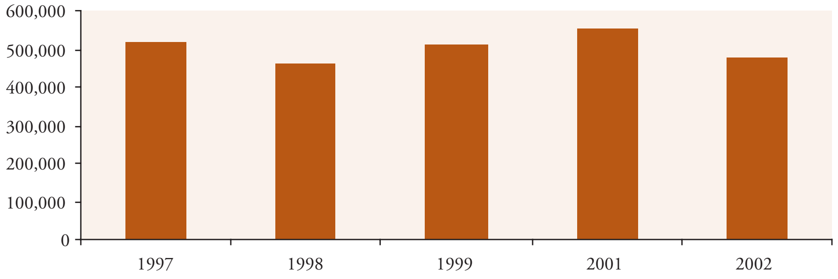
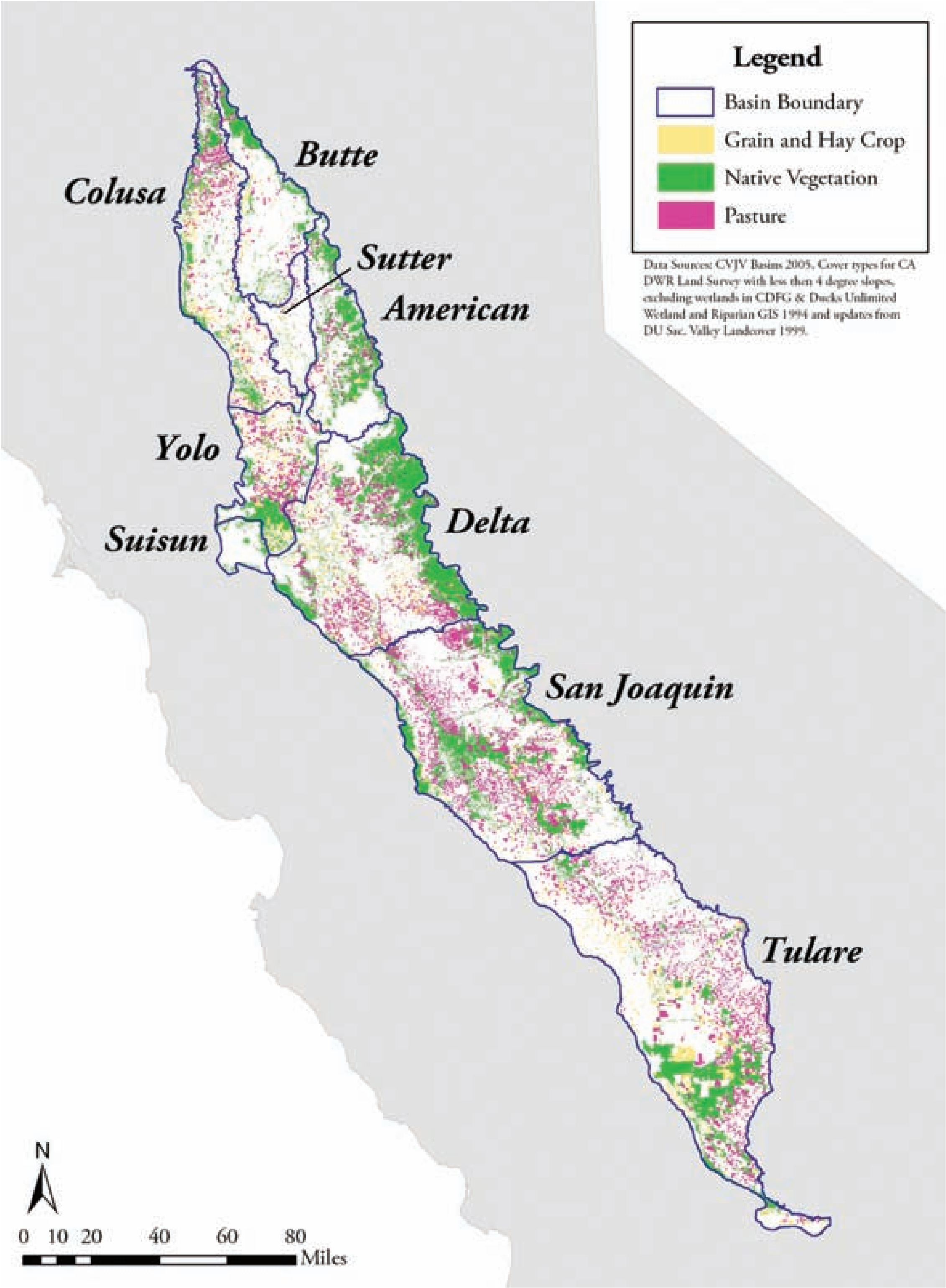


Figure 3-14. Acres of rice planted in the Central Valley between 1997 and 2002.



Data Sources: CVJV Basins 2005, Cover types for CA DWR Land Survey with less then 4 degree slopes, excluding wetlands in CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 and updates from DU Sac. Valley Landcover 1999.

Figure 3-13. Distribution of native vegetation, pasture, and grain and hay crops in the Central Valley.

Because USDA statistics are county-based, they cannot be used to estimate basin rice acres, as counties frequently cross basin boundaries. In both 1998 and 1999 the amount of rice planted in each basin, as well as for the entire Central Valley, was estimated using satellite imagery. Rice acre totals estimated from imagery were slightly less than USDA crop statistics for the 1998 and 1999 growing seasons, so basin estimates were adjusted upward to reflect these differences. The JV chose to use the 1998 imagery when making this adjustment because the agreement between crop statistics and rice image estimates was slightly better for 1998 than 1999.

Table 3-4. Estimate of rice acres in the Central Valley.

Basin	*Planted Acres*	*Winter-Flooded Acres*	*Non-Flooded Acres*
American	100,068	72,049	28,019
Butte	138,186	99,494	38,692
Colusa	197,076	141,895	55,181
Delta	1,399	1,007	392
Sutter	46,066	33,168	12,898
Yolo	9,750	7,020	2,730
Total[A]	**492,545**	**354,633**	**137,912**

[a] Excludes the 10,000 acres of rice annually planted in San Joaquin Basin. Post harvest treatment of rice in this basin is believed to render it of little use to wetland dependent species.

Rice acreage in the Central Valley varies from one year to the next, so 1998 imagery estimates were further adjusted to reflect the average acres of rice planted between 1997 and 2001 (Table 3-4). The distribution of rice in the Central Valley is depicted in Figure 3-15.

The value of rice habitat for wetland dependent birds is increased by winter flooding in the post-harvest period. Beginning in 1995-1996, growers were interviewed to determine the amount of rice that is winter-flooded for waterbirds and/or straw decomposition. These annual surveys included between 180 and 220 growers that accounted for over 40 % of all rice grown (J.D. Garr, Ducks Unlimited, unpublished report).

The total area of winter-flooded rice has increased as a result of an increase in total rice acreage, the 1992 legislated ban on rice straw burning, a growing awareness of the environmental benefits of this agricultural practice, and improved agronomics (Fleskes et.al. 2005). During winter 1995-1996, half of all rice acreage was winter-flooded. By 2002-2003, this figure had increased to over 70%. The 2006 Plan assumes that 72% of all rice grown in the Central Valley is now intentionally flooded in winter (J.D. Garr, Ducks Unlimited, unpublished report). This estimate was applied to all major rice growing basins (Table 3-4).

Corn

Corn acreages are available for all counties in the Central Valley according to USDA crop statistics summaries. Because parts of some counties occur outside the Valley, corn acres were “deleted” from these outlying areas using GIS when estimating the amount of corn planted in a basin. Although substantial amounts of corn are grown in the San Joaquin and Tulare Basins, most is harvested as silage for the dairy industry. As a result, corn was not considered as a potential habitat in these two basins (Table 3-3).

Many harvested cornfields are intentionally flooded in the Delta Basin to provide waterfowl habitat, and to minimize subsidence of Delta soils that are high in organic content. Surveys to determine the amount of flooded corn were conducted in Delta Basin, and these estimates are used in the 2006 Plan (M. Casazza, U.S. Geological Service, unpublished data).

Socio-economic Factors

Human Population Growth

Human population growth forecasts for all of California as well as for individual counties are available to 2040 (California State Department of Finance). Human populations in California are projected to increase from 34.7 million in 2000 to 58.7 million by 2040, an increase of nearly 70%. Forecasts for Central Valley counties predict a population increase from 5.7 million to 13.1 million people over the same period, a 130% gain (Figure 3-16). To understand how population growth forecasts differ by basin, population

Figure 3-15. Distribution of rice in the Central Valley.

projections were combined for all counties in a basin. These forecasts suggest higher growth rates in the southern half of the Central Valley (Figure 3-17). Population increases by 2040 are expected to exceed 2 million in both the Tulare and Delta Basins, while increases in the San Joaquin Basin will surpass one million people. Growth forecasts for the northern basins vary between 100,000 and 500,000. The southern portion of the American Basin provides an exception to this south to north trend because of its proximity to Sacramento. Sacramento County, which leads the Central Valley in projected growth, includes parts of both the Delta and American Basins. However, all these population increases have been assigned to the Delta Basin, as forecasts cannot be divided at less than a county level. In reality, much of the growth forecasted for Sacramento County is likely to occur in the southern end of the American Basin, as housing developments north of the city of Sacramento continue to expand.

Table 3-5. Estimates of planted corn for Central Valley basins.

Basin	*Planted Acreage*	*Winter-Flooded Acreage*	*Non-Flooded Acreage*
American	2,292	0	2,292
Butte	5,019	0	5,019
Colusa	26,841	0	26,841
Delta	117,953	29,488	88,465
Sutter	5,750	0	5,750
Yolo	41,280	0	41,280
Total[a]	**199,135**	**29,488**	**169,647**

[a] *Excludes the 218,724 acres of corn planted in San Joaquin and Tulare Basins, as post-harvest treatment of corn in these basins is believed to make it unavailable to waterfowl.*

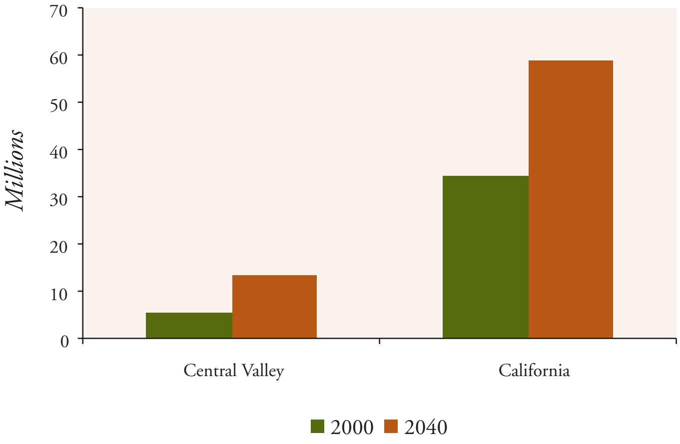


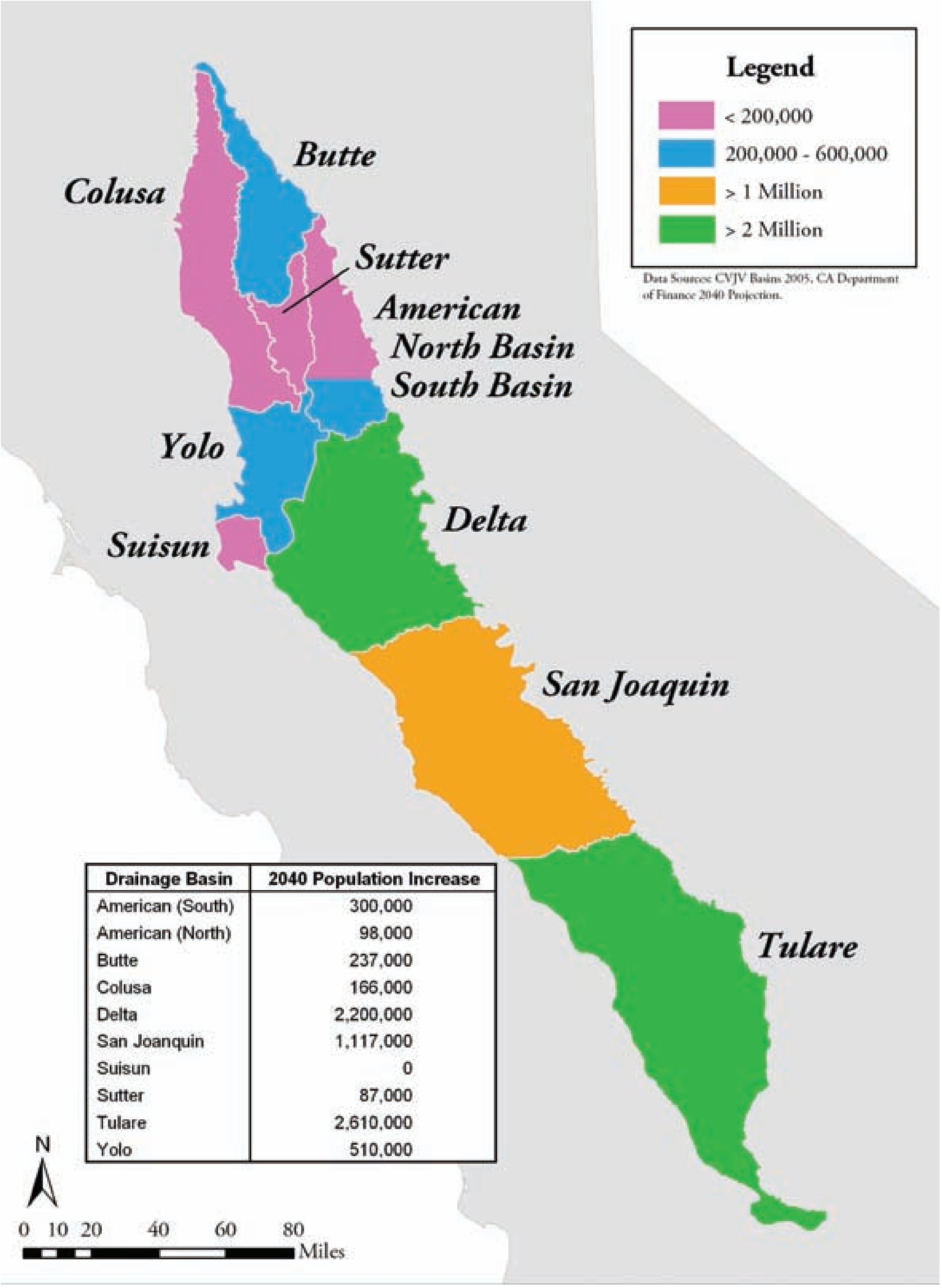
Figure 3-16. Population increases (millions) for the Central Valley and for California as a whole.

Changes in Land Use

Population growth within the Central Valley will result in substantial increases in urban development, mostly occurring on agricultural lands. The effects of land conversion are twofold and include loss of agricultural habitats important to wetland dependent birds, and loss of agricultural buffers that increase the quality of wetland and riparian habitats. Probable urban development patterns for the Central Valley have been mapped using 2040 population forecasts and actual development trends from 1988 to 1992 (American Farmland Trust 1995). These mapping efforts identified three major areas of urban development centered on the cities of Fresno, Modesto, and Sacramento. A general corridor of development was identified along Highway 99 from Bakersfield to Yuba City.

San Joaquin River National Wildlife Refuge
Photo: USFWS

The effect of population growth on agricultural crops was also estimated for the Central Valley to 2040 (American Farmland Trust 1995). Crop type in the Central Valley is broadly categorized as irrigated or non-irrigated, and acreage losses in each of these categories were estimated for eleven of nineteen Central Valley counties (American Farmland Trust). The JV assumes that irrigated crop types (e.g., rice) represent the most important agricultural habitat types for wetland dependent birds, though not all irrigated crops have wildlife value (e.g., vineyards). Thus, only forecasted losses of irrigated cropland to 2040 were considered.



Data Source: CVJV Basins 2005, CA Department of Finance 2040 Projection.

Drainage Basin	2040 Population Increase
American (South)	300,000
American (North)	98,000
Butte	237,000
Colusa	166,000
Delta	2,200,000
San Joanquin	1,117,000
Suisun	0
Sutter	87,000
Tulare	2,610,000
Yolo	510,000

Figure 3-17. Forecasted population increases to 2040 for the Central Valley basins.


Faith Ranch, Lake Marie
Photo: Gary Zahm

There is a strong relationship between population growth forecasts and loss of irrigated cropland for the eleven counties included in the urban growth analysis (Figure 3-18). This relationship suggests that one acre of irrigated farmland is lost for every 10 additional people. On this basis, the JV used population forecasts to predict loss of irrigated cropland for Central Valley counties not included in the American Farmland Trust report.

County estimates of irrigated cropland loss were combined to provide information on farmland conversion for each basin. The predicted loss of irrigated cropland was highest for the Tulare, San Joaquin, and Delta Basins, as well as for the south end of American Basin (Figure 3-19). In contrast, basins in the Sacramento Valley were expected to experience only modest losses in irrigated farmland by 2040. Finally, the loss of rice habitat to 2040 was estimated for each basin by assuming that loss rates for rice were similar to that for other irrigated crops. The loss of rice acreage was generally small for all basins, and the total predicted loss of rice was less than 40,000 acres (Table 3-6). This is equivalent to 6% of the rice base in the Central Valley, and agrees with the 3% rice loss predicted by 2020 (California Department of Water Resources 1998).

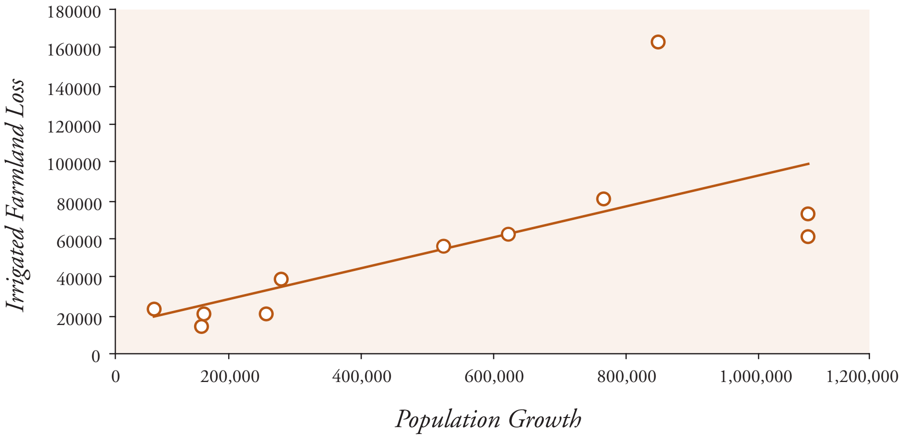
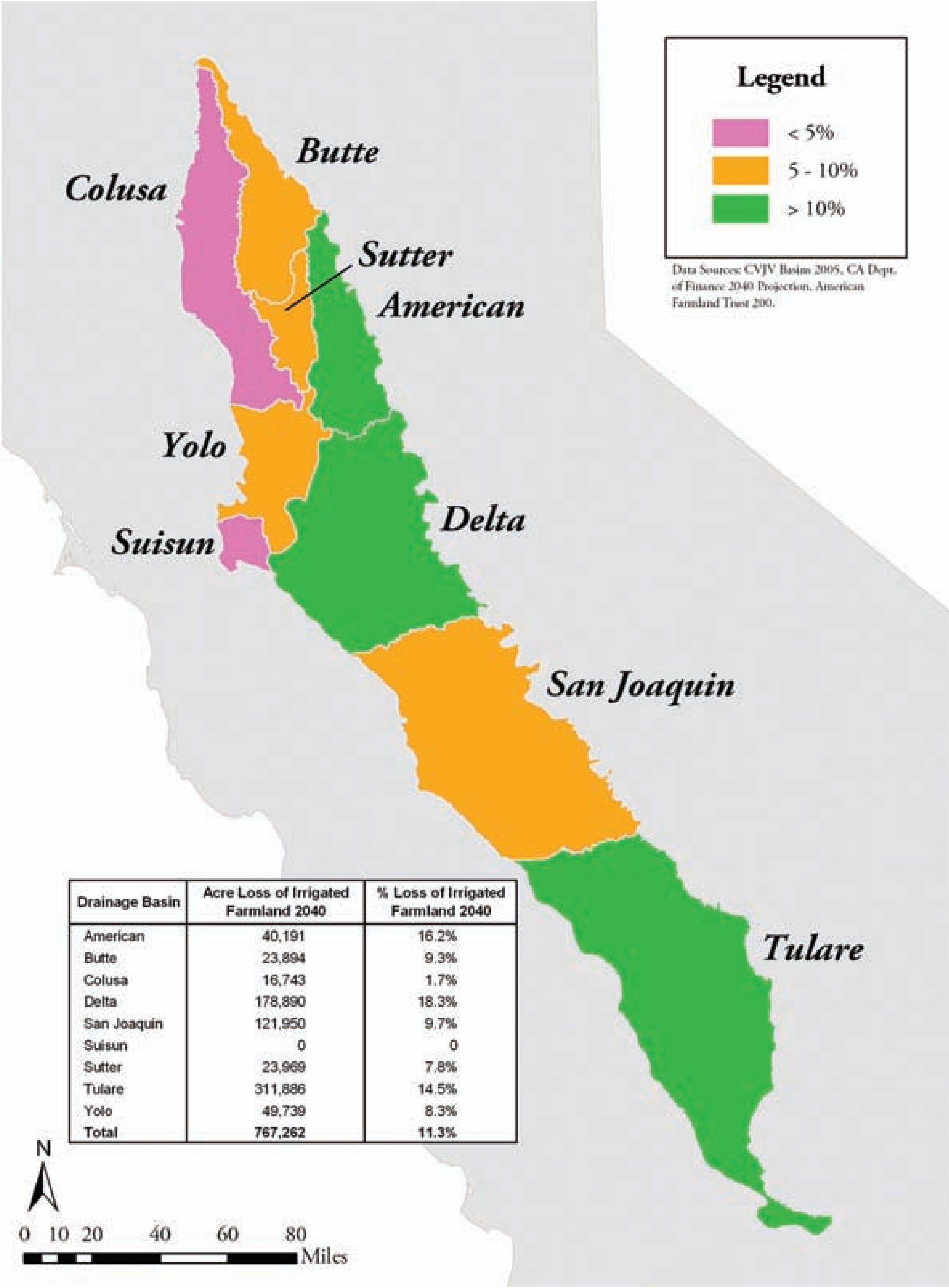


Figure 3-18. The relationship between population growth and loss of irrigated farmland for 11 Central Valley counties (from American Farmland Trust 1995).

Table 3-6. Projected loss of planted rice by basin.

Basin	*Current Acreage*	*Forecasted Acre Loss 2040*
AMERICAN	100,068	16,211
BUTTE	138,186	12,851
COLUSA	197,076	3,350
DELTA	1,399	256
SUTTER	46,066	3,593
YOLO	9,750	809
TOTAL	492,545	37,070



Data Sources: CVJV Basins 2005, CA Dept. of Finance 2040 Projection, American Farmland Trust 200.

Drainage Basin	Acre Loss of Irrigated Farmland 2040	% Loss of Irrigated Farmland 2040
American	40,191	16.2%
Butte	23,894	9.3%
Colusa	16,743	1.7%
Delta	178,890	18.3%
San Joaquin	121,950	9.7%
Suisun	0	0
Sutter	23,969	7.8%
Tulare	311,886	14.5%
Yolo	49,739	8.3%
Total	767,262	11.3%

Figure 3-19. Projected loss of irrigated farmland by 2040 for Central Valley basins.

Northern pintails
Photo: Bob McLandress, CWA

Chapter Four: WINTERING WATERFOWL

This chapter identifies the conservation objectives for wintering waterfowl, defined as non-breeding migrating or wintering ducks, geese, and swans using the Central Valley between August and March. The chapter is divided into five sections: (1) Introduction; (2) Biological inputs used in the TRUEMET model; (3) Overall assessment of habitat conditions in the Central Valley; (4) Methods for establishing and prioritizing conservation objectives for winter waterfowl in each basin; and (5) Conservation objectives and priorities for wintering waterfowl in each basin.

Introduction

The Central Valley of California is the most important waterfowl wintering area in the Pacific Flyway, supporting up to 60% of the total Flyway population in some years. Food availability is a key factor limiting waterfowl populations during migration and winter (Miller 1986, Conroy et al. 1989, Reinecke et al. 1989), and habitat conditions on the wintering grounds may influence reproductive success (Heitmeyer and Fredrickson 1981, Kaminski and Gluesing 1987, Raveling and Heitmeyer 1989). The JV assumes that food limits waterfowl populations during migration and winter. Specifically, food is the primary need of waterfowl during migration and winter. Adequate foraging habitat will ensure that survival outside of the breeding season does not limit population growth.

The Central Valley Habitat Joint Venture Implementation Plan (1990 Plan, “Central Valley Habitat Joint Venture 1990) included a food energy model that linked population and habitat objectives for wintering waterfowl. Using this approach the food energy needs of waterfowl populations in the Central Valley were converted into foraging habitat objectives. Figure 4-1 depicts this model. Waterfowl energy needs are a product of population objectives and the daily energy requirement (DER) of an average bird, while food supplies are a product of habitat acres and the amount of food provided by each acre. Foraging habitat is adequate when food supplies equal or exceed waterfowl energy needs.

“The Central Valley of California is, and will always remain, one of the critical wintering areas for waterfowl in North America. We have an enduring obligation to ensure the vitality and viability of our remaining wetlands and associated agricultural habitats upon which millions of wintering waterfowl and other wetland-dependent wildlife rely.”

John Eadie, Ph.D.
Professor, Department of Wildlife, Fish & Conservation Biology
University of California, Davis

The JV has retained the food energy approach for the 2006 Plan. However, research efforts by JV partners over the past decade have greatly improved the biological inputs used in the energetic model. In addition, a computer model (TRUEMET) was developed for use in the 2006 Plan. The model calculates population energy demand and population energy supplies for specific time periods, and can incorporate effects like food decomposition and temporal variation in habitat availability (Figure 4-2). The model was used to evaluate the current status of waterfowl food resources in the Central Valley based on a defined set of habitats and to estimate conservation objectives for wintering waterfowl in each basin.

The TRUEMET Model

Most joint ventures use a food energy approach when establishing habitat objectives for wintering waterfowl. The TRUEMET model was developed to estimate waterfowl habitat requirements by comparing food energy needs to food energy supplies. The model calculates population energy needs from the daily energy requirement of a single bird and from time specific population objectives. Food energy supplies are dependant 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 effects of waterfowl food consumption, decomposition of foods over time, and changes in habitat availability that result from flooding schedules or other events like freezing. Waterfowl populations can also be divided into foraging guilds to reflect differences in the foods eaten. Although the model may be useful for assessing current habitat conditions for wintering waterfowl, it can also be used to predict how changes in policy, land use, or habitat programs might impact the birds. For example, the loss of agricultural habitats can be evaluated and habitat programs needed to offset these losses can be identified.

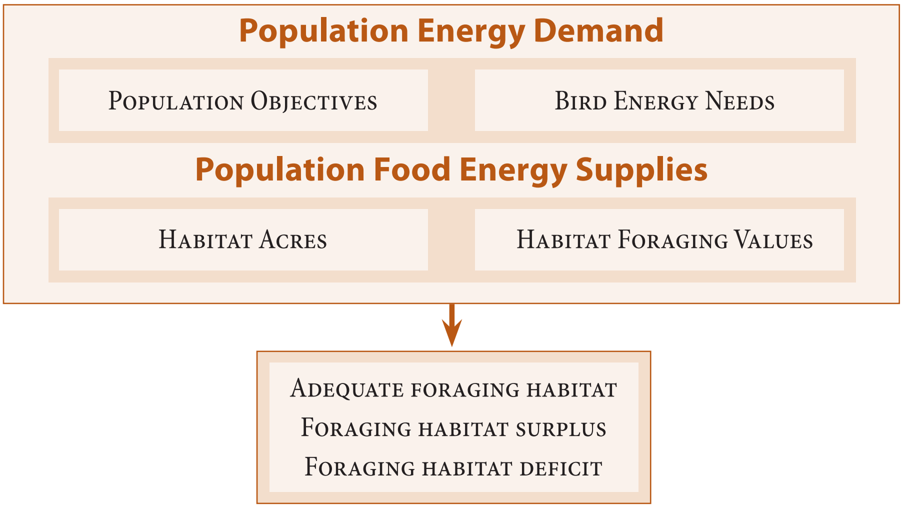


Figure 4-1. Basic energy model used to assess the availability of foraging habitat relative to waterfowl needs.

Biological Inputs Used in the TRUEMET Model

Biological inputs used in the TRUEMET model include: (1) population objectives; (2) daily energy requirements for individual birds; (3) habitat acreage; and (4) habitat foraging values (energy density). This section describes how these inputs were derived and describes many of the assumptions made for wintering waterfowl in the 2006 Plan. Some biological inputs are applied to all basins, while other inputs are basin-specific. Inputs that are applied across basins are presented here to avoid redundancy. However, basin-specific inputs are presented in the final section of this chapter when establishing conservation objectives for wintering waterfowl. Biological inputs that were used to provide an overall assessment of habitat conditions in the Central Valley are also reported in this section.

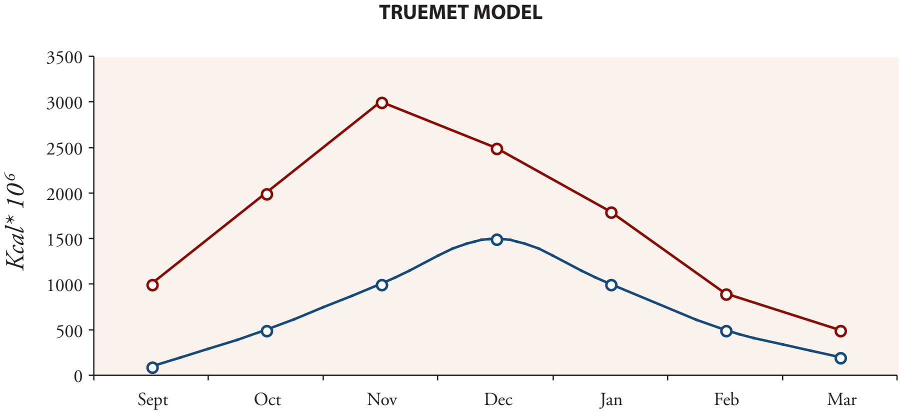


Figure 4-2. A hypothetical example of the TRUEMET model. Population energy demand (blue) vs. food energy supplies (red).

Population Objectives

Ducks

In 1986 the North American Waterfowl Management Plan (NAWMP; North American Waterfowl Management Plan Committee 1986) developed population objectives for North American duck species based on environmental conditions and breeding waterfowl numbers from 1970-1979. Waterfowl populations in the 1970's met the demands of both consumptive and non-consumptive users and provided a basis for future conservation efforts. The 1990 Implementation Plan identified a peak population objective of 4.7 million ducks in the Central Valley. Populations were assumed to peak in late December or early January and decline thereafter. Because the 1990 objective was based on the annual mid-winter inventories (MWI), waterfowl numbers in the Central Valley between 1970 and 1979 provided a direct link to the NAWMP. However, MWI counts alone are not suitable for establishing population objectives, because they do not represent bird numbers at other times. In addition, the pattern of waterfowl use varies among the JV basins, and peak use in some basins does not occur at the time of the mid-winter survey, as was assumed in the 1990 Plan (Fleskes 2000).

Duck population objectives from the NAWMP have recently been stepped down to each Joint Venture. By combining information from the mid-winter waterfowl survey with estimates of waterfowl harvest and mortality, population objectives for the mid-winter period (late December-early January) were estimated for every county in the U.S. Counties were then combined to develop Joint Venture population objectives (Koneff 2003). Population objectives stepped down from the NAWMP only apply to the late December–early January period. However, wintering waterfowl rely on the Central Valley from August through March and therefore, population objectives must be developed for this entire period. As a result, population objectives from the NAWMP (Table 4-1) were combined with information on migration chronology for the Central Valley to generate population objectives at fifteen-day intervals between August 16 and March 31 (Figure 4-3). Migration chronology was determined from monthly surveys of waterfowl between September and March of 1998-1999 and 1999-2000 (Figure 4-3, Fleskes et al. 2000).

Duck populations stepped down from the NAWMP were modified for some species. The NAWMP objective for gadwall ducks *(Anas strepera)* in the Central Valley is 102,420 birds during mid-winter (Table 4-1). However, the MWI in 1999 reported 223,800 gadwalls in the Central Valley, with nearly 150,000 birds observed in 1998 (Fleskes et al. 2000). These surveys suggest that NAWMP goals for gadwalls in the Central Valley have been exceeded. This was expected because gadwall populations in the late 1990's were substantially higher than populations in the 1970's, and NAWMP objectives are based on bird numbers from this earlier period. To "adjust" gadwall population objectives, the JV assumed that gadwall and wigeon were observed with equal probability during the 1998 and 1999 surveys. The ratio of gadwall to wigeon averaged 0.35 during these two years, with wigeon populations at or near NAWMP goals. The mid-winter NAWMP population objective for wigeon is 1,103,440 (Table 4-1). As a result, the gadwall objective was adjusted upward to 386,204 birds (1,103,440 x 0.35). Population objectives for other duck species were also adjusted because some foods eaten by these species were not included in the energetic model. For example, invertebrates make up 49% of northern shoveler diets during fall and winter in the Central Valley; while seeds from managed wetlands make up the other 51% (Heitmeyer 1989). The biomass and type of invertebrates eaten by shovelers have not been estimated for Central Valley wetlands, though these habitats obviously provide some of these food resources. In contrast, seed abundance has been estimated for managed wetlands, and this food source is included in the energetic model. Using NAWMP objectives for shovelers would overestimate the impact shovelers have on seed resources in managed wetlands, because the model would assume that 100% of their energy requirements are met from seeds. This leads to an overestimate of duck habitat needs. To correct this overestimate, shoveler numbers were reduced to 51% of the NAWMP objective when using the energetic model to estimate habitat needs.


American widgeon
Photo: Dale Garrison, USFWS

Table 4-1. Mid-winter population objectives for ducks in the Central Valley.

Species	*NAWMP Objective*	*Duck numbers used in TRUEMET model*
Mallard (*Anas platyrhynchos*)	670,074	670,074
Northern pintail (*Anas acuta*)	2,418,339	2,418,339
Gadwall (*Anas strepera*)[b]	102,420 (386,204)[a]	270,343
American wigeon (*Anas americana*)[b]	1,103,440	772,408
Green-winged teal (*Anas crecca*)	486,215	486,215
Cinnamon teal (*Anas cyanoptera*)	2,990	2,990
Northern shoveler (*Anas clypeata*)[b]	581,999	296,819
Wood duck (*Aix sponsa*)	106,137	106,137
Total Dabblers	**5,471,613**	**5,023,325**
Redhead (*Aythya americana*)[b]	1,007	504
Canvasback (*Aythya valisineria*)[b]	39,336	19,668
Greater and lesser scaup (*Aythya marila, A. affinis*)[b]	223,406	111,703
Ring-necked duck (*Aythya collaris*)[b]	42,327	21,164
Ruddy duck (*Oxyura jamaicensis*)[b]	155,167	77,584
Total Divers	**461,243**	**230,623**
Total Ducks	**5,932,856**	**5,253,948**

[a] *Gadwall objectives were adjusted to reflect population increases from the 1970's.*

[b] *Population objectives for these duck species were adjusted because some foods eaten by these species were not included in the energetic model.*

Bird number adjustments based on diet were also made for wigeon and gadwall, as well as for all diving ducks (Table 4-1). Food habitat studies indicate that plant material other than seeds make up 30% of wigeon diets in the Central Valley (Heitmeyer 1989), and gadwall were assumed to have a similar diet. As a result, bird numbers for these two species were reduced to 70% of NAWMP goals in the model. Food habit studies indicate that seeds make up half the diet of diving ducks, and bird numbers for these species were reduced by 50% (Table 4-1).

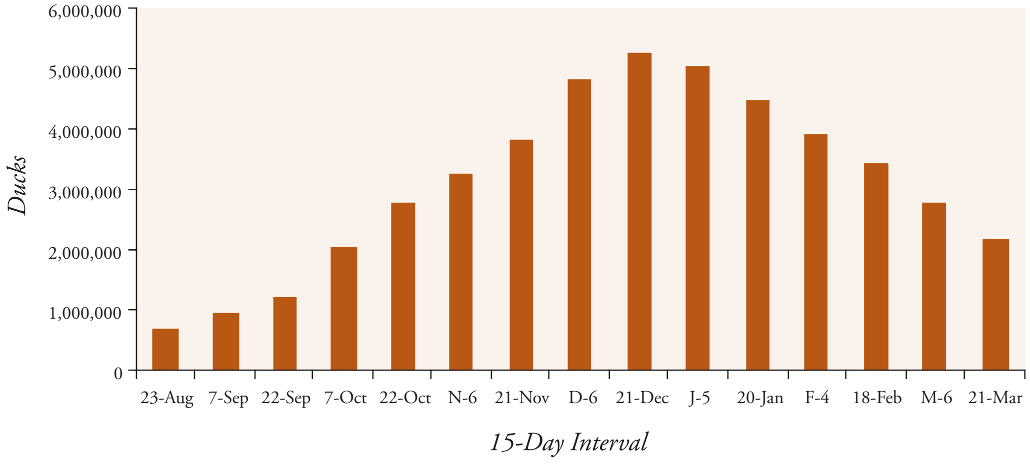


Figure 4-3. Population objectives by 15-day intervals for ducks in the Central Valley.

Correcting population objectives based on diet assumes that food sources not included in the energy model are available to the birds. For example, the JV assumes that plant materials other than seeds are available in quantities > 30% of wigeon energy needs. Although these assumptions can lead to an underestimate of habitat needs, duck population objectives used in the 2006 Plan were 90% of the original NAWMP goal (Table 4-1). In addition, the peak mid-winter population objective of 4.7 million birds used in the 1990 Plan was close to the 5.3 million peak adopted in the 2006 Plan.

Population objectives for Central Valley ducks were divided among basins to reflect current and historic waterfowl distribution. The distribution of duck objectives closely followed the 1990 Plan, although objectives did change for some basins (Table 4-2). Population objectives stepped down to the basins were further divided into 15-day intervals by using information from waterfowl surveys conducted between September and March 1998-1999 and 1999-2000 (Fleskes et al. 2002).

Table 4-2. Distribution of 1990 and 2005 Central Valley duck population objectives among basins.

Basin	*1990 Population Objectives*	*2005 Population Objectives*
American	5%	9%
Butte	23%	20%
Colusa	15%	12%
Delta	10%	13%
San Joaquin	25%	25%
Suisun	5%	5%
Sutter	7%	3%
Tulare	5%	8%
Yolo	5%	5%

Geese and Swans

Although goose populations have been stepped down from the NAWMP, Joint Ventures have been advised to use recent goose counts for establishing population objectives (M. Koneff, U.S. Fish and Wildlife Service, personal communication). As a result, waterfowl surveys between September and March 1998-1999 and 1999-2000 were used to develop population objectives for geese and swans (Fleskes 2000). There are three groups of geese in the Central Valley; (1) "white geese" [lesser snow geese (*Chen caerulescens*), Ross's geese (*C. rossii*) and tundra swans (*Cygnus columbianus*)]; (2) white-fronted geese [Greater Pacific (*Anser albifrons*) and Tule (*A.a. gambelli*)subspecies); and (3) Canada geese [primarily Aleutian Canada geese (*Branta canadensisia leucopareia*)]. All swans were assumed to be tundra swans (Fleskes et al. 2000). White-fronted geese and Canada geese were combined to establish "dark goose" population objectives because these two species exploit similar habitat types. Swans were also included with white geese because the two bird groups rely on similar habitats in the Central Valley. Dark and white goose population objectives for each fifteen-day interval were established for the entire Central Valley, as well as for individual basins (Figure 4-4 and 4-5).

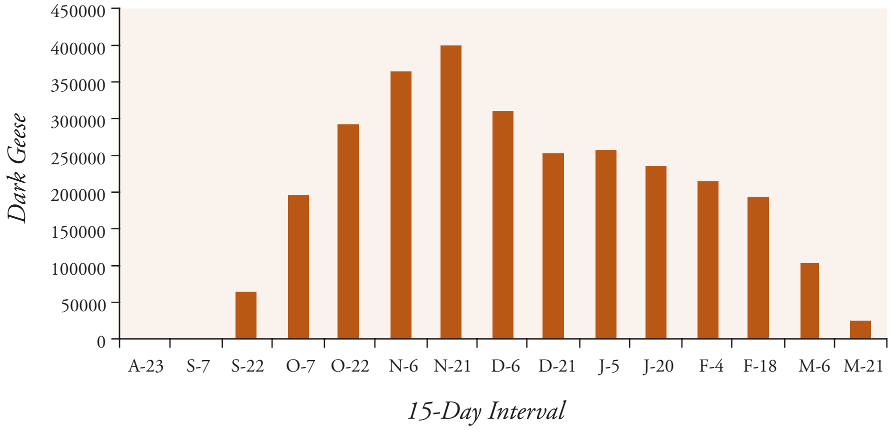


Figure 4-4. Population objectives by 15-day intervals for dark geese in the Central Valley.

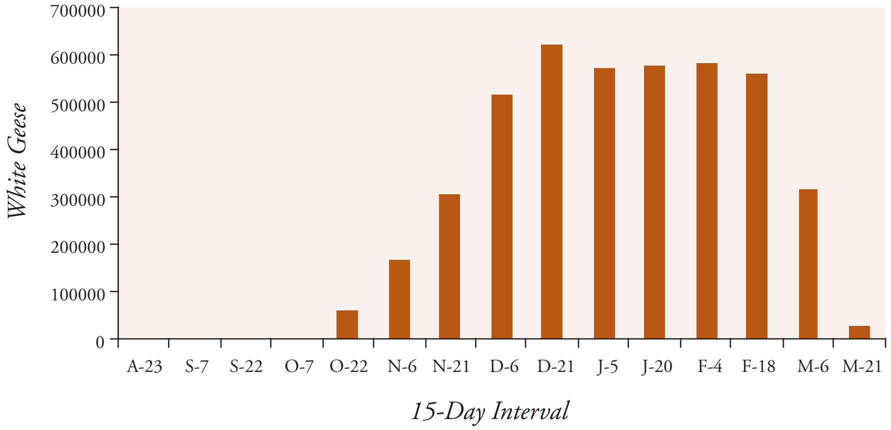
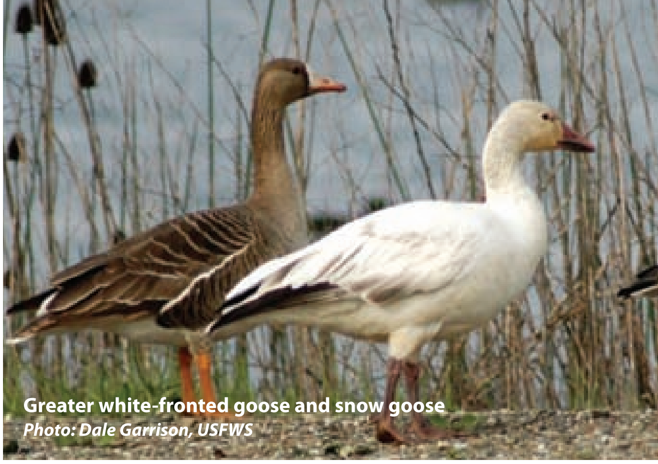


Figure 4-5. Population objectives by 15-day intervals for white geese in the Central Valley.

Daily Energy Requirements for Individual Birds



Greater white-fronted goose and snow goose
Photo: Dale Garrison, USFWS

Ducks

Waterfowl energy needs are strongly dependent on body mass, and equations exist to estimate food energy needs using body mass. Duck population objectives for the Central Valley include several species. As a result, a weighted body mass was calculated for Central Valley ducks based on each species' contribution to total duck numbers and average body mass for that species. The average body mass included male and female weights, and was adjusted for the ratio of males to females in the population (Bellrose 1980).

Weighted body mass for ducks in the Central Valley is 0.84 kg or 1.87 lbs. This estimate is similar to that for northern pintails alone (0.92 kg), which represent 46% of the total valley duck population objective (Table 4-1). Pintail energy requirements have been measured in the valley using information on body mass and carcass composition, and changes in pintail energy needs between August and March have been determined (Miller and Newton 1999). This approach provides a more accurate estimate of energy needs than body mass equations. Because pintail mass and weighted body mass for all ducks in the Central Valley were similar, estimates of pintail daily energy requirements was applied to all ducks by Miller and Newton (1999).

Daily energy requirements of pintails by 2-week time periods are presented in Table 4-3. Miller and Newton (1999) provided estimates of pintail energy requirements for both a wet and dry year in the Central Valley and these results were averaged. Energy requirements of male and female pintails also differ, and information on seasonal changes in pintail sex ratios was used to adjust daily energy needs in each 2-week interval (Heitmeyer 1989). The daily energy requirements presented in Table 4-3 were applied across basins. Although daily duck flight distances vary among basins (Fleskes et al. 2005), data are lacking to determine whether this translates into differences among basins in energy needs.

Dark Geese

Daily energy requirements for both geese and swans were estimated using body mass equations. Body mass estimates for white-fronted geese were available on a monthly basis and this information was used to estimate daily energy requirements in that month. These energy needs were then applied to the appropriate 15-day period. The make-up of dark goose populations (% white-fronted vs. % Canada geese) varies by time interval for all basins and for the entire Central Valley. As a result, daily energy requirements for dark geese were based on the relative abundance of white-fronted and Canada geese in each 15-day interval. These energy needs were estimated for the entire Central Valley (Table 4-4), and for each basin.

White Geese and Swans

Energy needs for white geese were determined by calculating a weighted body mass for lesser snow and Ross's geese. Survey data indicate that lesser snow geese make up 60% of white geese in the Central Valley, with Ross's geese accounting for 40% (M. Wolder, U.S. Fish and Wildlife Service, personal communication). Body mass estimates for both species were available from November through February, and this information was used to estimate daily energy requirements in those months. These energy needs were then applied to appropriate 15-day interval. No time-specific body mass estimates were available for swans. Instead, a single body mass value reported by Bellrose (1980) was used to calculate a daily energy need of 1106 kcal/day. This estimate was applied to all intervals. The make-up of white goose populations varies by time interval for all basins and for the entire Central Valley. As a result, daily energy requirements for white geese were based on the relative abundance of snow/Ross's geese and swans in each 15-day interval. These energy needs were estimated for the entire Central Valley (Table 4-5), and for each basin.

Table 4-3. Daily energy requirements (DER) of ducks in the Central Valley.

Interval	*DER (Kcal/day)*
Aug 23	194
Sept 7	194
Sept 22	236
Oct 7	231
Oct 22	231
Nov 6	233
Nov 21	210
Dec 6	208
Dec 21	218
Jan 5	218
Jan 20	260
Feb 4	260
Feb 19	224
Mar 6	224
Mar 21	224

Habitat Acreage

Although waterfowl rely on a variety of wetland and agricultural habitats to meet their food energy needs, specific assumptions were made about the types of habitats used by ducks and geese and the foods consumed in these habitats. Ducks were assumed to rely on seed resources in managed wetlands, waste grain in rice fields that are winter-flooded, and waste grain in harvested cornfields, regardless if these fields are flooded. Ducks undoubtedly exploit food resources in unmanaged wetlands. However, the JV lacks an estimate of the amount of unmanaged habitat available to waterfowl in the Central Valley, and the food resources that are provided by these habitats. While managed wetlands are available in most years, it is not clear how reliable unmanaged habitats are from one year to the next. For these reasons, the JV did not include unmanaged habitats in the TRUEMET model when evaluating waterfowl food supplies. However, the importance of understanding the role of unmanaged wetlands in meeting waterfowl needs in the Central Valley and how the JV might address maintaining these habitats is recognized. Finally, the JV assumed that ducks consumed macro-invertebrate food resources in managed wetlands in late winter and early spring (see following section on invertebrate food resources in managed wetlands). Although this assumption appears to contradict our earlier statement that invertebrate food resources used by shovelers were not included in the TRUEMET model, shovelers rely heavily on non-macroinvertebrates (e.g., zooplankton), for which there is no available information.

Table 4-4. Daily energy requirements (DER) for dark goose populations in the Central Valley.

Interval	*Canada goose DER (Kcal/Day)*	*White-fronted goose DER (Kcal/Day)*	*Dark goose DER (Kcal/Day)*[a]
Aug 23	387	523	0
Sept 7	387	523	0
Sept 22	387	523	522
Oct 7	387	523	522
Oct 22	387	523	522
Nov 6	387	539	538
Nov 21	387	539	538
Dec 6	365	547	544
Dec 21	365	547	540
Jan 5	365	506	497
Jan 20	365	506	498
Feb 4	365	563	553
Feb 19	365	563	553
Mar 6	365	563	549
Mar 21	365	563	538

[a] *Dark goose DER based on the relative abundance of Canada geese and white-fronted geese in the Central Valley during each 15-day interval.*

Dark geese were assumed to rely on seed resources in managed wetlands and waste grain in winter-flooded rice fields, dry rice fields and harvested cornfields. It was assumed that white geese and swans use the same agricultural habitats as dark geese, though swans are largely restricted to flooded agricultural habitats. The JV also assumed that white geese and swans did not exploit food resources in managed wetlands (see Habitat Foraging Values Section). Table 4-6 provides a summary of the natural and agricultural habitats available to wintering waterfowl in the Central Valley. As with the 1990 Plan, the JV assumed that 25% of all dry or unflooded rice is unavailable to waterfowl because of post-harvest practices. The JV also assumed that 50% of all unflooded corn is unavailable to waterfowl because of post-harvest practices (M. Casazza, U.S. Geological Survey, personal communication). These assumptions were applied to all basins except the San Joaquin and Tulare Basins where post harvest practices make all corn unavailable to waterfowl on private lands. Basin specific totals for each foraging habitat are presented later in this chapter. Information on how habitat estimates were derived is presented in Chapter 3.

Table 4-5. Daily energy requirements (DER) for white goose populations in the Central Valley.

Interval	*Snow/Ross's goose DER (Kcal/Day)*	*Swan DER (Kcal/Day)*	*White goose DER (Kcal/Day)*[a]
Aug 23	499	1106	0
Sept 7	499	1106	0
Sept 22	499	1106	499
Oct 7	499	1106	499
Oct 22	499	1106	632
Nov 6	499	1106	632
Nov 21	499	1106	636
Dec 6	486	1106	635
Dec 21	486	1106	622
Jan 5	486	1106	575
Jan 20	486	1106	557
Feb 4	488	1106	541
Feb 19	488	1106	525
Mar 6	488	1106	520
Mar 21	488	1106	503

[a] *White goose DER based on the relative abundance of snow/Ross's geese and swans in the Central Valley during each 15-day interval.*

Temporal variation in habitat availability can strongly influence the food supplies available to ducks and geese. To better understand when food resources become available to waterfowl, information on flooding schedules was obtained for public and privately managed wetlands, as well as for harvest and flooding of important agricultural crops. Timing of rice harvest was based on earlier work in the Colusa Basin, and is assumed to be representative of other rice growing regions in the Central Valley (Figure 4-6).

Flooding schedules were developed for public and privately managed wetlands in the Central Valley (Figure 4-7), as well as for rice habitat that is winter-flooded (Figure 4-8). Flooding schedules were also developed for private and public wetlands in the Sacramento Valley and applied to basins in the region (Figure 4-9). Flooding schedules that are specific to public and private wetlands in the San Joaquin and Tulare Basins were also developed (Figure 4-9).

Habitat Foraging Values

Table 4-6. Foraging habitats available to wintering waterfowl in the Central Valley.[d]

Managed Seasonal Wetlands[a]	*Flooded Rice*	*Dry Rice*[b]	*Flooded Corn*	*Dry Corn*[c]
179,232	354,633	103,435	29,488	70,080

[a] *Includes 119,173 acres of private wetlands and 60,059 acres of public wetlands.*

[b] *Excludes 25% of all dry rice acres in the Sacramento Valley that provide no food resources because of post harvest practices. Excludes all 10,000 acres of rice annually planted in the San Joaquin Basin because post harvest practices in the basin eliminate waste rice.*

[c] *Excludes 50% of all dry corn acres in the Sacramento Valley that provide no food resources because of post harvest practices. Excludes 218,724 acres of corn planted in the San Joaquin and Tulare Basin because post harvest practices in these Basins eliminate waste corn.*

[d] *Excludes cropland that is flooded after harvest from one to several weeks in Tulare Basin.*

The 1990 Implementation Plan assumed that managed wetlands in the Central Valley provided an average of 750 lbs of food per acre. This estimate was based on studies of managed wetlands in the Midwest. The 2006 Plan updates this information by using food production estimates from several sites in the Central Valley during fall and winter of 1999-2000 (hereafter 2000) and 2000-2001 (hereafter 2001). Three major habitat types were sampled: (1) semi-permanent wetlands that are primarily managed for brood habitat; (2) seasonal wetlands managed for watergrass (*Echinochloa crus-galli*); and (3) seasonal wetlands managed for swamp timothy (*Crypsis schoenoides*, (Naylor et al. 2002). In both 2000 and 2001, seasonal wetlands dominated by watergrass and swamp timothy were sampled in the Sacramento Valley and San Joaquin Basin. These sampling efforts focused exclusively on seed density, and included both irrigated and non-irrigated seasonal wetlands. Semi-permanent wetlands were sampled only in 2000, because results indicated few seeds available in this habitat type (Naylor et al. 2002).

Food density estimates for seasonal wetlands were based on 2001 results because sample sizes were larger in 2001. Sampling also began earlier in 2001 and provided a better estimate of food density in the Central Valley prior to bird arrival. Differences in food density between seasonal wetlands dominated by watergrass vs. swamp timothy were not significant, nor were differences in food abundance between the Sacramento Valley and San Joaquin Basin (Naylor et al. 2002). As a result, the average value of 566 lbs/acre reported for these two plant communities was used (Naylor et al. 2002) and applied to all seasonal wetlands in all basins (see exceptions for the Suisun and Tulare Basins).

Waterfowl do not consume all the foods available in wetlands because foraging efficiency declines with decreasing food densities (Reinecke et al. 1989). To estimate this "foraging threshold," seed density left in wetlands after spring migration was estimated in 2000 and 2001 (Naylor et al. 2002). These densities were lower in 2000 than 2001, and the 2000 result (about 30 lbs/acre) was adopted as the foraging threshold for wetland habitats. This figure was subtracted from the seed density estimate of 566 lbs/acre to yield a seasonal wetland food density of 533 lbs/acre.

Results from 2000 indicate that seed density in semi-permanent wetlands was less than the 30 lbs/acre foraging threshold (Naylor et al. 2002). As a result, semi-permanent wetlands were assumed to provide no food for either ducks or dark geese. However, waterfowl may consume the leaf, stem, and root/tuber

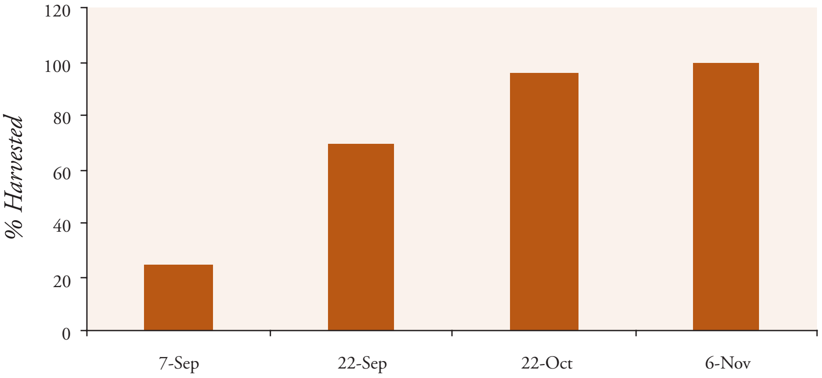


Figure 4-6. Percent of planted rice harvested by time period in the Central Valley.

material of some wetland plants. Although these foods do not appear to be important for ducks in the Central Valley (Euliss and Harris 1987, Miller 1987), geese may exploit them. For example, snow geese are known to consume alkali bulrush in semi-permanent wetlands throughout the Central Valley (C. Isola, U.S. Fish and Wildlife Service, personal communication). Semi-permanent wetlands only account for 10-15% of all wetlands in a basin. However, a better understanding of food resources in this habitat type would allow a better assessment of waterfowl needs in the future.

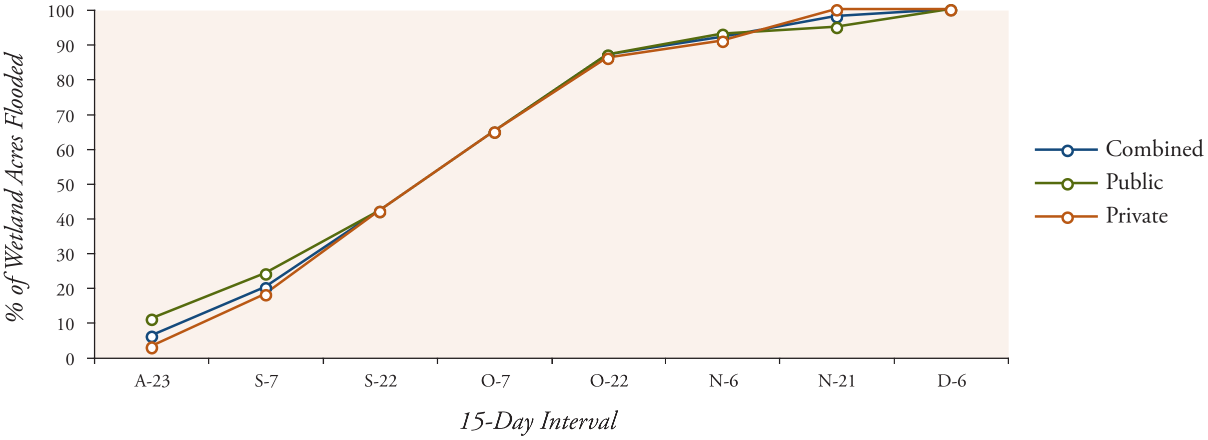


Figure 4-7. Flooding schedules for managed public and private seasonal wetlands in the Central Valley. A "combined" flooding schedule for private and public wetlands was estimated using the relative abundance of these ownership classes.

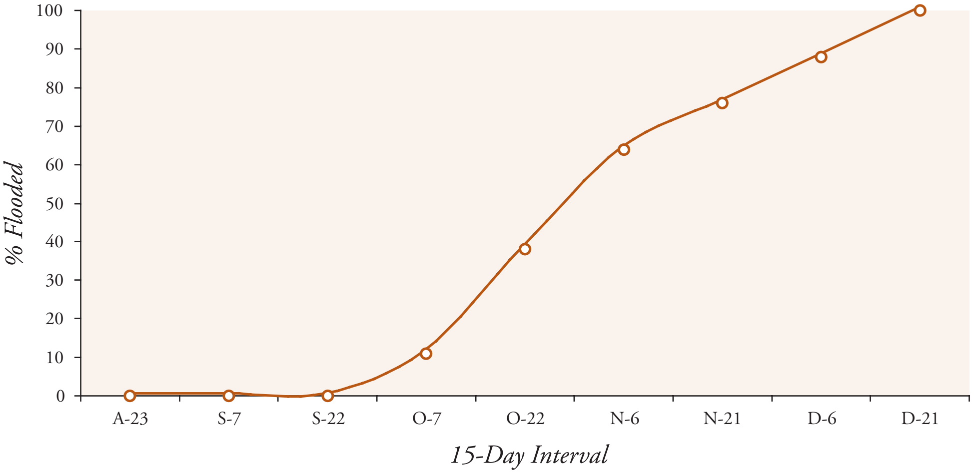


Figure 4-8. Winter-flooding schedule for harvested rice fields in the Central Valley. This flooding schedule was applied to all rice growing basins.

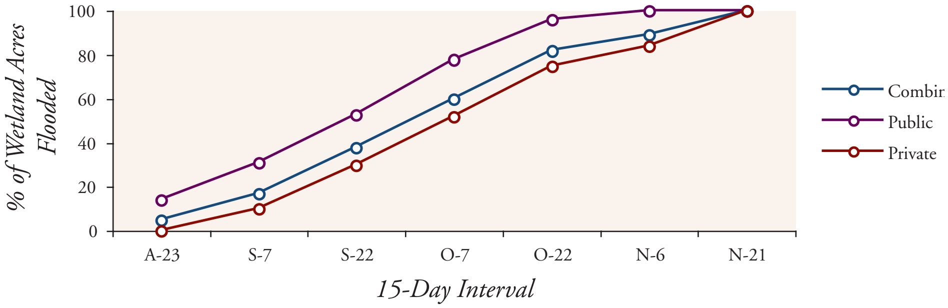


Figure 4-9(a).

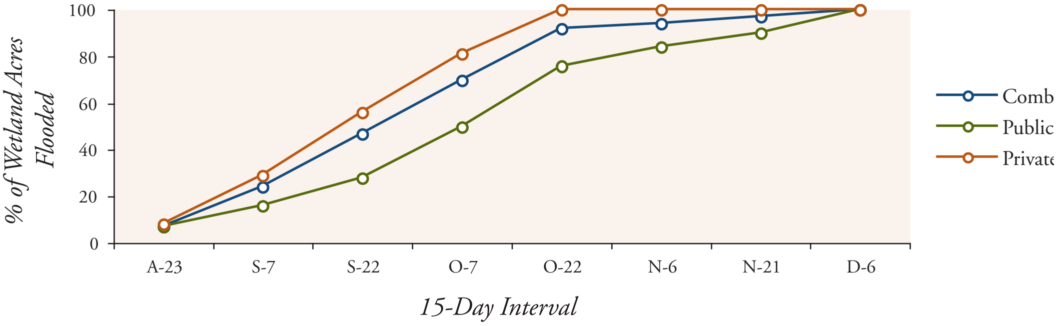


Figure 4-9(b).

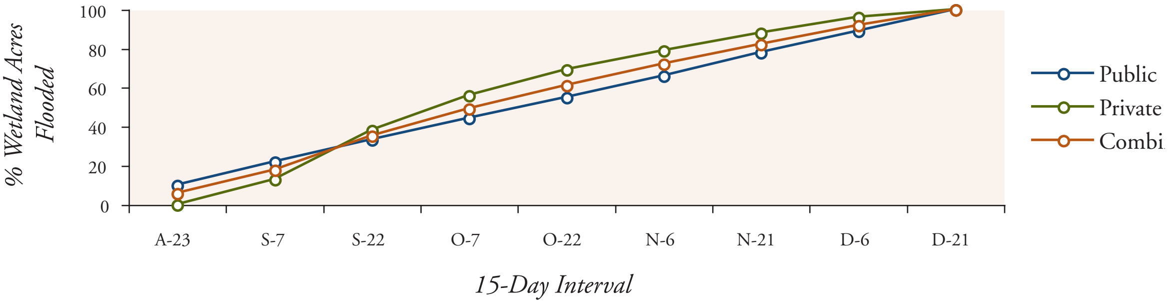


Figure 4-9(c).

Figure 4-9. Seasonal wetland flooding schedules for basins in Sacramento Valley (a), San Joaquin Basin (b), and Tulare Basin (c).

Food habitat studies in the Central Valley indicate that invertebrates become increasingly important to dabbling ducks in late winter and spring (Euliss and Harris 1987), and may be important throughout the wintering period in some habitats in the Tulare Basin (Euliss 1984, J. Fleskes, U.S. Geological Survey, personal communication). Unfortunately, information on invertebrate biomass is lacking for Central Valley wetlands. However, there is evidence that increases in invertebrate populations in late winter and spring correspond to increased waterfowl consumption (Batzer et al. 1993). Seasonal shifts in diet suggest that invertebrate consumption by most Central Valley ducks is minimal prior to January. However, invertebrates can make up twenty-five percent of the diet from January through March (Euliss and Harris 1987). To recognize the importance of invertebrates during late winter in the Central Valley, the JV estimated that seasonal wetlands provide 28 lbs of macro-invertebrate matter per acre beginning January 1. This estimate is based on late winter estimates of invertebrate biomass for seasonal wetlands in the Mississippi Alluvial Valley (Manley 1999).

The 1990 Plan assumed that rice and corn habitats provide 250 lbs (280Kg/ha) of food per acre. This estimate equaled the amount of rice left in fields that are burned after harvest in the Sacramento Valley (Heitmeyer 1989). Although the 1990 Plan recognized that moist-soil and invertebrate food resources were likely present in rice, the amount of these food resources was unknown. Thus, 1990 foraging values were based solely on waste rice availability. The food density of corn was assumed to be the same as for rice because no information was available for this habitat type.

Miller et al. (1989) estimated that 349 lbs/acre of rice was left in conventionally harvested fields in the mid-1980's. Rice harvest technique has changed in the last decade to include "strip harvest" that may leave less rice in the field (Miller and Wylie 1996). Post-harvest treatment of rice has also changed in response to air quality restrictions and the new strip harvest methods. For example, few rice fields are now burned in the Central Valley and current manipulation of straw in harvested fields (e.g., disking, bailing, and flooding) may have reduced the amount of waste rice that is accessible to waterfowl. The 2006 Plan also assumes that 349 lbs/acre of rice is available to waterfowl immediately after harvest (Miller et al. 1989). Consumption of rice by non-waterfowl species reduces the amount of grain available to ducks and geese between harvest, bird arrival, and winter flooding of rice fields. As a result, 15% of waste rice is assumed to be eaten by non-waterfowl species based on estimates of this loss in the Mississippi Alluvial Valley; (Stafford et al. 2006), leaving 297 lbs/acre. Moist-soil food resources average 25 lbs/acre in California rice fields (M.R. Miller, U.S. Geological Survey, unpublished data). This further increased the food density for rice habitat to 322 lbs/acre. Finally the 30 lb/acre foraging threshold established for wetland habitats was applied to rice, which reduced food density in this habitat to 292 lbs/acre. Although work in the Mississippi Alluvial Valley indicates that invertebrates average five to six lbs/acre in rice fields in winter (Hohman et al. 1996, Manley 1999), invertebrates were not included as a food resource in the Central Valley due to uncertainty over the type, biomass, and seasonal availability of invertebrates in rice fields.

Food densities used for rice in the 2006 Plan were based on twenty-year-old estimates. Increases in harvest efficiency, rice yields, and changing post-harvest practices may have reduced the amount of waste grain now available to waterfowl. Although these uncertainties do not affect wetland restoration goals, they do reduce the JV's ability to estimate the amount of rice that must be available to meet waterfowl needs.

Table 4-7. Densities (lbs/acre) and true metabolizable energy (TME) of important waterfowl foods in the Central Valley.

Food[a]	*Density (lbs/acre)*	*TME (Kcal/g)*
MOIST-SOIL[b]	533	2.5
INVERTEBRATES[c]	28	2.39
RICE[d]	292	3.0
CORN[e]	463	3.9

[a] *Does not include agricultural foods unique to Tulare Basin.*
[b] *TME estimates for moist-soil seeds from Checkett et al. 2002.*
[c] *TME estimates for invertebrates from Checkett et al. 2002.*
[d] *TME estimates for rice from Reinecke et al. 1989.*
[e] *TME estimates for corn from Petrie et al. 1997.*

While rice provides most of the agricultural habitat for waterfowl in the Central Valley, corn is an important food source in some areas, particularly the Delta Basin. Food density of corn was determined by multiplying average corn yields for the Central Valley by the amount of corn remaining on the ground after harvest (5.6%). Non-waterfowl consumption of corn was assumed to be the same as for rice, as was the 30 lb/acre foraging threshold. Overall, cornfields are assumed to provide 463 lbs/acre of waste grain (Table 4-7). In the Tulare Basin, waterfowl rely heavily on post-harvest flooded fields of several different crop types during August–October (e.g., safflower, barley/wheat, alfalfa; Fleskes et al. 2003).

Waterfowl carrying capacity is strongly dependant on food densities. However, the energy or calories provided by these foods also influences waterfowl carrying capacity. As a result, metabolizable energy density estimates for moist soil seeds, rice, corn, and invertebrates were obtained from published studies for use in the energetic model (Table 4-7).

Moist soil seeds and agricultural grains decompose under flooded conditions, and deterioration of these foods can significantly reduce waterfowl energy supplies. Decomposition rates for moist soil seeds have been determined from fall through spring in the Central Valley (Naylor et al. 2002), while decomposition rates for rice and corn have been determined for agricultural habitats in the Mississippi Alluvial Valley (Nelms and Twendt 1996). These decomposition rates were incorporated into the energetic model when estimating waterfowl food supplies between August and March.

Overall Assessment of Habitat Conditions in the Central Valley

Habitat conditions for wintering waterfowl were evaluated for the entire Central Valley, as shown in Figure 4-10. This figure depicts the relationship between food energy supplies and population energy demand for all ducks in the Central Valley between August and March as estimated by the TRUEMET model. Duck food supplies are adequate even when duck populations are at NAWMP goals. Prior to mid-September energy supplies are low, as few seasonal wetlands are flooded and no winter-flooded rice is available. However, food supplies are well above population needs by late October, as the majority of public and private wetlands are flooded for opening of hunting season. Habitat conditions continue to improve for ducks well into November, as winter-flooded rice becomes available. Duck energy supplies begin to decline by mid to late December as fewer habitats are added to the landscape, and the effects of waterfowl consumption and food decomposition begin to take effect. However, food supplies remain well above population needs through March when most ducks begin leaving the Valley (Figure 4-10).

Food supplies for both dark and white goose populations in the Central Valley are also well above population needs (Figure 4-11). Geese begin arriving in the valley at the peak of rice harvest and food supplies become increasingly available through November. Although food supplies begin to decline after this point, both dark and white goose populations continue to have access to abundant food resources throughout winter and early spring (Figures 4-11a and 4-11b).

Wetland restoration efforts over the past two decades coupled with increases in winter-flooded rice have substantially improved habitat conditions for Central Valley ducks. To illustrate, food supplies in the 1970's were compared to duck energy needs. Seasonal wetlands in the 1970's were estimated at 140,000 acres by subtracting the number of acres restored between 1986 and 2003 from current wetland estimates. Wetland restoration was not tracked prior to 1986. Winter-flooded rice was estimated at 50,000 acres based on interviews with resource professionals, while corn acres were assumed to be the same. Waterfowl populations during the 1970's were assumed to be at NAWMP goals.

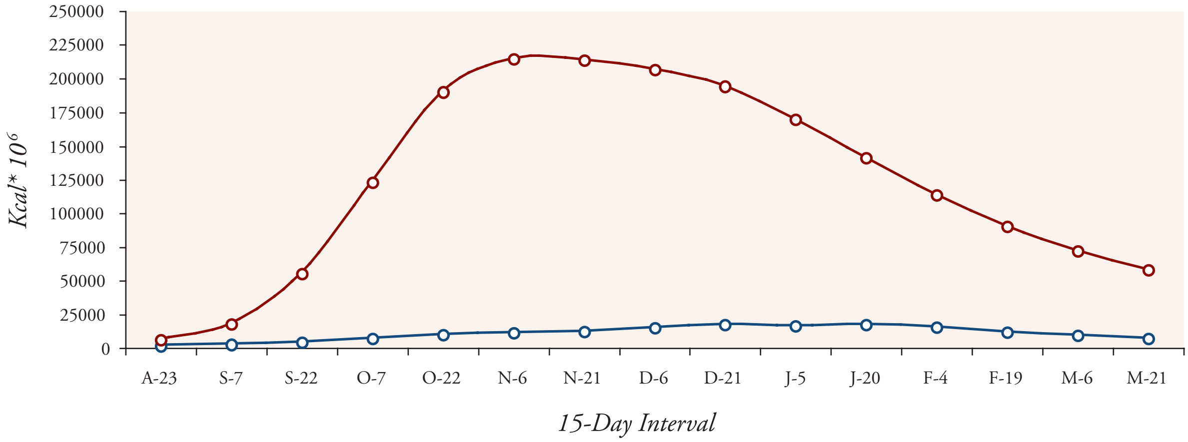


Figure 4-10. Population energy demand (blue) vs. food energy supply (red) for ducks in the Central Valley when duck populations are at NAWMP goals.

Food supplies for dabbling ducks during the 1970s may have been inadequate after late January (Figure 4-12). The likelihood that duck populations in the Central Valley are limited by conditions on the wintering grounds has almost certainly declined during the past twenty-five years.

Approximately two-thirds of the waterfowl habitat in the Central Valley is privately owned. To demonstrate the importance of these habitats, ducks were restricted to foraging on public lands in the TRUEMET model. Duck food resources in this "public lands only" scenario were exhausted by early November (Figure 4-13). This result demonstrates the importance of private lands for waterfowl and the need to develop conservation objectives for these habitats.

Food resources for ducks in the Central Valley are adequate even when populations are at NAWMP goals. However, 68% of all food resources are provided by agricultural habitats, with winter-flooded rice providing the bulk of these foods. Agricultural habitats are currently afforded little or no long-term protection. As a result, conservation objectives should be aimed at increasing the security of waterfowl food resources in each of the valley's basins.

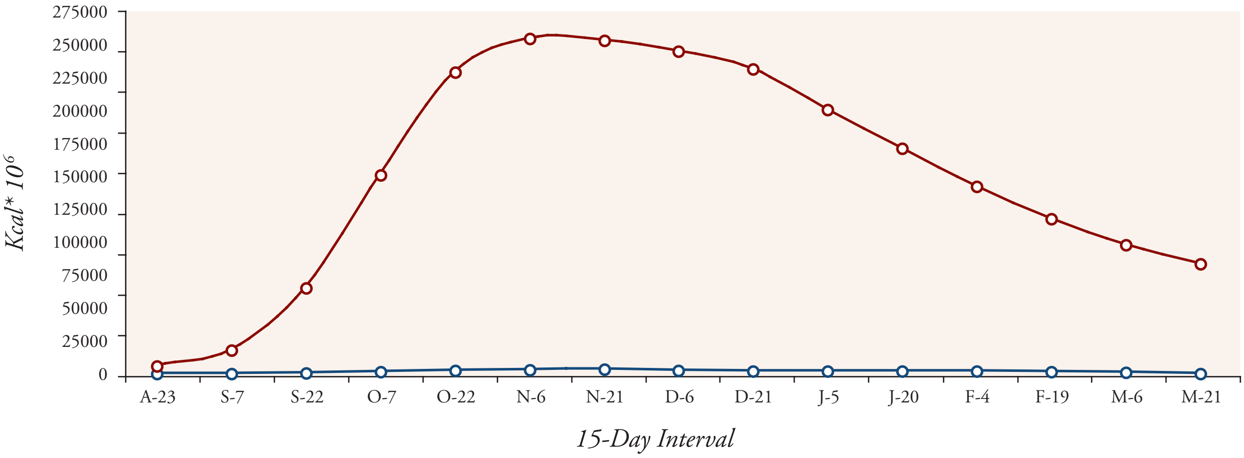


Figure 4-11(a). Dark goose population energy demand (blue) vs. food energy supplies (red) for the Central Valley.

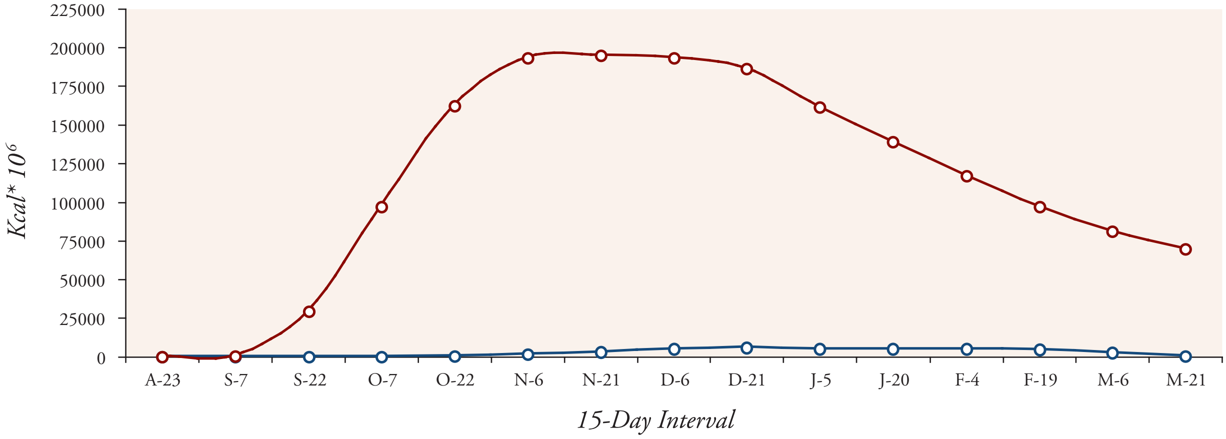


Figure 4-11(b). White goose population energy demand (blue) vs. food energy supplies (red) for the Central Valley.

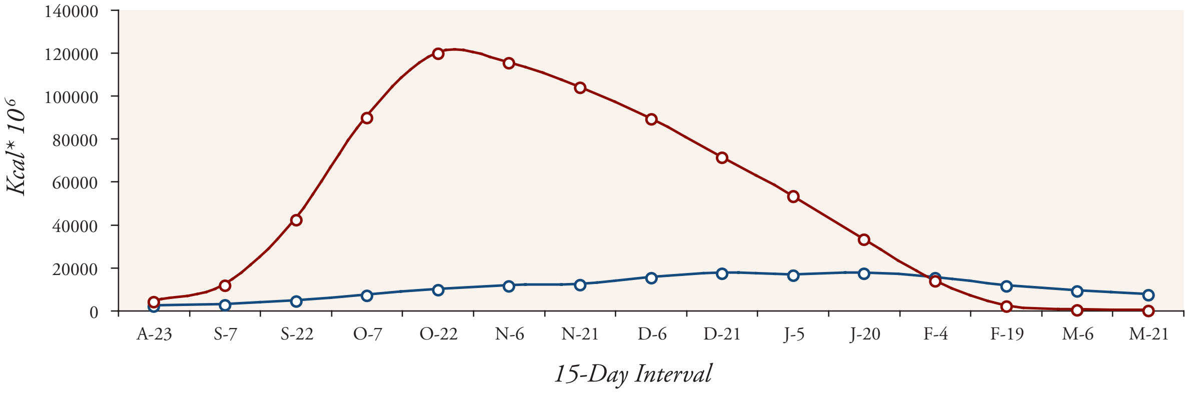


Figure 4-12. Population energy demand (blue) vs. food energy supply (red) for ducks in the Central Valley during the 1970s.

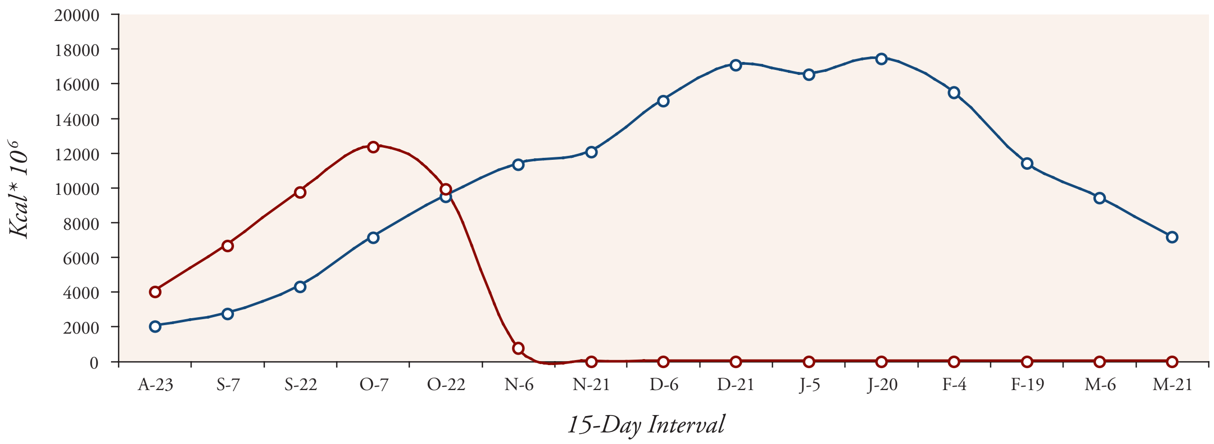


Figure 4-13. Population energy demand (blue) vs. food energy supply (red) for ducks in the Central Valley if only public lands are available.

Methods for Establishing and Prioritizing Conservation Objectives for Wintering Waterfowl in Each Basin

Conservation objectives for wintering waterfowl in the Central Valley were established at the basin scale. The 1990 Plan identified five conservation objectives for wintering waterfowl including: (1) Wetland restoration; (2) Protection of existing wetland habitats; (3) Wetland enhancement; (4) Adequate power and water supplies for wetland management; and (5) Agricultural land enhancement. Two additional conservation objectives were added in the 2006 Plan to recognize the agricultural community's critical role in meeting waterfowl needs and to provide greater flexibility in working with landowners. These include farmland easements that maintain waterfowl food resources on agricultural land (Type I), and farmland easements that buffer existing wetlands from urban and residential growth (Type II). Type I easements seek to maintain waterfowl-friendly practices on agricultural land in perpetuity (e.g., winter-flooding of rice, use of wildlife friendly crop types and post-harvest practices). Type II easements are designed to serve as buffers between wetland habitats and industrial and residential development. This type of easement would not require landowners to provide waterfowl food sources, but would place development restrictions on a property (the legal conditions and qualifications of both easement types are beyond the scope of this document).

For the 2006 Plan, the JV elected to meet at least 50% of all duck energy needs through managed seasonal wetlands; hereafter this is referred to as the "wetland constraint." This planning goal was applied to all basins. The decision to meet 50% of all duck energy needs from wetlands considered both biological and socio-economic factors. Captive studies of non-breeding waterfowl indicate that ducks require a balance of natural and agricultural foods (Loesch and Kaminski 1989), and the JV favors habitat complexes that provide a mixture of agricultural and wetland resources. In addition, increases in harvest efficiency and changing agricultural markets could significantly reduce the food resources provided by grain crops. These events are largely beyond the control of the JV, and seeking a long-term balance between agricultural and wetland habitat is prudent. Agriculture now provides almost 70% of all waterfowl food resources in the Central Valley.

The same approach was used to establish conservation objectives in each basin. First, the relationship between population energy demand and existing food supplies was evaluated for ducks, dark geese, and white geese using the TRUEMET model. Second, the relative contribution that agriculture and managed seasonal wetlands make to waterfowl food supplies in the basin was estimated. Finally, changes in waterfowl carrying capacity that would result from the loss of agriculture were evaluated, as was the ability of public lands to meet duck energy needs. This overview of basin conditions provided the basis for establishing habitat conservation objectives, and may help identify which of these objectives should receive priority. Methods for establishing conservation objectives are described below.

Wetland Restoration Objectives

To determine how much wetland habitat was needed for each basin under the wetland constraint, duck population objectives in a basin were reduced by 50% and the TRUEMET model was used to estimate the wetland acres needed to meet the energy demands of this reduced population. Acres of wetland habitat were incrementally added to the basin until TRUEMET simulations indicated that food energy supplies remained above population energy demand for the entire August to March period. No agriculture was included. The number of wetland acres needed to achieve this result was compared to current wetland acres in the basin. The difference between these two figures represents the wetland restoration objective.

Wetland Enhancement

Water management is critical to producing sufficient quantities of waterfowl food in Central Valley wetlands. However, water control structures, levees, and water conveyance networks used to manage water levels must be periodically repaired or enhanced to maintain or improve food production. Interviews with resource professionals suggest that wetlands in the Valley should undergo some level of structural enhancement every ten to fifteen years. The JV assumes that managed wetlands in the Central Valley need some form of enhancement on average every twelve years. As a result, enhancement objectives are expressed on an annual basis and are perpetual. For example, a basin containing 24,000 acres would have an annual enhancement objective of 2,000 acres. Wetland acres will increase in most basins because of restoration efforts. As a result, enhancement objectives were calculated by 2,000-acre increments between existing wetland acres and basin wetland objectives. Failure to at least maintain the management capabilities of these wetlands will mean a decline in food production over time. These declines would result in an underestimate of the acres of wetlands needed to meet duck energy requirements.

The JV also recognizes the importance of management-based enhancement (e.g., vegetative manipulation and timing of drawdowns), and the cost-sharing programs that promote these activities. However, it is beyond the scope of this document to prescribe site specific enhancement recommendations. The JV assumes that wetland managers are best prepared to determine and to implement these activities.

Water Supplies for Seasonal Wetland Management

The Central Valley Wetlands Water Supply Investigations (Water Report; US Fish and Wildlife Service 2000) provides an estimate of the amount of water needed for optimal management of seasonal wetlands in the Central Valley. These water requirements differ by both time period and basin and this information was used when estimating basin water needs (Figure 4-14). These estimates assumed that wetland restoration objectives have been met, and represent the amount of reliable and affordable water needed for wetland management on public and private lands. Note that the water supply objective equals the amount of water needed for seasonal wetlands, and not the amount of water that is currently secured for wetland management.

Wetland Protection

The 1990 Plan estimated that forty percent of managed wetlands in the Central Valley were unprotected. Tracking of JV accomplishments indicate that most of these wetlands have received long-term protection (likely > 95%; see Chapter 2). Independent estimates of unprotected wetlands also indicate that less than five percent of managed wetlands in the Central Valley remain unprotected (K. Petrik, Ducks Unlimited, Inc., personal communication). Although most wetlands are now protected, the JV is unable to determine how many acres of managed wetlands remain unsecured in each basin. As a result, no wetland acreage protection objectives were established in the 2006 Plan. However, the JV will seek to secure long term protection as these wetlands are identified. The JV will document the amount of unprotected habitat in each basin in the immediate future, and these efforts will form the basis of new wetland protection goals in the next plan update.

Hedgerow Farms, Yolo County
Photo: John Anderson

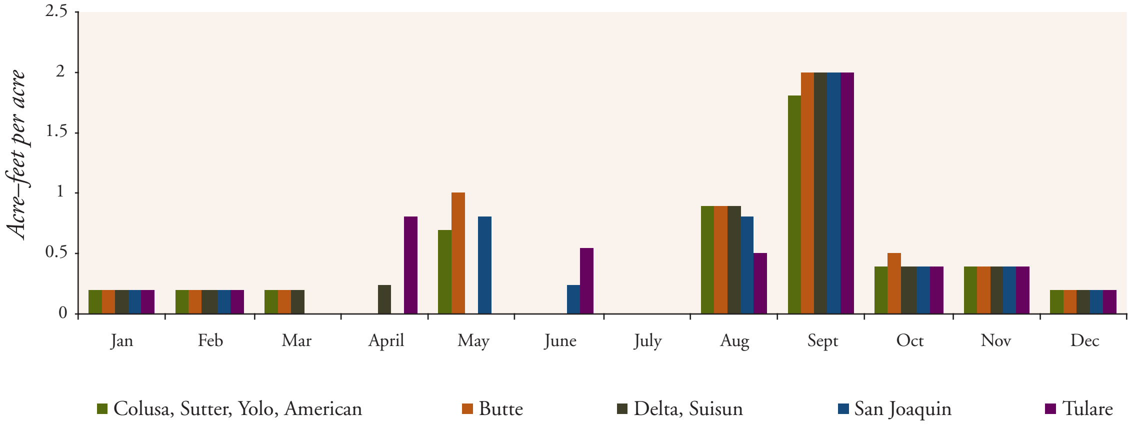


Figure 4-14. Monthly water requirements, acre-feet per acre, for seasonal wetlands in each of the Central Valley's basins.

Agricultural Enhancement

The Joint Venture's wetland constraint provides a balanced mix of agricultural and wetland habitat for each basin, as the JV assumes that agriculture will likely continue to provide 50% of all duck energy needs in most basins. The agricultural enhancement objective represents the amount of agricultural habitat that must be maintained for ducks, even when wetland restoration objectives are met in a basin. For ducks, agricultural enhancement includes rice fields that are winter-flooded or cornfields that are either winter-flooded and/or not deep plowed following harvest.

Geese in the Central Valley rely heavily on agricultural food sources to meet their daily energy requirements. Agricultural enhancement objectives that are based solely on duck needs may not be adequate for geese. As a result, TRUEMET was used to estimate the amount of agricultural habitat that must be maintained to meet the needs of ducks and geese when wetland restoration goals are met. The JV defines agricultural habitat types necessary to meet duck and goose energy requirements as waterfowl-friendly rice and/or waterfowl-friendly corn, depending on the basin. For basins dominated by rice, the waterfowl-friendly agricultural objective is divided into flooded and non-flooded categories because ducks are limited to winter-flooded fields, while geese would utilize dry fields provided they are not deep plowed. For basins dominated by corn, the waterfowl-friendly agricultural enhancement objective reflects the amount of corn that is either winter-flooded and/or not deep plowed following harvest.

Agricultural Easements for Maintaining Waterfowl Food Production (Type I)

Agricultural enhancement objectives represent the amount of farmland needed to meet waterfowl food energy needs when wetland restoration objectives are met. Agricultural easements that permanently maintain waterfowl food sources on farmlands (e.g., winter flooding of rice) contribute to this objective. This plan does not identify specific areas that are candidates for this type of agricultural easement. Instead, it provides background information that may be helpful to the JV in identifying what basins require an easement program in the immediate future and the general location within the basin where these easements might be sought. Three criteria were evaluated for each basin: (1) the importance of agricultural food resources in meeting waterfowl needs in the basin (e.g., Suisun Marsh Basin has no agriculture); (2) the extent to which these agricultural lands are threatened by human population growth and associated land conversion (see Chapter 3); and (3) wetland restoration goals. Most wetland restoration in rice growing basins will occur on rice ground. While wetland restoration provides obvious benefits, it also reduces the rice habitat available to waterfowl. Changes in rice habitat must consider the loss of riceland to development and conversion of rice to wetland habitat. This process is demonstrated using a hypothetical basin (Figure 4-15). The basin has 100,000 acres of planted rice. Seventy thousand acres are winter-flooded, while 20,000 acres are dry but are not deep plowed following harvest and thus, provide waterfowl food resources. The remaining 10,000 acres are dry and are deep plowed following harvest. The agricultural enhancement objective for the basin is 80,000 acres of waterfowl-friendly rice. Within the basin 20,000 acres will be lost to development and 10,000 acres will be converted to wetlands to meet the JV's wetland restoration objective. This leaves a planted rice base of only 70,000 acres, which is insufficient to meet the basin's agricultural enhancement goal (Figure 4-15).

Basins where waterfowl meet most of their food energy needs from agricultural habitats, and where these habitats are threatened by development are likely candidates for an easement program. Geographic Information Systems and local knowledge provided by the JV's basin working groups were used to assess development threats to agricultural habitats in each basin. Large wetland restoration objectives that further reduce the rice base may contribute to the need for a Type I easement program.

Agricultural Easements that Buffer Urban and Residential Growth (Type II)

The quality of existing wetlands may be reduced where urban or residential growth occurs at or near wetland boundaries. Easements that maintain land in agricultural production can buffer this development, even though these lands may contain no waterfowl foods. The 2006 Plan does not identify specific areas that are candidates for this type of agricultural easement. Instead, the 2006 Plan provides background information that may be helpful to the JV in identifying what basins require an easement program of this type (Type II), and generally where in the basin these easements might be sought. Basins that contain large blocks of private and/or public wetlands in areas of high urban or residential growth are likely candidates for an easement program. Geographic Information Systems and local knowledge provided by basin working groups were used to assess development threats to wetlands in each basin.

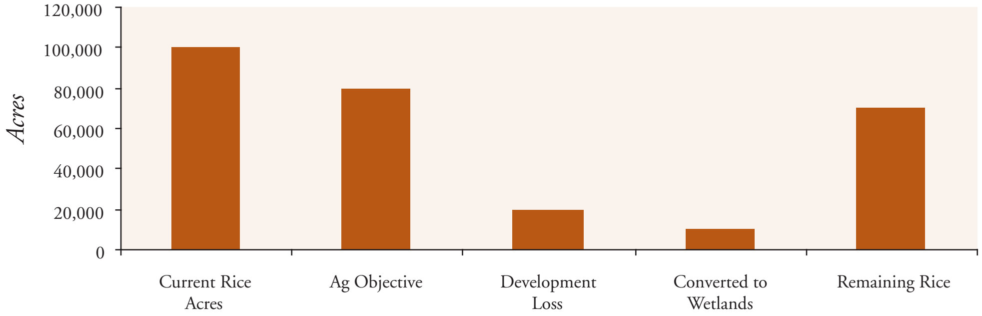


Figure 4-15. Forecasted changes in rice acreage for a hypothetical basin compared to the basin's agricultural enhancement objective.

Conservation Objective Priorities

Each conservation objective described above represents important habitat needs for ducks and geese. However, the JV recognizes that some of these objectives may need to be emphasized, at least in the short term. For example, should wetland restoration be highlighted in a basin or should efforts focus on enhancing agricultural habitats? In some cases multiple conservation objectives may be emphasized at the same time, especially where funding sources are tailored to specific objectives. To provide some insight into which objectives may be most important in the near future, the JV reviewed five biological and socio-economic factors that are described below. Some of these socio-economic factors were reviewed in Chapter 3 and this information is frequently referenced. The intent here is not to establish a rigid list of conservation objective priorities for each basin (i.e., there is no scoring process). Instead, the 2006 Plan seeks to provide resource managers with material that may help determine which objectives should be emphasized in the short and long term.

1. Population Energy Demand vs. Food Energy Supplies: Current Conditions

Overall, food resources in the Central Valley are currently adequate for waterfowl, even if duck populations were at NAWMP goals. However, food resources in some basins may not meet population energy needs. The extent to which existing food supplies now meet waterfowl needs in a basin when duck populations are at NAWMP goals was categorized as low (< than 75% of waterfowl energy needs met), moderate (75%-100% of waterfowl energy needs met), or high (> 100% of food energy needs met). In general, conservation objectives aimed at increasing the protection of existing habitats may be favored where waterfowl food energy supplies are already high in the basin.

2. Habitat Protection


Yolo Wildlife Area
Photo: Dave Feliz, DFG

The majority of waterfowl food resources in the Central Valley are found on agricultural lands that have little or no long-term protection. In contrast, most managed wetlands are afforded long-term protection through fee title purchases and conservation easements. However, the contributions that agricultural and wetland habitats make to total food supplies differ among basins. Current habitat protection for each basin was estimated as the percent of duck energy needs now supplied by wetlands, although the JV recognizes that not all wetlands are protected. One example involves a basin where 50% of duck energy needs are to be met through a wetland base of 30,000 acres, while the remaining 50% is met by a 50,000-acre agricultural enhancement objective. If 15,000 acres of wetland currently exist (leaving a 15,000 acre wetland restoration goal), then 25% of the food sources needed by ducks are currently protected (this assumes no current agricultural protection). This level of protection would increase as the wetland restoration goal is met and easements are obtained on farmland, provided that restored wetlands are also afforded permanent protection. Four levels of overall habitat protection were recognized: (1) very low (0-25%); (2) low (26-50%), (3) moderate (51-75%), and (4) high (76-100%).

3. Progress in Meeting Wetland Needs

Wetland restoration objectives are critical to offsetting the long-term risks of meeting waterfowl needs on unprotected agricultural habitat. The degree to which wetland acres in a basin meet the Joint Venture's 50% wetland constraint was categorized as; (1) very low (0-25%); (2) low (26-50%); (3) moderate (51-75%); and (4) high (76-100%). For example, "Progress in Meeting Wetland Needs" would be "very low" in a basin having 2,500 acres of wetlands, but needing 10,000 acres of wetlands to provide 50% of duck energy needs.

4. Human Population Growth

Although human populations in the Central Valley are predicted to increase by 130% over the next four decades, this growth will not be uniform among basins. Some basins will experience substantial increases in population growth by 2040, while growth in other basins will be modest. Forecasts for population growth were made earlier for each basin (Chapter 3). Four categories of population growth to 2040 were recognized when establishing conservation objective priorities: (1) very low (< 200,000); (2) low (200,000-600,000); (3) moderate (> 1,000,000); and (4) high (> 2,000,000). Geographic Information systems were also used to depict the spatial pattern of this growth relative to wetland and agricultural habitats.

5. Changes in Land Use

Changes in land use track increases in human populations. Some basins are projected to lose substantial amounts of irrigated farmland by 2040. This loss is important in basins where agriculture provides the majority of waterfowl food supplies. Estimates of farmland loss were made for each basin in Chapter 3. Estimates of rice loss were also made for basins where rice is an important crop. Three categories of pre-irrigated farmland or rice loss by 2040 were recognized: (1) low (< 5%); (2) moderate (5-10%); and (3) high (> 10%).

The 2006 Plan established some guidelines when interpreting these five factors. First, agricultural easements are emphasized in areas that are predicted to experience substantial urban or residential growth. Less emphasis is placed on easements in basins where little growth is predicted (an alternative view may be to emphasize easements in these basins as easements costs may be lower because of less competition from development). Second, wetland enhancement is emphasized in basins where wetland objectives are closer to being met. Enhancement is also necessary in basins that are farther from meeting their wetland restoration objectives, though restoration may ultimately be emphasized. It bears repeating that some resource managers may reach different conclusions when deciding what objectives to emphasize. However, the purpose here is to provide information that allows informed decisions when considering conservation priorities, not to develop a rigid list of those priorities.

Figure 4-16 describes conditions in a hypothetical basin. The basin contains 5,000 acres of seasonal wetlands and 50,000 acres of flooded rice. All 5,000 wetland acres are protected, while no agricultural habitat is under easement. Fifteen thousand acres of seasonal wetlands are needed to meet the JV's wetland constraint. This leaves a wetland restoration objective of 10,000 acres. Forty thousand acres of flooded rice are needed when the wetland restoration objective is met (i.e., when 15,000 acres of wetlands are present in the basin). An assessment of food energy demand vs. food energy supply concluded that the food resources provided by these existing habitats exceed 100% of duck needs (high). Although 100% of the basin's wetlands are protected (complete protection), the overall level of habitat protection was rated very low because only 5,000 of the 15,000 acres of wetlands needed are present, resulting in an overall level of habitat protection of less than 17%. (If wetland restoration objectives were met 50% of duck energy needs would be provided by protected habitats. Because only a third of these 15,000 acres are present, the current level of habitat protection is only 16.7% or 0.33 x 0.5).

Progress in meeting wetland needs was rated low because only 33% of needed wetlands are present (5,000/15,000). Most food resources are found on agricultural lands that are unprotected. However, population growth is forecasted as very low (< 200,000). As a result, loss of irrigated farmland is also expected to be low (< 5%).

Wetland restoration is emphasized for the hypothetical basin described in Figure 4-16. While most food resources are provided by agriculture, there is little evidence that these habitats are threatened by development prior to 2040. This lack of development may increase opportunities for wetland restoration, as land prices are not influenced by real estate speculation. Focusing on wetland restoration now may offset agricultural losses that occur after 2040.

Current Food Supplies	*Habitat Protection*	*Progress in Meeting Wetland Needs*	*Population Growth*	*Loss of Irrigated Farmland*	*Conservation Objective Priorities*
High	High	High	High	High	Wetland Restoration
Moderate	Moderate	Moderate	Moderate	Moderate	
Low	Low	Low	Low	Low	
	Very Low	Very Low	Very Low		

Figure 4-16. Factors used to identify which conservation objectives may be emphasized in a hypothetical basin.

Conservation Objectives and Priorities for Wintering Waterfowl in Each Basin

American Basin

Population Energy Demand vs. Food Energy Supplies: Current Conditions

Population objectives for wintering waterfowl in the American Basin are presented in Figures 4-17 through 4-19. Duck population objectives are highest during late winter, while population objectives for dark and white geese peak during November and early January respectively. Rice provides the majority of foraging habitat, as there are few privately owned wetlands and no publicly managed habitats (Table 4-8).

Food supplies for American Basin ducks are adequate in all time periods with peak supplies occurring in November and December (Figure 4-20). However, duck energy needs do not peak until late winter when food supplies are well below the November-December maximum. Food supplies for dark and white geese are also well above population needs, with peak use coinciding with maximum food resources (Figure 4-21). Agricultural habitat provides 95% percent of the food energy available to ducks in the American Basin. Loss of these agricultural foods would significantly reduce carrying capacity, as food supplies would be exhausted by early December if ducks are restricted to foraging in wetlands (Figure 4-22).

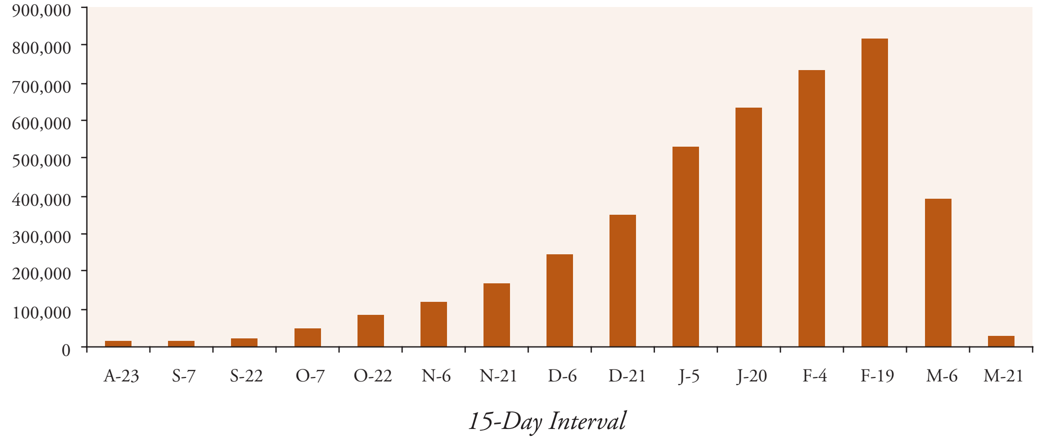


Figure 4-17. Population objectives by 15-day intervals for ducks in American Basin.

Conservation Objectives

Wetland Restoration

The amount of seasonal wetlands required to meet 50% of duck energy needs in American Basin is estimated at 23,187 acres. There are currently 3,187 acres of seasonal wetland habitat in the basin, leaving a wetland restoration objective of 20,000 acres.

Wetland Enhancement

The annual enhancement objective for existing wetlands in American Basin is 266 acres/year. Wetland enhancement objectives increase to 1,932 acres/year when wetland restoration objectives are met for the basin (Table 4-9).

Water Supplies for Seasonal Wetland Management

Annual management of seasonal wetlands in American Basin will require 115,945 acre-feet of water when wetland restoration objectives in the basin have been met. These annual water requirements are further broken down by time period to reflect flooding and summer irrigation needs (Table 4-10).

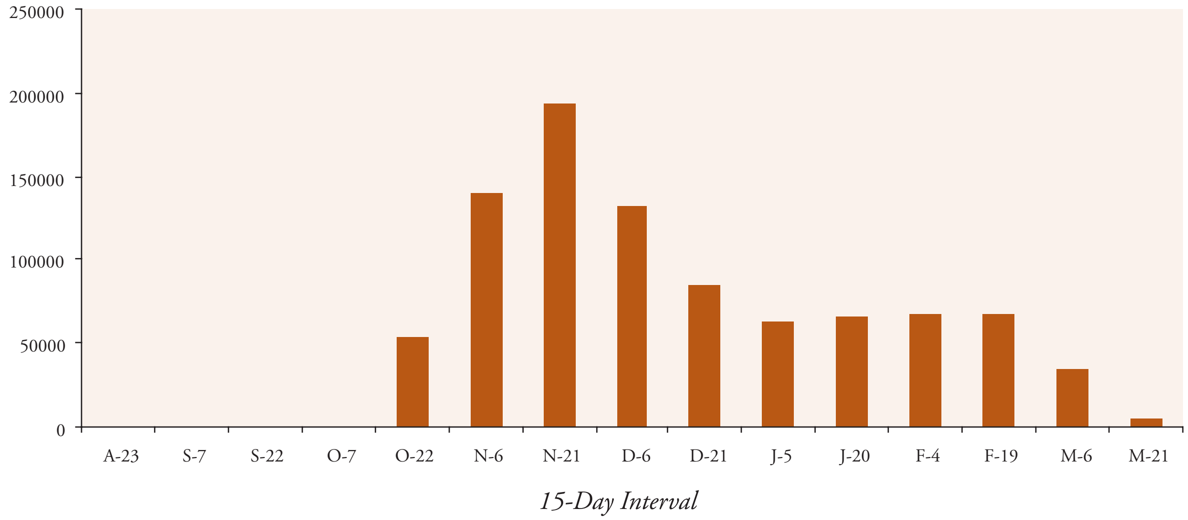


Figure 4-18. Population objectives by 15-day intervals for dark geese in American Basin.

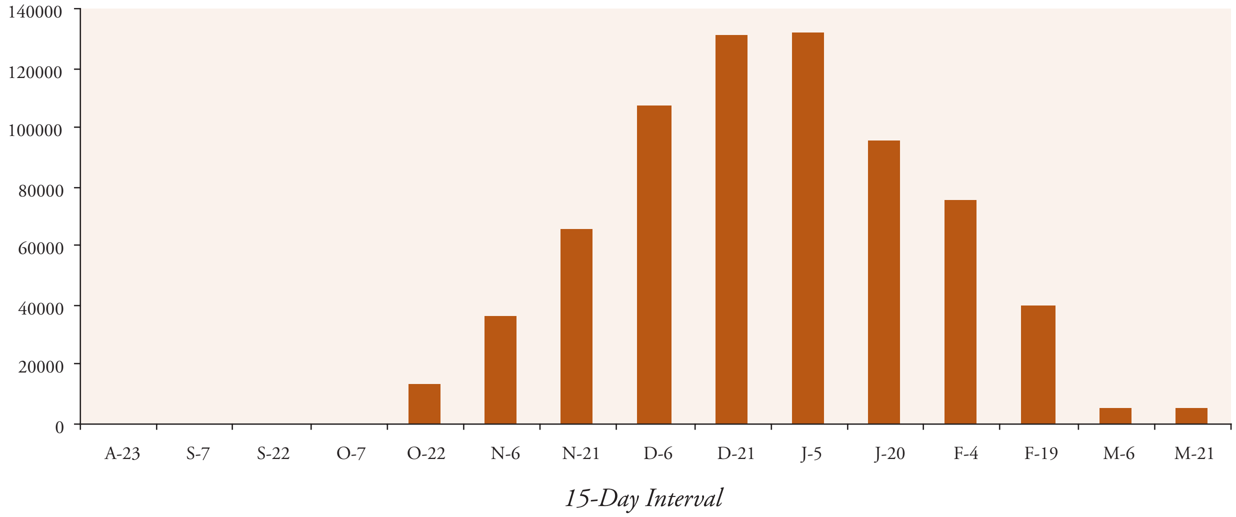


Figure 4-19. Population objectives by 15-day intervals for white geese in American Basin.

Table 4-8. Foraging habitats available to wintering waterfowl in the American Basin.

Seasonal Wetlands	*Flooded Rice*	*Unflooded Rice*	*Corn*
3,187	72,049	21,014	1,146

Agricultural Enhancement

The agricultural enhancement objective for American Basin is 69,000 acres, all of which is assumed to be rice. This objective represents the amount of rice habitat that must be maintained in a waterfowl-friendly state when wetland restoration objectives have been met for the basin. Fifty thousand of these acres must be winter-flooded to meet duck energy needs. Waterfowl-friendly rice habitat in the basin is currently estimated at over 93,000 acres with over 72,000 of these acres winter-flooded (Table 4-11). Agricultural enhancement objectives are currently exceeded for the basin.

Agricultural Easements for Maintaining Waterfowl Foods (Type I)

Agricultural habitats are extremely important to waterfowl in American Basin and provide 95% of the food energy now available to ducks (Figure 4-22). The loss of irrigated farmland in the basin by 2040 is predicted to be 40,000 acres or 16% of all irrigated lands (Figure 3-15). At least 16,000 acres will be riceland. This projected loss of rice should be considered a minimum because most development is occurring in rice growing areas and is not equally distributed among the different types of irrigated farmland (Figure 4-23). Most wetland restoration occurs on rice ground, and meeting wetland restoration goals for the basin could reduce rice acreage by an additional 20,000 acres. Planted rice in the basin is estimated at about 100,000 acres (Table 3-4). However, this figure could be reduced by a minimum of 36,000 acres if growth projections are accurate and wetland restoration objectives are met. This reduction in the rice base would make it extremely difficult to meet the basin's 69,000 acre objective for waterfowl-friendly rice (Figure 4-24). These forecasts suggest that easements to maintain agricultural foods are needed in the basin.

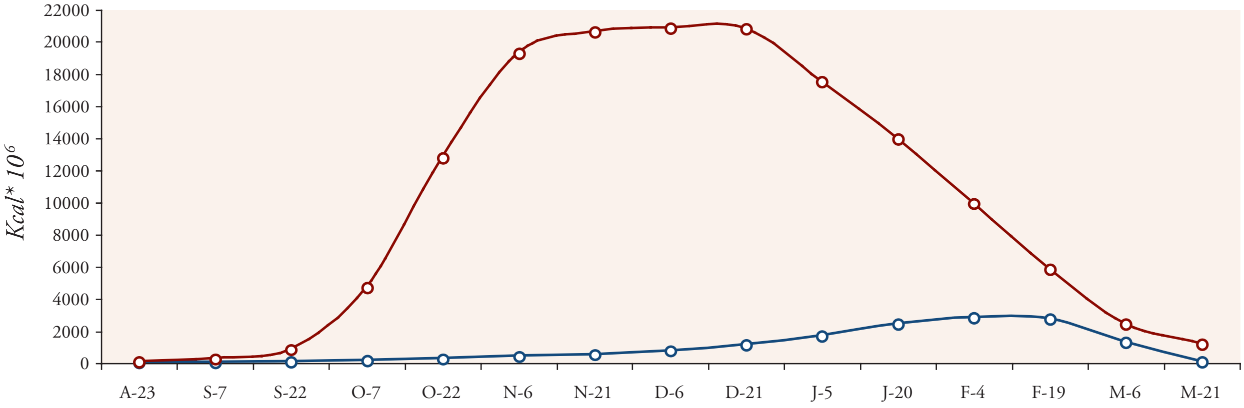


Figure 4-20. Population energy demand (blue) vs. food energy supply (red) for ducks in American Basin when duck populations are at NAWMP goals.

Agricultural Easements To Buffer Residential and Urban Growth (Type II)

Large wetland complexes that would benefit from Type II agricultural easements are currently lacking in the American Basin. However these complexes will develop if wetland restoration objectives are met. Agricultural easements to buffer the effects of growth will likely be needed at that time given growth projections for the basin.

Conservation Objective Priorities

Conservation objectives for the American Basin are summarized in Table 4-12. The information used to prioritize conservation objectives for American Basin is presented in Figure 4-25. Food supplies exceed 100% of duck needs and were classified as high, though habitat protection was rated as very low (7%). Progress in meeting wetland needs is also very low (3,178 acres present vs. 23,178 needed; or 13.7% of need). Loss of irrigated farmland is predicted to be high, and future reductions in the basin's rice acreage may make it difficult to meet agricultural enhancement objectives.

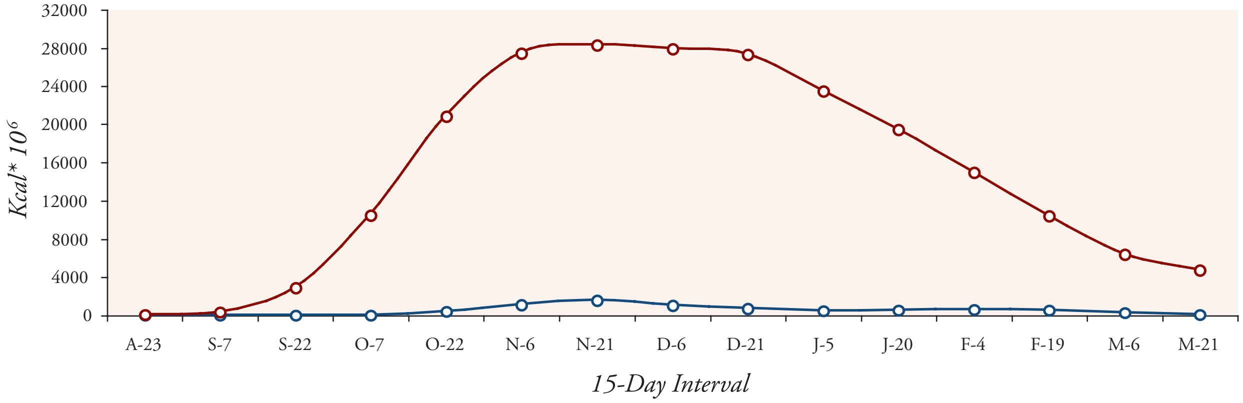


Figure 4-21 (a). Dark goose population energy demand (blue) vs. food energy supplies (red) in American Basin.

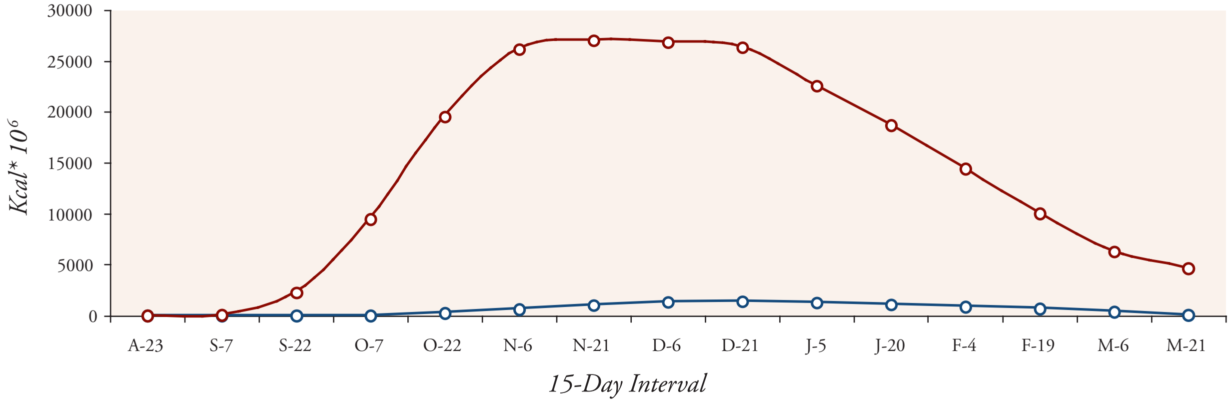


Figure 4-21 (b). White goose population energy demand (blue) vs. food energy supplies (red) in American Basin.

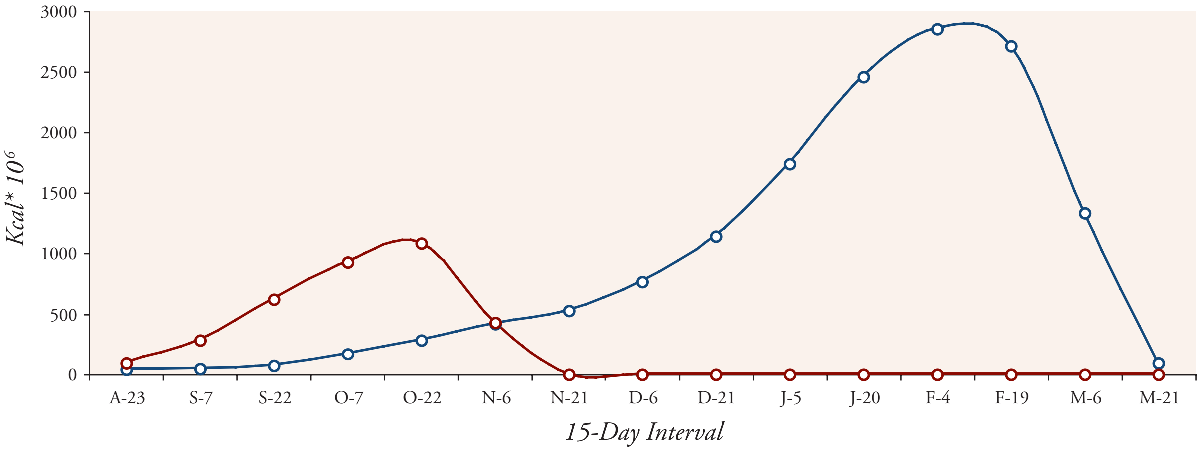


Figure 4-22. Population energy demand (blue) vs. food energy supply (red) for ducks in American Basin when no agricultural food supplies are available.

Wetland restoration is a priority for American Basin, because less than 14% of wetland needs have been met for ducks. Establishing an easement program to protect agricultural food sources should also be considered a priority in the immediate future.

Table 4-9. Annual wetland enhancement objectives for American Basin.

Wetland Acres	*Annual Enhancement Objective (Acres)*[c]
3,187[a]	266
5,187	432
7,187	599
9,187	766
11,187	932
13,187	1,098
15,187	1,265
17,187	1,432
19,187	1,599
21,187	1,766
23,187[b]	1,932

[a] *Current acres of wetlands in the American Basin.*
[b] *Acres of wetlands in the American Basin when wetland restoration objectives are met.*
[c] *Annual enhancement objectives reflect progress in meeting wetland restoration objectives for American Basin.*

Table 4-10. Water needs for seasonal wetlands in American Basin.

Month	*Water Need (Acre-Feet)*
January	4,636
February	4,636
March	4,636
April	0
May	16,225
June	0
July	0
August	20,860
September	41,720
October	9,271
November	9,271
December	4,636
Annual Need	**115,890**

Table 4-11. Agricultural enhancement objectives for American Basin.

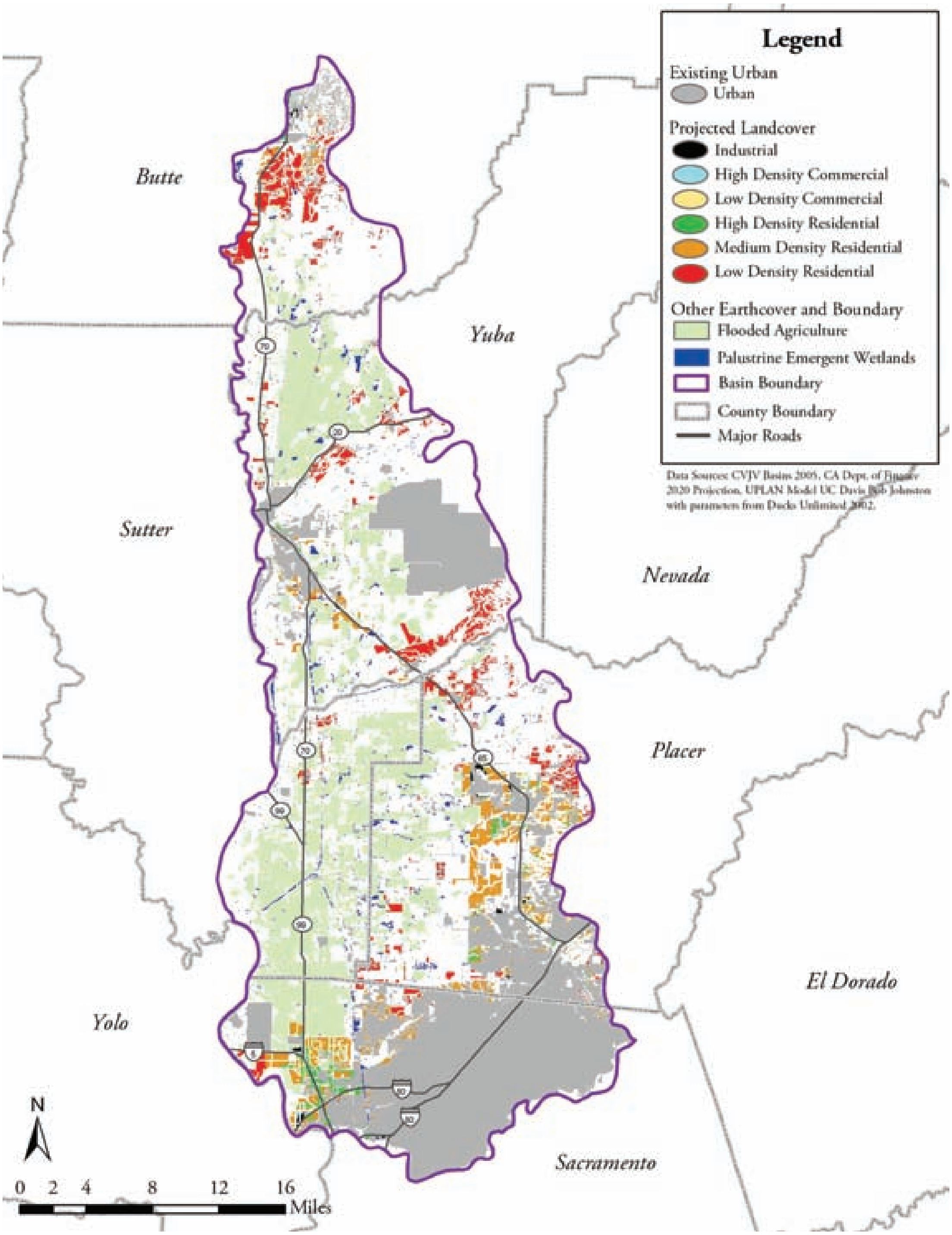
	Waterfowl-friendly Rice[a]	*Flooded Rice*
Objective	69,000	50,000
Current	93,063[b]	72,049

[a] *Waterfowl-friendly rice includes rice that is flooded and rice that is not deep plowed following harvest but which remains dry.*
[b] *Planted rice acreage in American Basin is estimated at 100,000 acres (Table 3-6). The JV assumes that 93,063 of these acres provide waterfowl-friendly habitat.*

Table 4-12. Conservation objectives for wintering waterfowl in American Basin.

Wetland Restoration (Acres)	*Wetland Enhancement (Acres)*	*Water Supplies (Acre-Feet)*	*Agricultural Enhancement (Acres)*	*Type I Agricultural Easements*	*Type II Agricultural Easements*
20,000	1932[a]	115,890[b]	69,000[c] 50,000[d]	Needed	Needed in Future

[a] *Annual enhancement objective when the wetland restoration objective is met.*
[b] *Annual water supply need when the wetland restoration objective is met.*
[c] *Total acres of rice that must be enhanced (includes 50,000 acres that must be flooded). Objective has been met.*
[d] *Total acres of rice that must be flooded out of the total enhancement objective of 69,000 acres. Objective has been met.*



Data Sources: CVJV Basins 2005, CA Dept. of Finance 2020 Projection, UPLAN Model UC Davis Bob Johnston with parameters from Ducks Unlimited 2002.

Figure 4-23. Projected growth in American Basin to 2020.

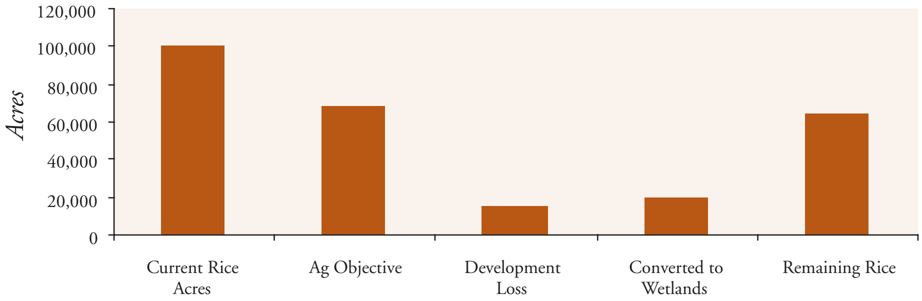


Figure 4-24. Forecasted changes in rice acreage for the American Basin compared to the basin's agricultural enhancement objective.

Current Food Supplies for Ducks	*Overall Level of Habitat Protection*	*Progress in Meeting Wetland Need*	*Population Growth*	*Loss of Irrigated Farmland*	*Conservation Objective Priorities*
High	High	High	High	High	Wetland Restoration
Moderate	Moderate	Moderate	Moderate	Moderate	Type I Agricultural Easements
Low	Low	Low	Low	Low	
	Very Low	Very Low	Very Low		

Figure 4-25. Factors used to identify conservation objective priorities for American Basin.

Butte Basin

Population Energy Demand vs. Food Energy Supplies: Current Conditions

Population objectives for wintering waterfowl in Butte Basin are presented in Figures 4-26 through 4-28. Duck and white goose population objectives are highest during late December, while population objectives for dark geese peak during November. Although rice provides the majority of foraging habitat in the basin, seasonal wetlands exceed 23,000 acres (Table 4-13).

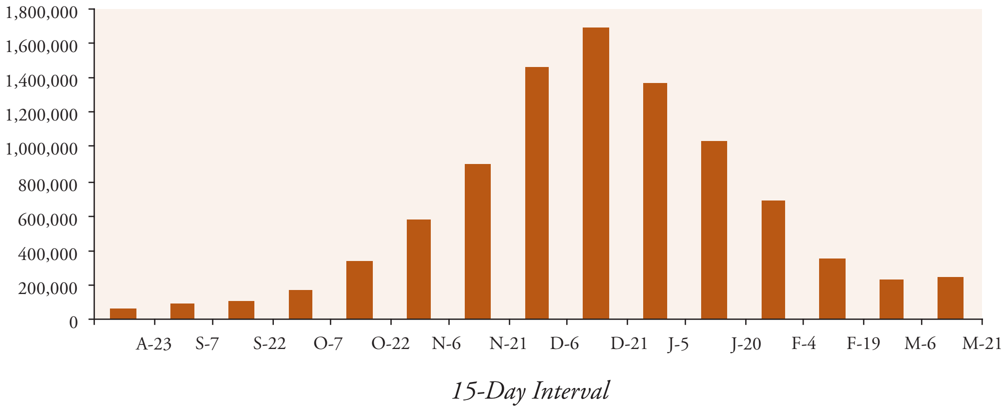


Figure 4-26. Population objectives by 15-day intervals for ducks in Butte Basin.

Food supplies for Butte Basin ducks are adequate in all time periods. Peak food supplies occur in November and December and coincide with high duck use of the basin (Figure 4-29). Dark and white goose food supplies are also well above population needs and large food surpluses occur in all time periods (Figure 4-30). Agricultural habitats provide 74% of the food energy available to ducks in the basin. Loss of these agricultural foods would significantly reduce carrying capacity, because food supplies are exhausted by mid-December if ducks are restricted to foraging in wetlands (Figure 4-31). Public wetlands alone can only meet duck needs through early November (Figure 4-32), though most duck use of the basin occurs after this date.

Conservation Objectives

Wetland Restoration

The amount of seasonal wetlands required to meet 50% of duck energy needs in Butte Basin is estimated at 40,340 acres. There are currently 23,340 acres of seasonal wetlands in the basin, leaving a wetland restoration goal of 17,000 acres.

Wetland Enhancement

The annual enhancement objective for existing wetlands in Butte Basin is 1,945 acres/year. Wetland enhancement objectives increase to 3,362 acres/year when wetland restoration objectives are met for the basin (Table 4-14).

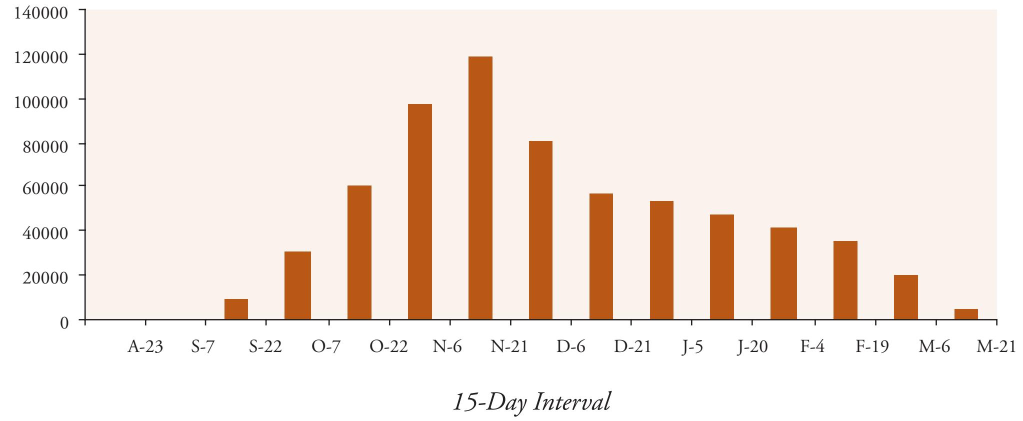


Figure 4-27. Population objectives by 15-day intervals for dark geese in Butte Basin.

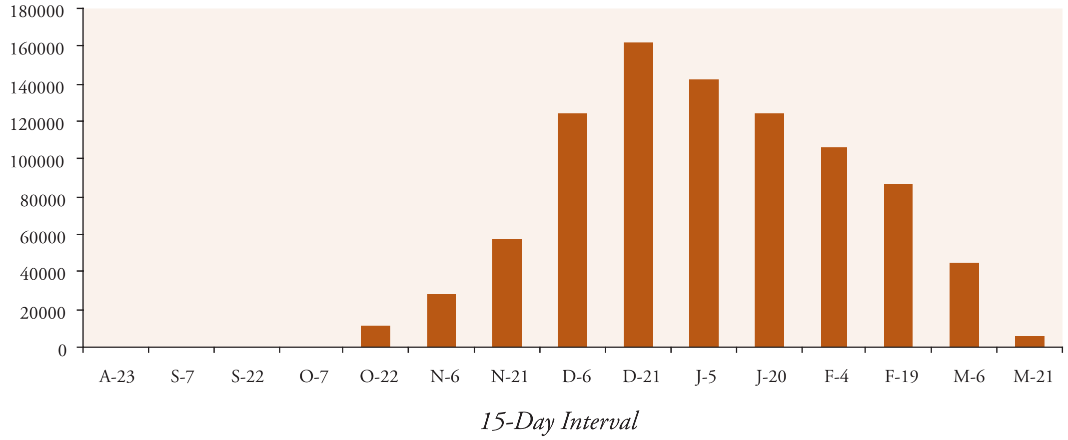


Figure 4-28. Population objectives by 15-day intervals for white geese in Butte Basin.

Table 4-13. Foraging habitats available to wintering waterfowl in Butte Basin.

Seasonal Wetlands	*Flooded Rice*	*Unflooded Rice*	*Corn*
23,340	99,494	29,019	2,510

Water Supplies for Seasonal Wetland Management

Annual management of seasonal wetlands in Butte Basin will require 225,904 acre-feet of water when wetland restoration objectives in the Basin have been met. These annual water requirements are further broken down by time period to reflect flooding schedules and summer irrigation needs (Table 4-15).

Agricultural Enhancement

The agricultural enhancement objective for Butte Basin is 104,000 acres, all of which is assumed to be rice. This objective represents the amount of rice habitat that must be maintained in a waterfowl-friendly state when wetland restoration objectives have been met for the basin. Sixty-two thousand of these acres must be winter-flooded to meet duck energy needs. Waterfowl-friendly rice habitat in the basin is currently estimated at over 128,000 acres with nearly 100,000 of these acres winter-flooded (Table 4-16). Agricultural enhancement objectives are currently exceeded for the basin.

Agricultural Easements for Maintaining Waterfowl Foods

Agricultural habitats are extremely important to waterfowl in Butte Basin and provide 74% of the food energy now available to ducks (Figure 4-31). The loss of irrigated farmland in the basin by 2040 is predicted to be almost 24,000 acres or 9% of existing lands (Figure 3-15). Nearly 13,000 of these acres are predicted to be rice (Table 3-4). Most wetland restoration occurs on rice ground, and meeting wetland restoration goals for the basin could reduce rice acreage by an additional 17,000 acres. (Table 4-16). Planted rice in the basin is estimated at 138,000 acres (Table 3-4). However, that figure may be reduced by 30,000 acres if growth projections are accurate and wetland restoration objectives are met. This reduction in the rice base could make it increasingly difficult to meet the basin's 104,000 acre objective for waterfowl-friendly rice (Figure 4-33).

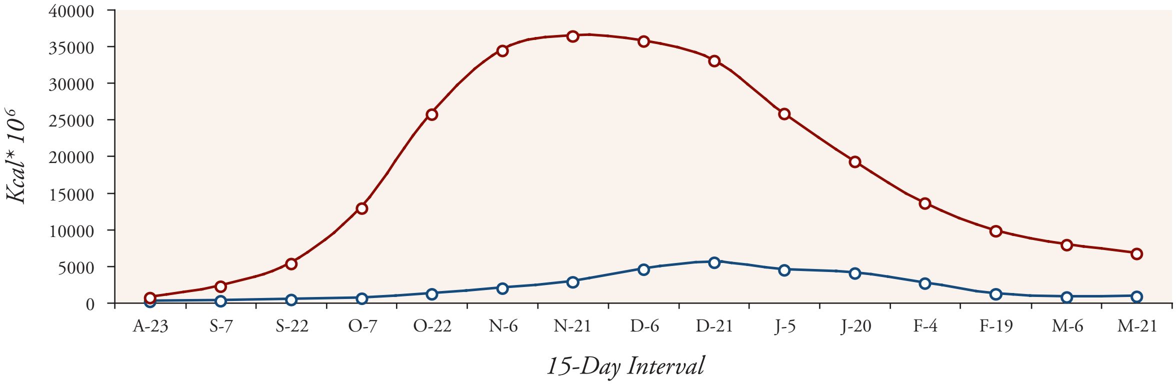


Figure 4-29. Population energy demand (blue) vs. food energy supply (red) for ducks in Butte Basin when duck populations are at NAWMP goals.

Agricultural Easements to Buffer Residential and Urban Growth

Growth projections for Butte Basin indicate that low-density residential housing southeast of Gridley may eventually abut key wetland habitats in the Butte Sink area, especially near Gray Lodge Wildlife Area (Figure 4-34). An easement program northeast of Gray Lodge could buffer the effects of this development.

Conservation Priorities

Conservation objectives for the Butte Basin are summarized in Table 4-17. The information used to prioritize these objectives is provided in Figure 4-35. Food supplies exceed 100% of duck needs and were classified as high, though habitat protection in the basin is low (29%). Progress in meeting wetland needs was rated medium (23,340 acres present vs. 40,340 acres needed; or 58% of need), while 2040 population forecasts for the basin are low at 237,000 people. Although agricultural enhancement objectives are currently met for the basin, the loss of rice habitat to development is projected to be 13,000 acres by 2040. Therefore, meeting wetland restoration objectives may diminish the planted rice base by a further 17,000 acres.

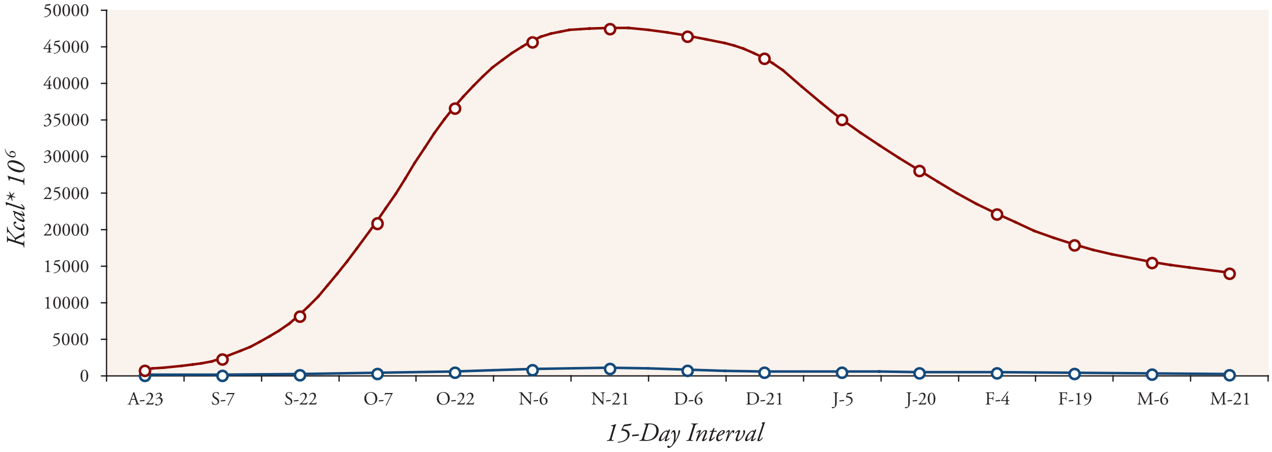


Figure 4-30 (a). Dark goose population energy demand (blue) vs. food energy supplies (red) in Butte Basin.

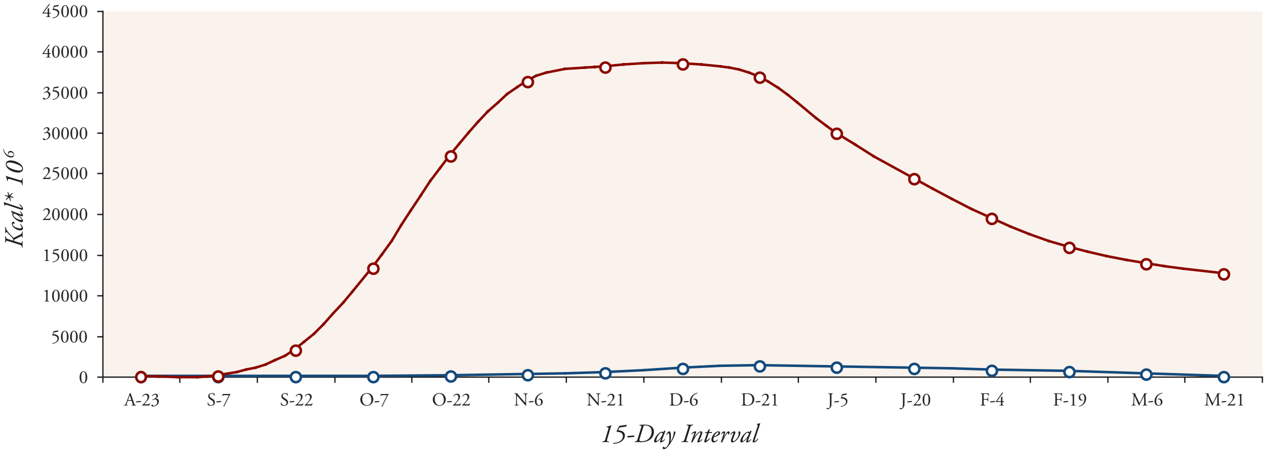
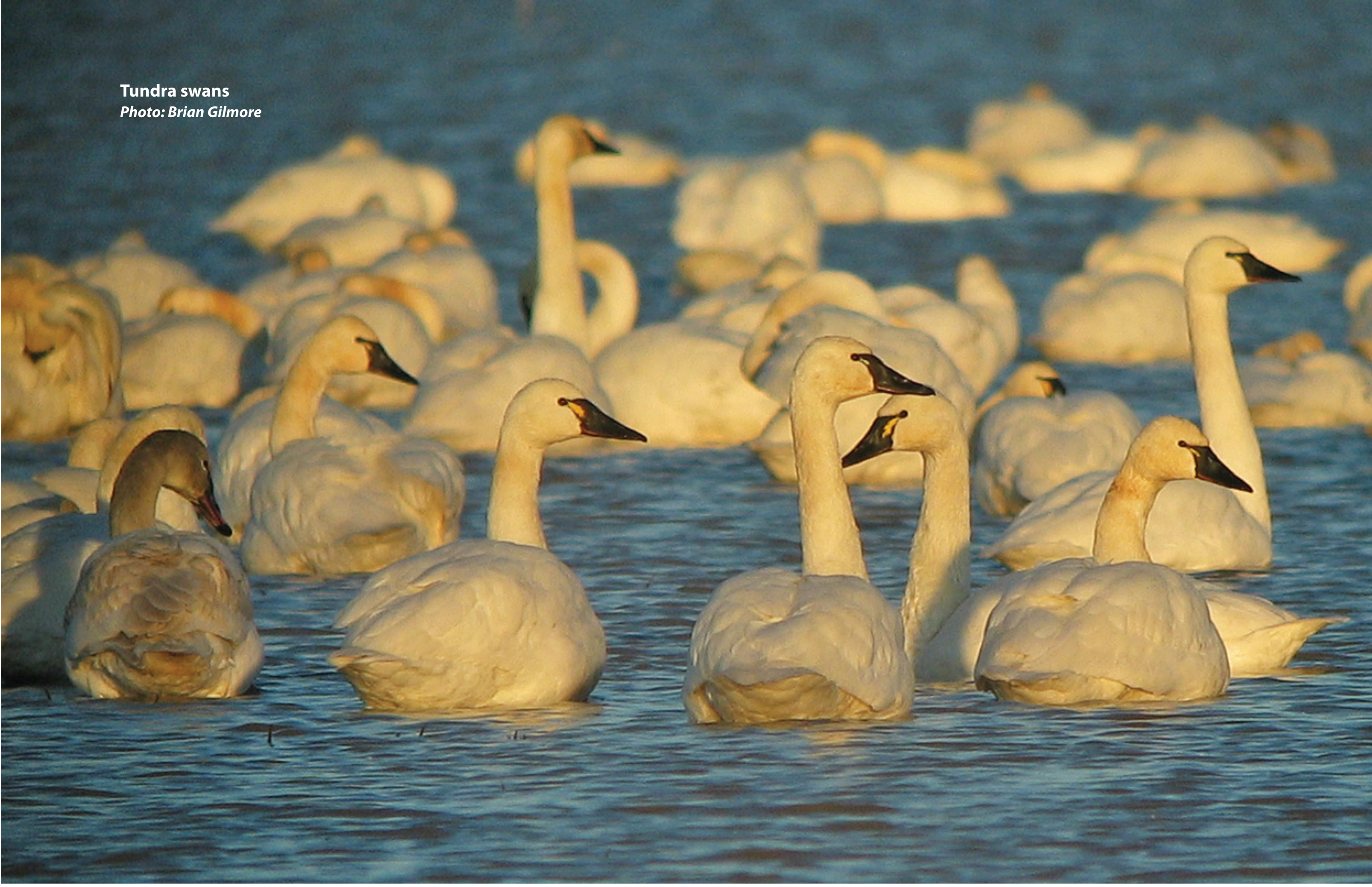


Figure 4-30 (b). White goose population energy demand (blue) vs. food energy supplies (red) in Butte Basin.

Wetland restoration may be a priority for Butte Basin, especially in the short term, as less than 60% of wetland needs have been met for ducks. Although agricultural enhancement objectives are currently met, forecasted declines in the basin's rice acreage may require an easement program that maintains agricultural food supplies.



Tundra swans
Photo: Brian Gilmore

Table 4-14. Annual wetland enhancement objectives for Butte Basin.

Wetlands Acres	*Annual Enhancement Objective (Acres)*[c]
23,340[a]	1,945
25,340	2,112
27,340	2,278
29,340	2,445
31,340	2,612
33,340	2,778
35,340	2,945
37,340	3,112
39,340	3,278
40,340[b]	3,362

[a] Current acres of wetlands in Butte Basin.
[b] Acres of wetlands in Butte Basin when wetland restoration objectives are met.
[c] Annual enhancement objectives reflect progress in meeting wetland restoration objectives for Butte Basin.

Table 4-15. Water needs for seasonal wetlands in Butte Basin.

Month	*Water Need (Acre-Feet)*
JANUARY	8,068
FEBRUARY	8,068
MARCH	8,068
APRIL	0
MAY	40,340
JUNE	0
JULY	0
AUGUST	36,306
SEPTEMBER	80,680
OCTOBER	20,170
NOVEMBER	16,136
DECEMBER	3,227
ANNUAL NEED	**225,904**

Table 4-16. Agricultural enhancement objectives for Butte Basin.

	Waterfowl-friendly Rice[a]	*Flooded Rice*
OBJECTIVE	104,000	62,000
CURRENT	128,513[b]	99,494

[a] Waterfowl-friendly rice includes rice that is flooded and rice that is not deep plowed following harvest but which remains dry.
[b] Planted rice acreage in Butte Basin is estimated at 138,186 acres (Table 3-6). The JV assumes that 128,513 of these acres provide waterfowl-friendly habitat.

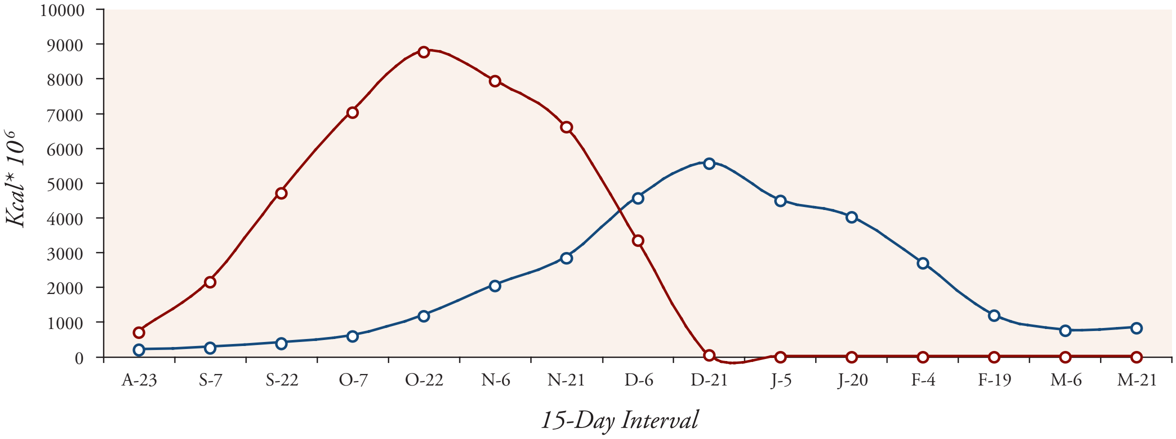


Figure 4-31. Population energy demand (blue) vs. food energy supply (red) for ducks in Butte Basin when no agricultural food sources are available.

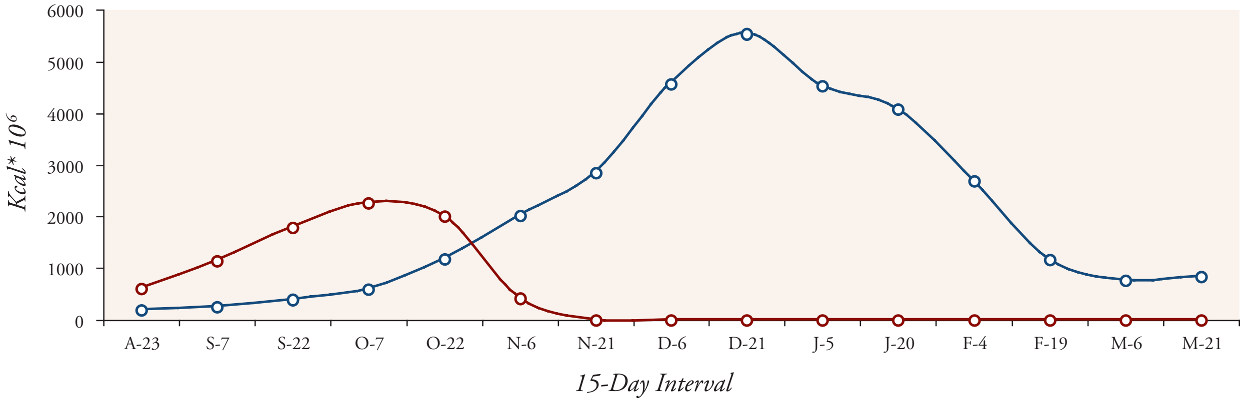
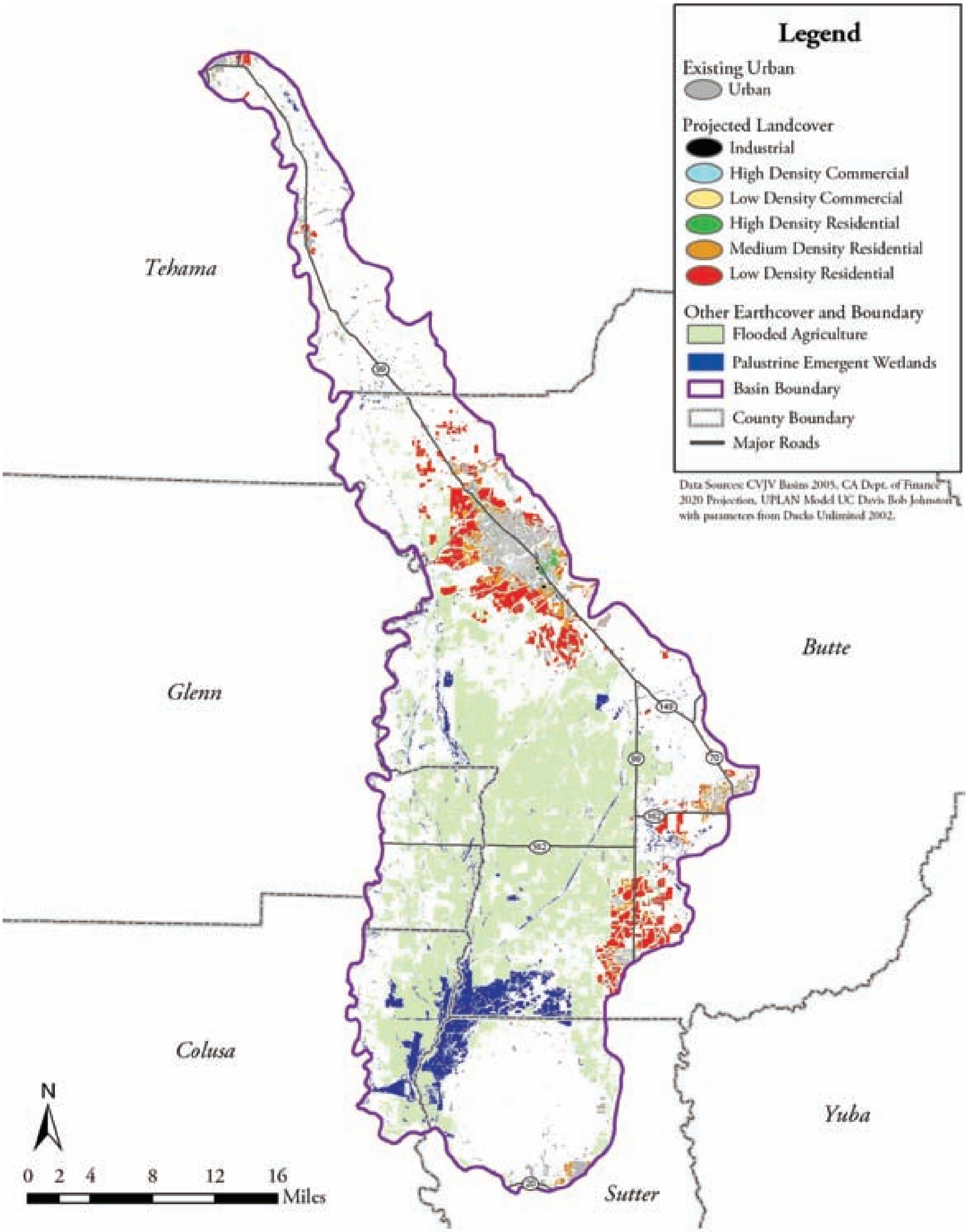


Figure 4-32. Population energy demand (blue) vs. food energy supply (red) for ducks in Butte Basin if ducks are restricted to foraging on public lands.

Figure 4-33. Forecasted changes in rice acreage for Butte Basin compared to the basin's agricultural enhancement objective.



Data Sources: CVJV Basins 2005, CA Dept. of Finance 2020 Projection, UPLAN Model UC Davis Bob Johnston with parameters from Ducks Unlimited 2002.

Figure 4-34. Projected growth in Butte Basin to 2020.

Table 4-17. Conservation objectives for wintering waterfowl in Butte Basin.

Wetland Restoration (Acres)	*Wetland Enhancement (Acres)*	*Water Supplies (Acre-Feet)*	*Agricultural Enhancement (Acres)*	*Type I Agricultural Easements*	*Type II Agricultural Easements*
17,000	3362[a]	225,904[b]	104,000[c] 62,000[d]	Needed	Needed

[a] Annual enhancement objective when the wetland restoration objective is met.

[b] Annual water supply need when the wetland restoration objective is met.

[c] Total acres of rice that must be maintained in a waterfowl-friendly state (includes 62,000 acres that must be flooded). Objective has been met.

[d] Total acres of rice that must be flooded out of the total enhancement objective of 104,000 acres. Objective has been met.

Current Food Supplies	*Habitat Protection*	*Progress in Meeting Wetland Needs*	*Population Growth*	*Loss of Irrigated Farmland*	*Conservation Priorities*
[✓ High]	High	High	High	High	Wetland Restoration
Moderate	Moderate	[✓ Moderate]	Moderate	[✓ Moderate]	Type I Agricultural Easements
Low	[✓ Low]	Low	[✓ Low]	Low	
	Very Low	Very Low	Very Low		

Figure 4-35. Information used to identify conservation objective priorities for Butte Basin.

Colusa Basin

Population Energy Demand vs. Food Energy Supplies: Current Conditions

Population objectives for migrating and wintering waterfowl in Colusa Basin are presented in Figures 4-36 through 4-38. Duck and white goose population objectives are highest during mid-winter, while population objectives for dark geese peak during October. Rice provides the majority of foraging habitat in the basin, though seasonal wetlands exceed 22,000 acres (Table 4-18).

Food supplies for Colusa Basin ducks are adequate in all time periods, with peak supplies occurring in late December (Figure 4-39). Food supplies are also well above the needs of both dark and white geese, and large food surpluses occur in all time periods (Figures 4-40a and 4-40b). Agricultural habitats provide 83% of the food energy available to ducks in the basin. Although loss of these food resources would significantly decrease carrying capacity, there are enough wetland acres to meet duck energy needs through mid-January (Figure 4-41). Public wetlands alone could meet duck needs through late November (Figure 4-42).

Conservation Objectives

Wetland Restoration

The amount of seasonal wetland habitat needed to provide 50% of duck energy needs in Colusa Basin is estimated at 24,396 acres. There are currently 22,396 acres of seasonal wetlands in the basin, leaving a wetland restoration goal of 2,000 acres.

Wetland Enhancement

The annual enhancement objective for existing wetlands in Colusa Basin is 1,866 acres/year. Wetland enhancement objectives increase to 2,033 acres/year when wetland restoration objectives are met for the basin (Table 4-19).

Water Supplies for Seasonal Wetland Management

Annual management of seasonal wetlands in Colusa Basin will require 121,980 acre-feet of water when wetland restoration objectives for the basin have been met. These annual water requirements are further broken down by time period to reflect flooding schedules and summer irrigation needs (Table 4-20).

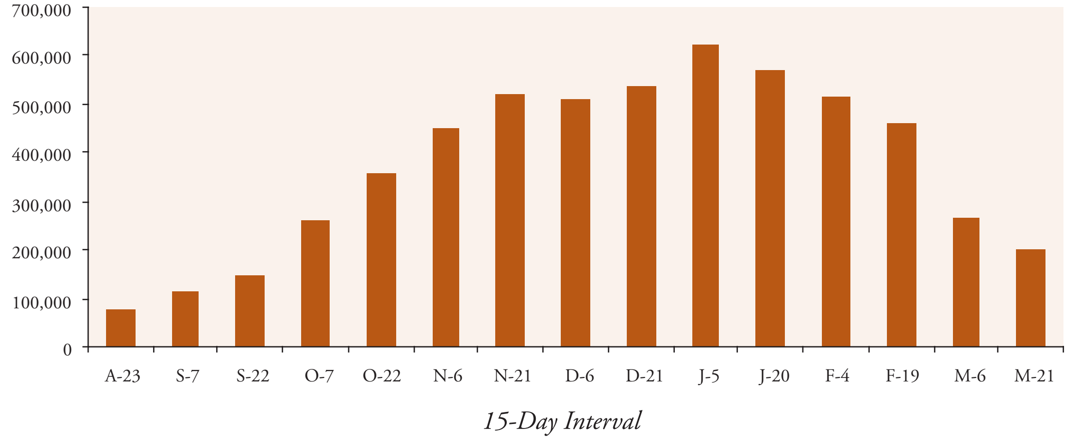


Figure 4-36. Population objectives by 15-day intervals for ducks in Colusa Basin.

Agricultural Enhancement

The agricultural enhancement objective For Colusa Basin is 85,000 acres, all of which is assumed to be rice. This objective represents the amount of rice habitat that must be maintained in a waterfowl-friendly state when wetland restoration objectives have been met for the basin. Forty-five thousand of these acres must be winter-flooded to meet duck energy needs. Waterfowl-friendly rice habitat in the basin is currently estimated at over 183,000 acres with nearly 142,000 of these acres winter-flooded (Table 4-21). Agricultural enhancement objectives are currently exceeded for the basin.

Agricultural Easements for Maintaining Waterfowl Foods (Type I)

Agricultural habitats are extremely important to waterfowl in Colusa Basin and provide 83% of the food energy now available to ducks (Figure 4-41). The loss of irrigated farmland by 2040 is estimated at nearly 17,000 acres or 1.7% of existing lands (Figure 3-15). Approximately 3,300 of these acres are predicted to be rice (Table 3-4). Although most wetland restoration occurs on rice ground, wetland restoration objectives for the basin only total 2,000 acres. Planted rice in the basin is now estimated at 197,000 acres, and the loss of 5,300 acres to development and wetland restoration should not impair the JV's ability to meet its 85,000 acre agricultural enhancement objective (Figure 4-43). As a result, agricultural easements to maintain waterfowl foods may not be needed in the near future.

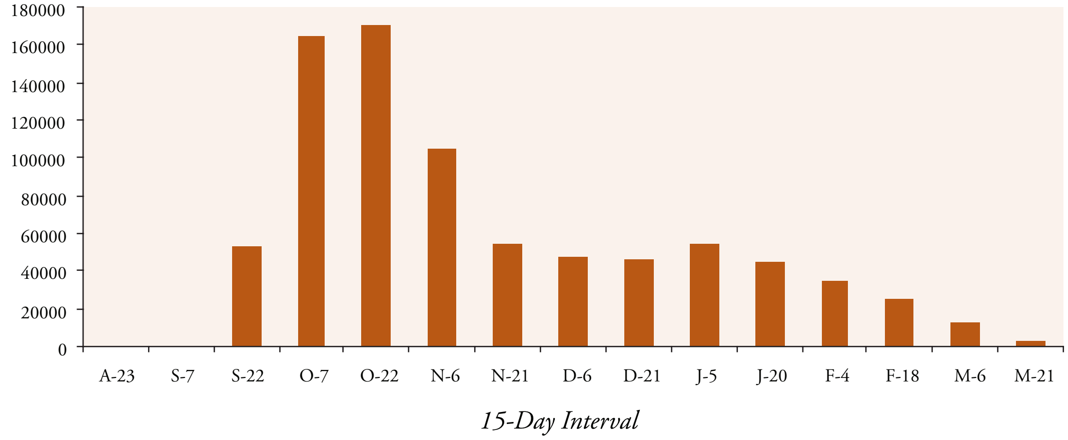


Figure 4-37. Population objectives by 15-day intervals for dark geese in Colusa Basin.

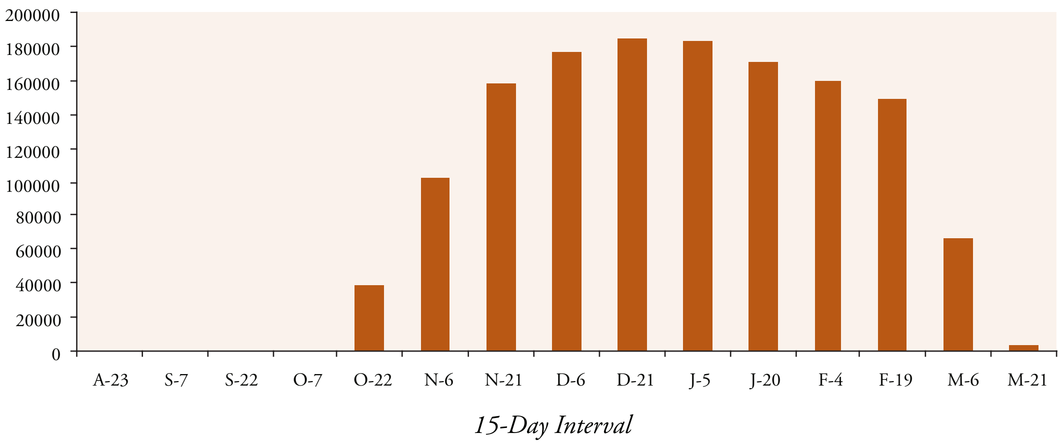


Figure 4-38. Population objectives by 15-day intervals for white geese in Colusa Basin.

Agricultural Easements To Buffer Residential and Urban Growth (Type II)

Growth projections for Colusa Basin indicate that little residential or urban development will occur near existing wetlands (Figure 4-44). As a result, no agricultural easements to buffer growth are suggested for the basin.

Conservation Objective Priorities

Conservation objectives for Colusa Basin are summarized in Table 4-22. The information used to prioritize these objectives is provided in Figure 4-45. Current food supplies exceed 100% of duck needs and were rated high, while habitat protection was rated low (but approaching moderate at 46%). Progress in meeting wetland needs was rated as high (23,396 present vs. 24,396 needed; or 92% of need). Population increase forecasts were very low and loss of rice land was rated as low.

Wetland enhancement was identified as a conservation priority for Colusa Basin. Wetland restoration objectives are nearly met, while agricultural enhancement objectives are exceeded by several thousand acres. A wetland enhancement program in the basin should track when wetlands were last enhanced, and should periodically determine when future maintenance or repair is needed. The JV is developing a database that will include these tracking functions. Wetlands in the basin could be placed on a formal schedule for assessing enhancement needs and this system could be applied to other basins as other conservation objectives are met.

Table 4-18. Foraging habitats (acres) available to wintering waterfowl in Colusa Basin.

Seasonal Wetlands	*Flooded Rice*	*Unflooded Rice*	*Corn*
22,396	141,895	41,386	13,421

Table 4-19. Annual wetland enhancement objectives for Colusa Basin.

Wetland Acres	*Annual Enhancement Objective (Acres)*[c]
22,396[a]	1,866
24,396[b]	2,033

[a] Current acres of wetlands in Colusa Basin.
[b] Acres of wetlands in Colusa Basin when wetland restoration objectives are met.
[c] Annual enhancement objectives reflect progress in meeting wetland restoration objectives for Colusa Basin.

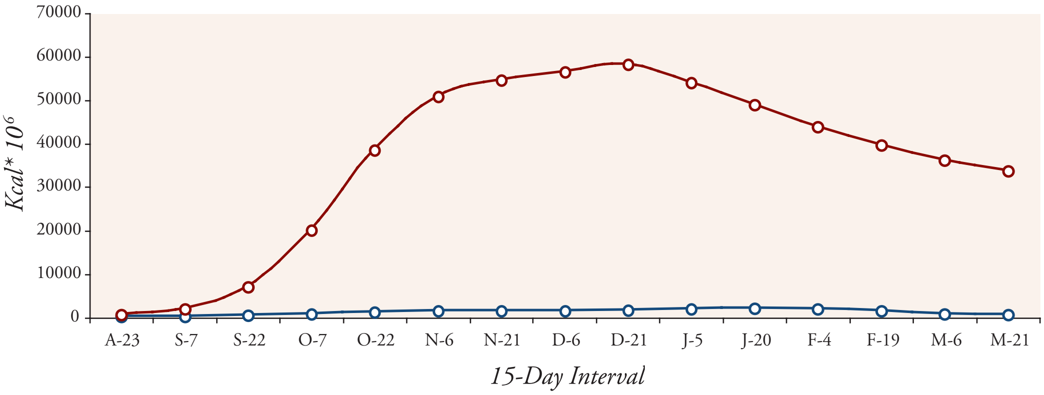


Figure 4-39. Population energy demand (blue) vs. food energy supply (red) for ducks in Colusa Basin when duck populations are at NAWMP goals.

Cinnamon teal
Photo: Dale Garrison, USFWS

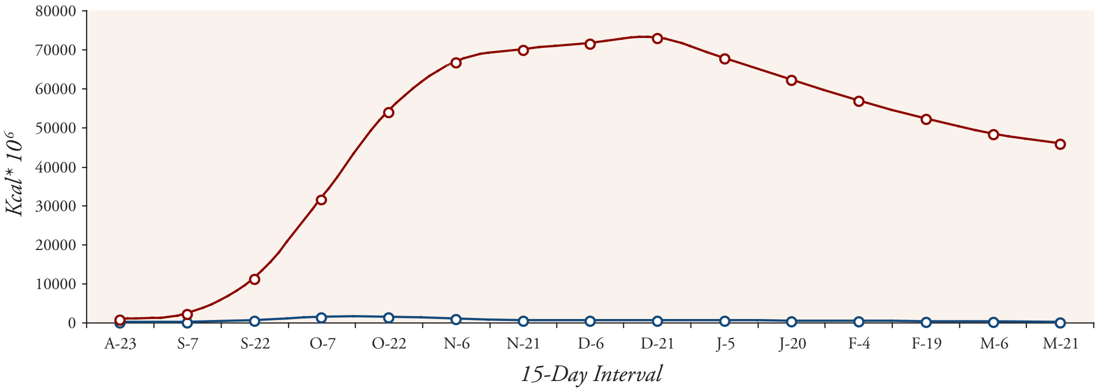


Figure 4-40 (a). Dark goose population energy demand (blue) vs. food energy supplies (red) in Colusa Basin.

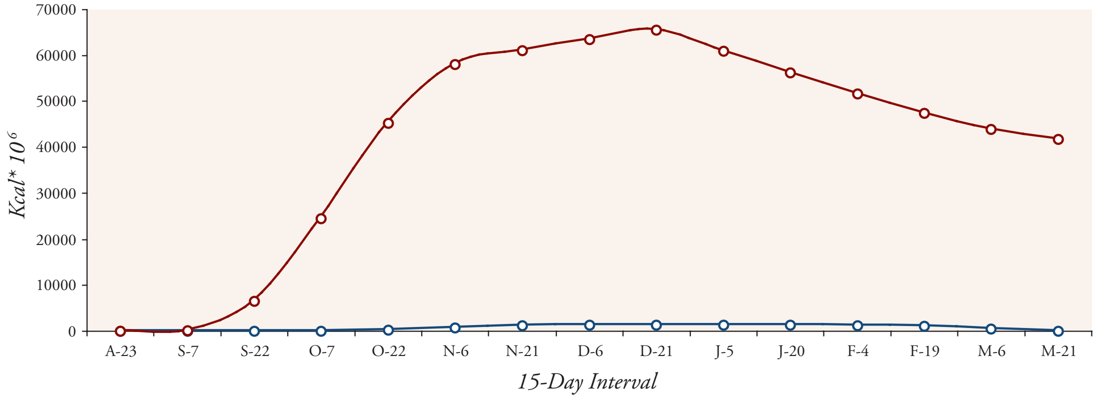


Figure 4-40 (b). White goose population energy demand (blue) vs. food energy supplies (red) in Colusa Basin.

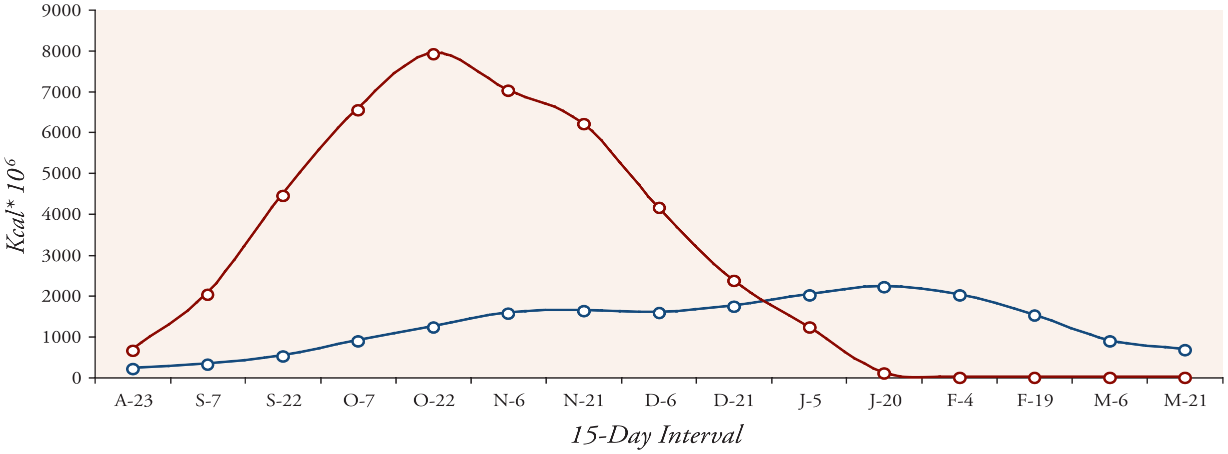


Figure 4-41. Population energy demand (blue) vs. food energy supply (red) for ducks in Colusa Basin if no agricultural foods are available.

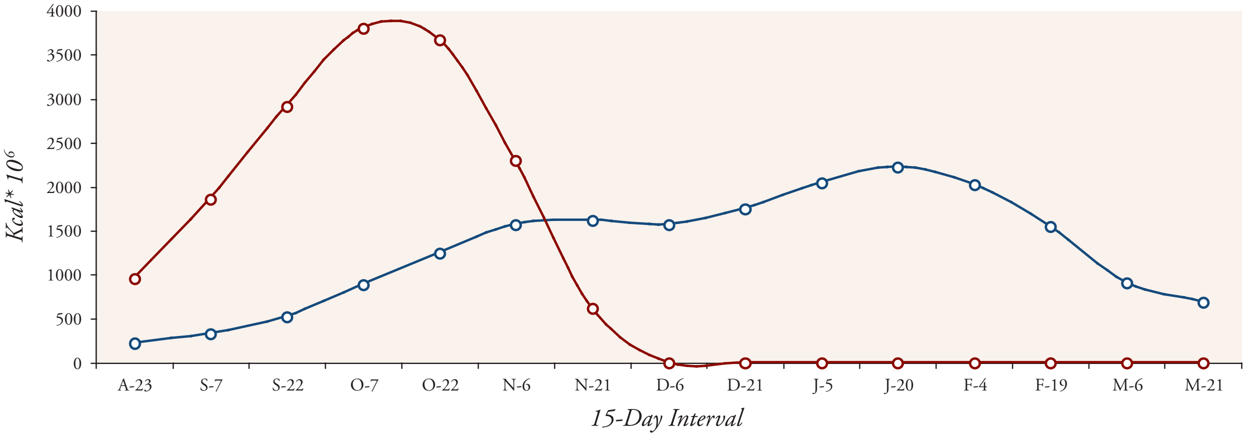


Figure 4-42. Population energy demand (blue) vs. food energy supply (red) for ducks in Colusa Basin if ducks are restricted to foraging on public habitats.

Table 4-20. Water needs for seasonal wetlands in Colusa Basin.

Month	*Water Need (Acre-Feet)*
January	4,879
February	4,879
March	4,879
April	0
May	17,077
June	0
July	0
August	21,956
September	43,913
October	9,758
November	9,758
December	4,879
Annual Need	**121,980**

Table 4-21. Agricultural enhancement objectives for Colusa Basin.

	Waterfowl-friendly Rice[a]	*Flooded Rice*
Objective	85,000	45,000
Current	183,281[b]	141,895

[a] Waterfowl-friendly rice includes rice that is flooded and rice that is not deep plowed following harvest but which remains dry.

[b] Planted rice acreage in Colusa Basin is estimated at 197,076 acres (Table 3-6). The JV assumes that 183,281 of these acres provide waterfowl-friendly habitat.


Greater white-fronted geese
Photo: Dale Garrison, USFWS

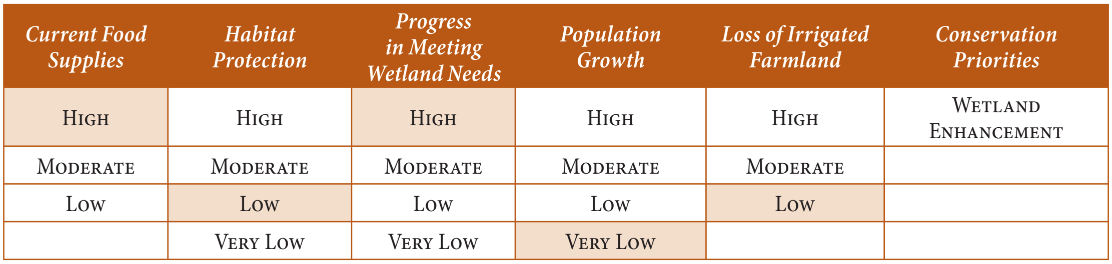

Waterfowl hunting
Photo: USFWS

Figure 4-43. Forecasted changes in rice acreage for Colusa Basin compared to the basin's agricultural enhancement objective.

Table 4-22. Conservation objectives for wintering waterfowl in Colusa Basin.

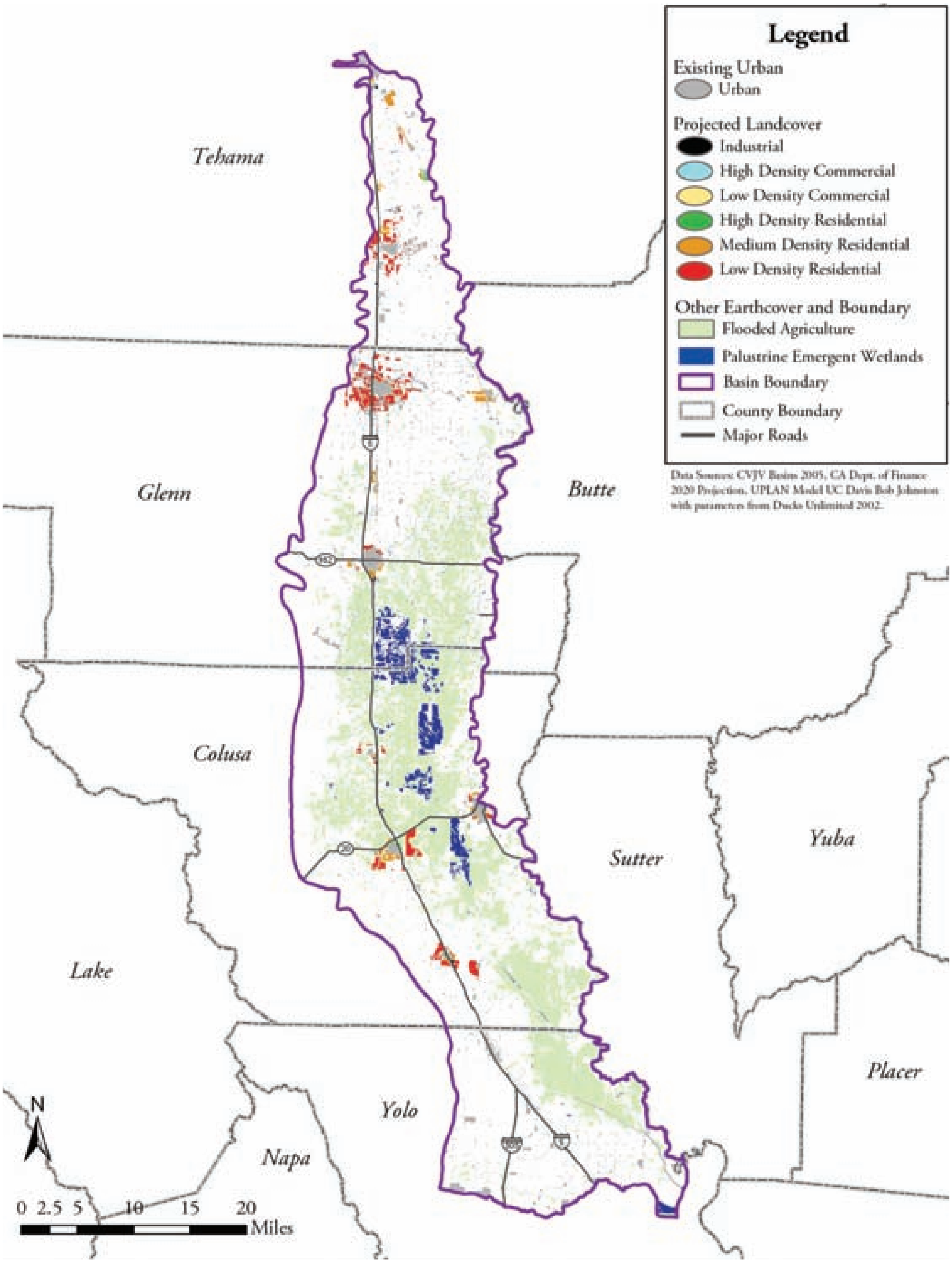
Wetland Restoration (Acres)	*Wetland Enhancement (Acres)*	*Water Supplies (Acre-Feet)*	*Agricultural Enhancement (Acres)*	*Type I Agricultural Easements*	*Type II Agricultural Easements*
2,000	2,033[a]	121,980[b]	85,000[c] 45,000[d]	None	None

[a] *Annual enhancement objective when the wetland restoration objective is met.*
[b] *Annual water supply need when the wetland restoration objective is met.*
[c] *Total acres of rice that must be enhanced (includes 45,000 acres that must be flooded). Objective has been met.*
[d] *Total acres of rice that must be flooded out of the total enhancement objective of 85,000 acres. Objective has been met.*



Current Food Supplies	*Habitat Protection*	*Progress in Meeting Wetland Needs*	*Population Growth*	*Loss of Irrigated Farmland*	*Conservation Priorities*
High	High	High	High	High	Wetland Enhancement
Moderate	Moderate	Moderate	Moderate	Moderate	
Low	Low	Low	Low	Low	
	Very Low	Very Low	Very Low		

Figure 4-45. Information used to identify conservation objective priorities for Colusa Basin.



Data Sources: CVJV Basins 2005, CA Dept. of Finance 2020 Projection, UPLAN Model UC Davis Bob Johnston with parameters from Ducks Unlimited 2002.

Figure 4-44. Projected growth in Colusa Basin to 2020.

Delta Basin

Population Energy Demand vs. Food Energy Supplies: Current Conditions

Population objectives for wintering waterfowl in Delta Basin are presented in Figures 4-46 through 4-48. Duck population objectives are highest in late December and early January, while population objectives for dark and white geese peak during December. Corn provides the majority of foraging habitat in the basin, while seasonal wetlands total less than 6,500 acres (Table 4-23).

Table 4-23. Foraging habitats available to wintering waterfowl in Delta Basin.

Habitat Type	*Acres*
SEASONAL WETLANDS	6,349
FLOODED CORN	29,488
UNFLOODED CORN	29,488
FLOODED RICE	1,399
UNFLOODED RICE	294

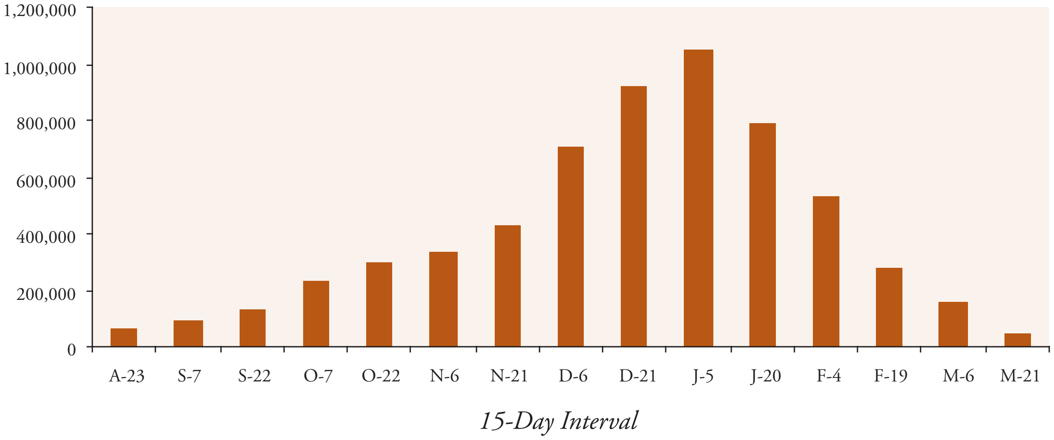


Figure 4-46. Population objectives by 15-day intervals for ducks in Delta Basin.

Duck food supplies in Delta Basin are adequate from fall through spring with peak supplies occurring in early November. Duck energy needs remain high from late November through early February (Figure 4-48). Food supplies are also adequate for dark and white geese with large food surpluses occurring in most time periods (Figure 4-49).

Agricultural habitats provide 81% of the food energy available to ducks in the basin. Loss of these agricultural foods would significantly decrease duck carrying capacity, as food supplies are exhausted by mid-November if ducks are restricted to foraging in wetlands (Figure 4-50). Public wetlands alone can only meet duck energy needs through early October (Figure 4-51).

Conservation Objectives

Wetland Restoration

The amount of seasonal wetland habitat required to meet 50% of duck energy needs in Delta Basin is estimated at 25,349 acres. There are currently 6,349 acres of seasonal wetlands in the basin, leaving a wetland restoration goal of 19,000 acres.

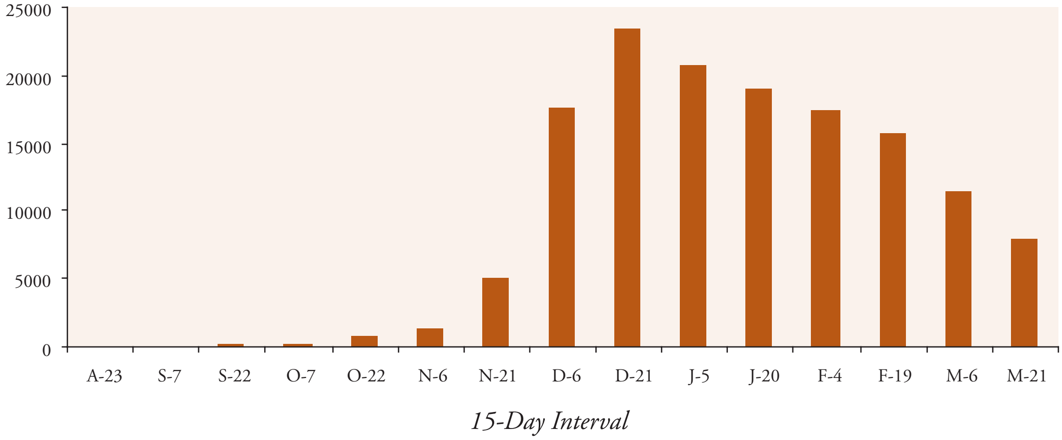


Figure 4-47. Population objectives by 15-day intervals for dark geese in Delta Basin.

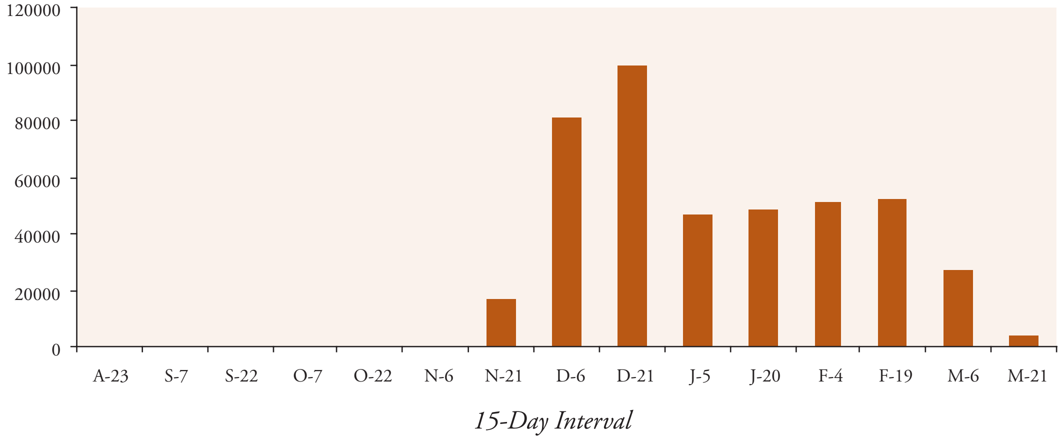


Figure 4-48. Population objectives by 15-day intervals for white geese in Delta Basin.

Wetland Enhancement

The annual enhancement objective for existing wetlands in Delta Basin is 529 acres/year. Wetland enhancement objectives increase to 2,112 acres/year when wetland restoration objectives are met for the basin (Table 4-24).

Water Supplies for Seasonal Wetland Management

Annual management of seasonal wetlands in Delta Basin will require 120,408 acre-feet of water when wetland restoration objectives for the basin are met. These annual water requirements are further broken down by time period to reflect flooding schedules and summer irrigation needs (Table 4-25).

Agricultural Enhancement

The agricultural enhancement objective for Delta Basin is 23,000 acres, all of which is assumed to be corn. This objective represents the amount of corn habitat that must be maintained in a waterfowl-friendly state when wetland restoration objectives have been met for the basin. Corn habitat in the basin is currently estimated at 58,976 acres (4-26). Agricultural enhancement objectives are currently exceeded for the basin.

Consumnes River Preserve
Photo: Ducks Unlimited

Agricultural Easements for Maintaining Waterfowl Foods

The loss of irrigated farmland in the Delta Basin is estimated at nearly 180,000 acres or 18.3% of existing lands by 2040 (Figure 3-15). Much of this loss will result from residential and urban growth along the I-99 corridor from Manteca to Sacramento (Figure4-53). Although most of this agricultural land may not be used by waterfowl, the ongoing urbanization of Brentwood, Oakley, and Discovery Bay does threaten agricultural areas that have been traditionally important to ducks and geese. Similar growth around Tracy, Lathrop, and Stockton also threaten agricultural lands used by waterfowl (B. Burkholder, California Department of Fish and Game, personal communication). These land use projections suggest that Type I agricultural easements may be needed in the basin, especially in the southern portion of the Sacramento-San Joaquin River Delta.

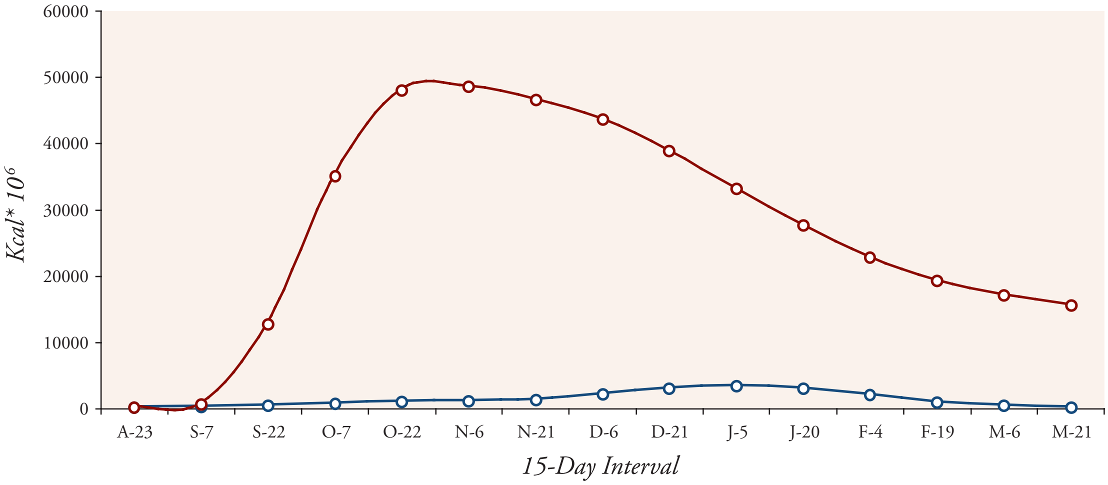


Figure 4-49. Population energy demand (blue) vs. food energy supply (red) for ducks in Delta Basin when duck populations are at NAWMP goals.

Agricultural Easements to Buffer Urban Growth

Many wetlands in the Delta Basin lie west of the I-99 corridor and outside areas of intensive growth. However, development in the cities of Elk Grove and Galt has continued to move south and west. The Stone Lakes National Wildlife Refuge and a portion of the Cosumnes River Preserve are located in the City of Elk Grove Planning Area for future development, while Galt continues to expand west and north. An easement program that buffers existing wetlands from growth of Elk Grove and Galt may be needed.

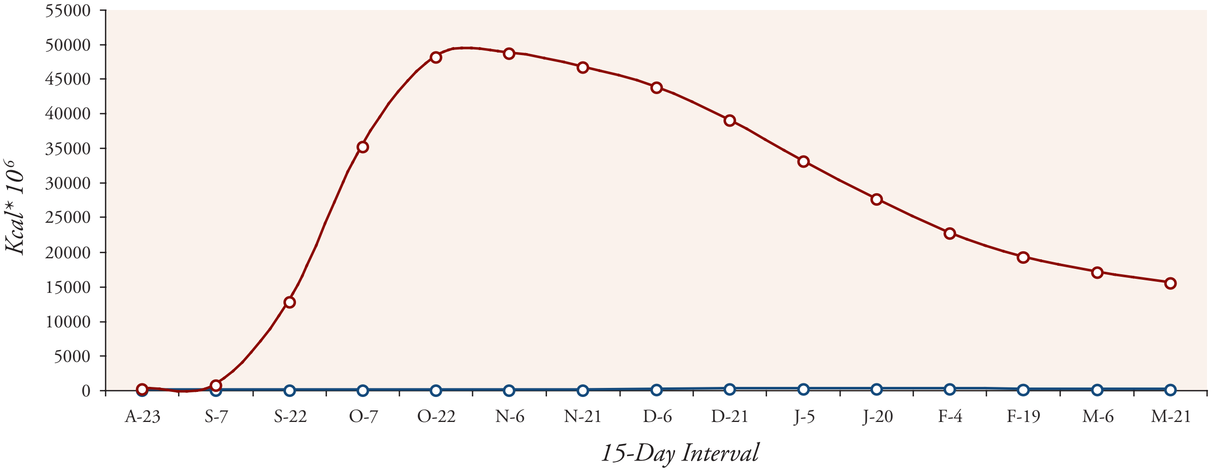


Figure 4-50 (a). Dark goose population energy demand (blue) vs. food energy supplies (red) in Delta Basin.

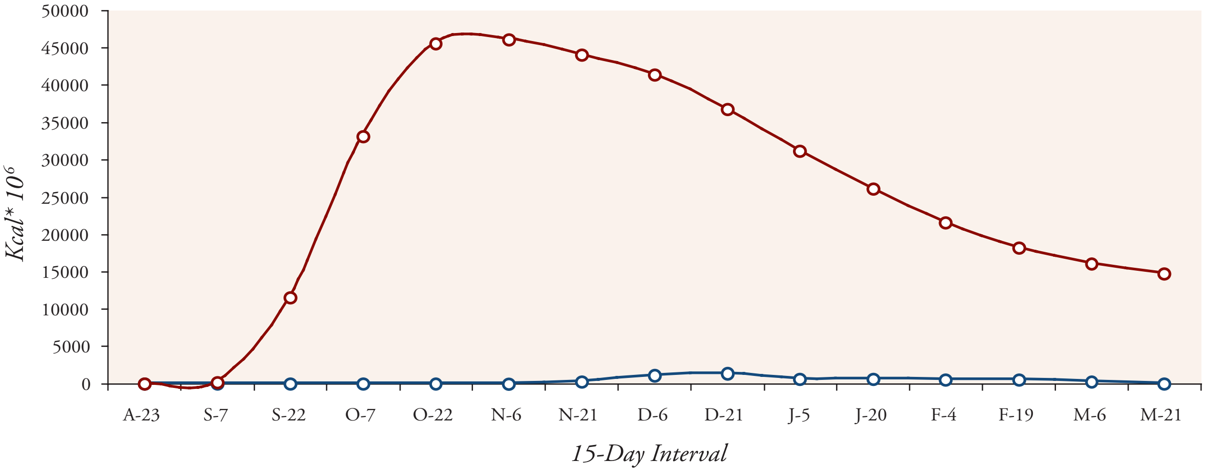


Figure 4-50 (b). White goose population energy demand (blue) vs. food energy supplies (red) in Delta Basin.

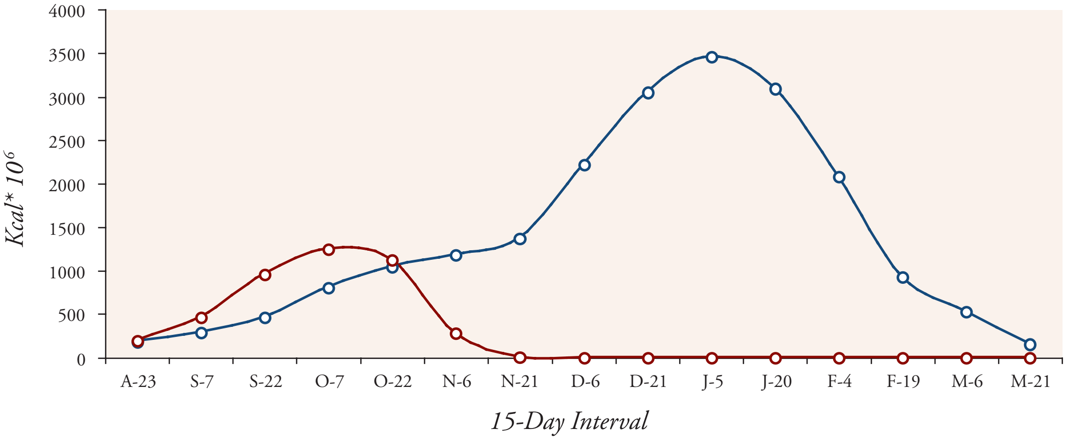


Figure 4-51. Population energy demand (blue) vs. food energy supplies (red) for ducks in Delta Basin when no agricultural food sources are available.

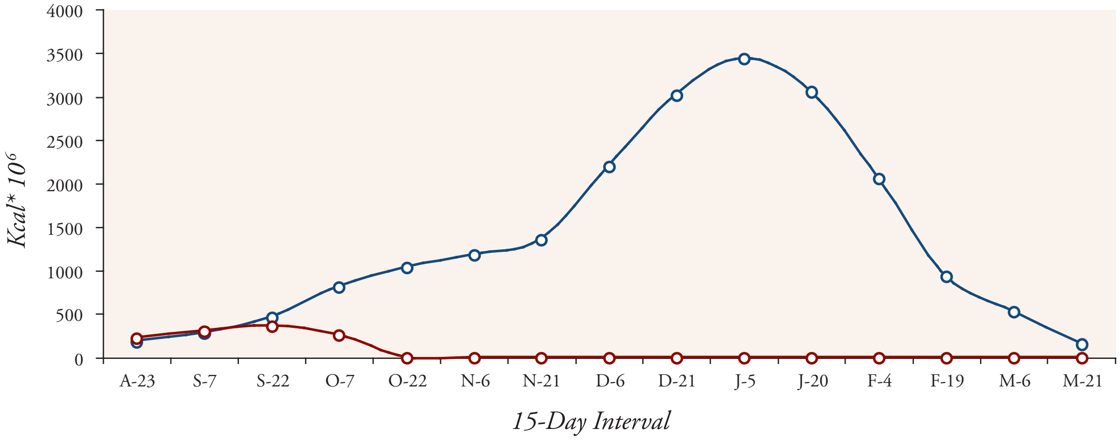
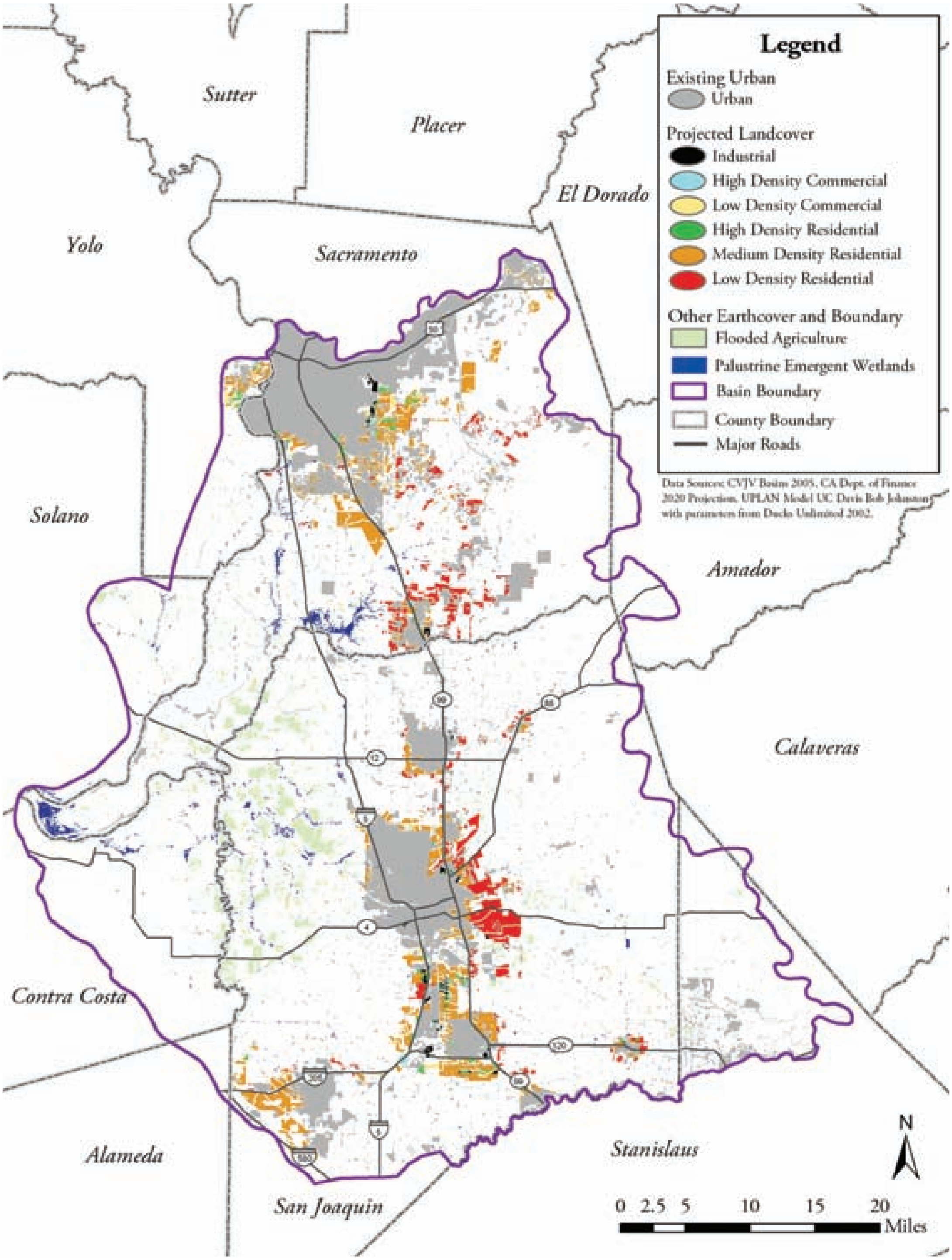
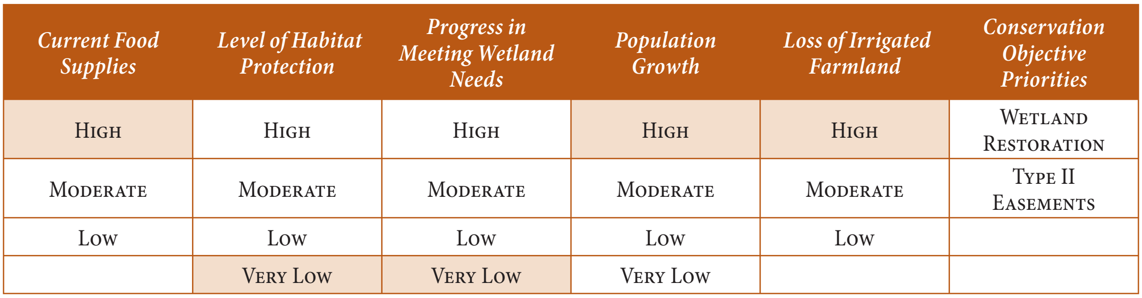


Figure 4-52. Population energy demand (blue) vs. food energy supplies (red) for ducks in Delta Basin if ducks are restricted to foraging on public lands.



Data Sources: CVJV Basins 2005, CA Dept. of Finance 2020 Projection, UPLAN Model UC Davis Bob Johnston with parameters from Ducks Unlimited 2002.

Figure 4-53. Projected growth in Delta Basin to 2020.



Current Food Supplies	Level of Habitat Protection	Progress in Meeting Wetland Needs	Population Growth	Loss of Irrigated Farmland	Conservation Objective Priorities
High	High	High	High	High	Wetland Restoration
Moderate	Moderate	Moderate	Moderate	Moderate	Type II Easements
Low	Low	Low	Low	Low	
	Very Low	Very Low	Very Low		

Figure 4-54. Information used to identify conservation objective priorities for Delta Basin.

Table 4-24. Annual wetland enhancement objectives for Delta Basin.

Wetland Acres	Annual Enhancement Objective (Acres)[c]
6,349[a]	529
8,349	696
10,349	862
12,349	1,029
14,349	1,196
16,349	1,362
18,349	1,529
20,349	1,696
22,349	1,862
24,349	2,029
25,349[b]	2,112

[a] *Current acres of wetlands in Delta Basin.*
[b] *Acres of wetlands in Delta Basin when wetland restoration objectives are met.*
[c] *Annual enhancement objectives reflect progress in meeting wetland restoration objectives for Delta Basin.*

Table 4-25. Water needs for seasonal wetlands in Delta Basin when wetland restoration objective is met.

Month	Water Need (Acre-Feet)
January	5,070
February	5,070
March	5,070
April	6,337
May	0
June	0
July	0
August	22,814
September	50,698
October	10,140
November	10,140
December	5,070
Annual Need	**120,408**

Conservation Objective Priorities

Conservation objectives for Delta Basin are summarized in Table 4-27. The information used to identify conservation objective priorities for the basin is presented in Figure 4-54. Food supplies exceed 100% of duck needs and were rated high. Habitat protection is very low at 13%, as is progress in meeting wetland needs (6,349 acres present vs. 25,349 needed or 25% of need). Population growth and loss of irrigated farmland were rated high for the basin. Wetland restoration is a priority for the basin as only 25% of seasonal wetland needs have been met. Agricultural easements that buffer existing wetlands from growth may also be a conservation priority.

Table 4-26. Agricultural enhancement objective for Delta Basin.

	Total Corn	Flooded Corn
Objective	23,000	undetermined
Current	58,976	29,488

Table 4-28. Foraging habitats available to wintering waterfowl in San Joaquin Basin.

Habitat Type	Acres
Seasonal Wetlands	61,013

Table 4-27. Conservation objectives for wintering waterfowl in Delta Basin.

Wetland Restoration (Acres)	Wetland Enhancement (Acres)	Water Supplies (Acre-Feet)	Agricultural Enhancement (Acres)	Type I Agricultural Easements	Type II Agricultural Easements
19,000	2,112[A]	120,408[B]	23,000	Needed	Needed

[a] *Annual enhancement objective when the wetland restoration objective is met.*
[b] *Annual water supply need when the wetland restoration objective is met.*

San Joaquin Basin

Population Energy Demand vs. Food Energy Supplies: Current Conditions

Population objectives for migrating and wintering waterfowl in San Joaquin Basin are presented in Figures 4-55 through 4-57. Duck population objectives are highest from mid-October through early November, while population objectives for dark and white geese peak during late winter. Wetlands are assumed to provide all the food resources available to ducks, because post-harvest treatment of most rice and corn in the basin makes these foods unavailable to waterfowl (Table 4-28).

The energetic model predicts that food supplies for ducks in the San Joaquin Basin are completely depleted by early February (Figure 4-58). This result assumes that ducks are at NAWMP goals. However, pintails make up 46% of the Central Valley's duck population objective, and pintails have been well below NAWMP goals since the early 1980s. Therefore, it is unlikely that duck food supplies are now exhausted prior to spring migration. Duck use of the basin generally tracks food supplies. Peak populations occur during periods of maximum food energy, while declines in duck numbers track the depletion of food resources. Ducks in the basin are assumed to rely exclusively on wetlands so the loss of agriculture has no affect on duck carrying capacity. However, 75% of all managed wetlands in the basin are privately owned and public habitats can only sustain duck populations through mid-October (Figure 4-59).

The JV did not model food supplies for geese in the San Joaquin Basin because of uncertainty over the type and amount of foraging habitat available to geese. However, some food resources are clearly available given goose population estimates for the basin. For example, management efforts in the San Luis NWR complex include providing corn for Aleutian and Ross's geese, as well as managing grasslands for the benefit of geese (M. Miller, U.S. Geological Survey, personal communication). Future JV planning efforts will better define the food resources available to geese in the San Joaquin Basin.

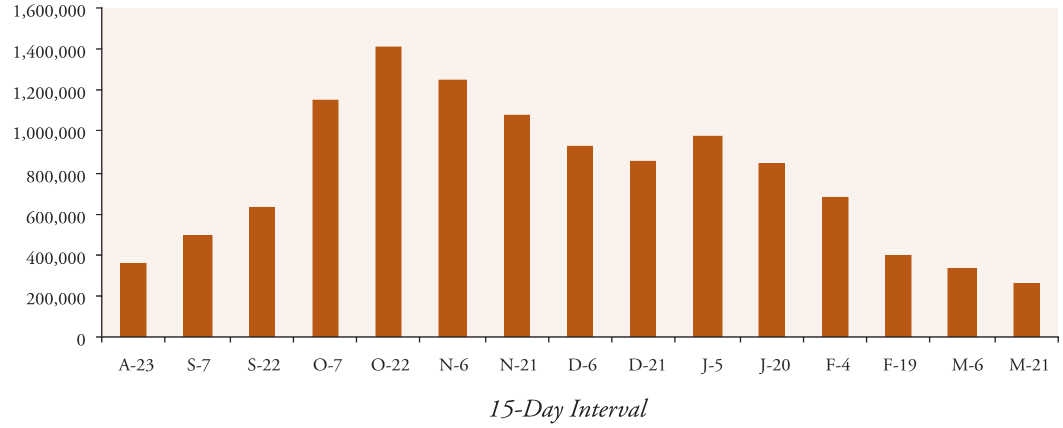


Figure 4-55. Population objectives by 15-day intervals for ducks in San Joaquin Basin.

Conservation Objectives

Wetland Restoration

Wetland restoration objectives for San Joaquin Basin assume that 100% of duck energy needs are met from wetland food sources. The amount of seasonal wetland habitat needed to provide this food is estimated at 81,013 acres. There are currently 61,013 acres of seasonal wetlands in the basin leaving a wetland restoration goal of 20,000 acres.

Wetland Enhancement

The annual enhancement objective for existing wetlands in San Joaquin Basin is 5,084 acres/year. Wetland enhancement objectives increase to 6,751 acres/year when wetland restoration objectives are met for the basin (Table 4-29).

Water Supplies for Wetland Management

Annual management of seasonal wetlands in San Joaquin Basin will require 441,521 acre-feet of water when wetland restoration objectives for the basin have been met. These annual water requirements are further broken down by time period to reflect flooding schedules and summer irrigation needs (Table 4-30).

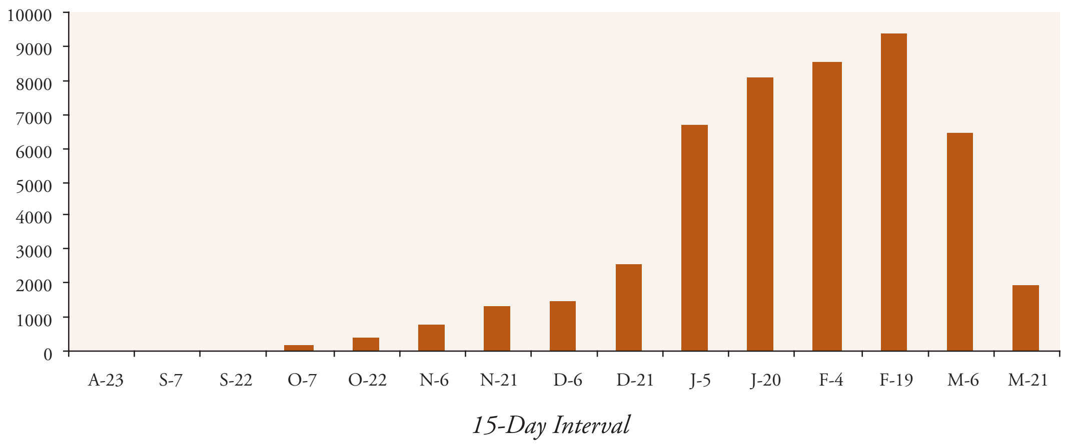


Figure 4-56. Population objectives by 15-day intervals for dark geese in San Joaquin Basin.

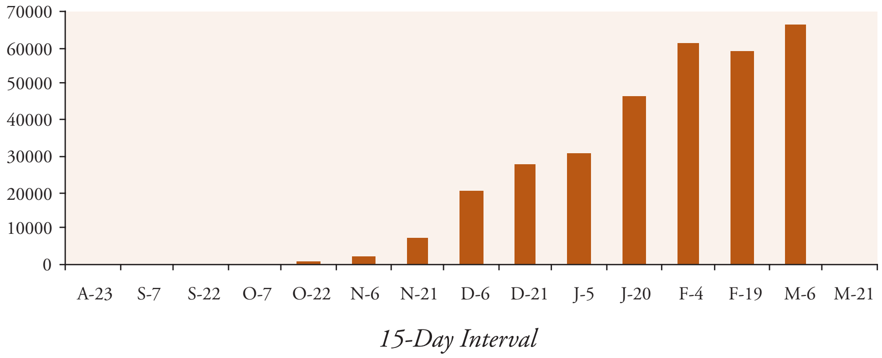


Figure 4-57. Population objectives by 15-day intervals for white geese in San Joaquin Basin.

Agricultural Enhancement

There is no agricultural enhancement objective for San Joaquin Basin, because wetlands provide the overwhelming majority of food sources.

Agricultural Easements for Maintaining Waterfowl Foods (Type I)

No easement areas of this type are proposed for San Joaquin Basin, because wetlands provide the overwhelming majority of food sources.

Agricultural Easements to Buffer Residential and Urban Growth (Type II)

Human population projections for San Joaquin Basin are the second highest in the Central Valley (Figure 3-15). Growth is projected from several directions towards public and private wetlands in the Grasslands, but is especially prevalent along the Interstate 5 corridor and State Highways 165, 152, and 33 (Figure 4-60). Easements that buffer wetlands from this growth should be considered.

Table 4-29. Annual wetland enhancement objectives for San Joaquin Basin.

Wetland Acres	*Annual Enhancement Objective (Acres)*[c]
61,013[a]	5,084
63,013	5,251
65,013	5,418
67,013	5,584
69,013	5,751
71,013	5,918
73,013	6,084
75,013	6,251
77,013	6,418
79,013	6,584
81,013[b]	6,751

[a] *Current acres of wetlands in San Joaquin Basin.*
[b] *Acres of wetlands in San Joaquin Basin when wetland restoration objectives are met.*
[c] *Annual enhancement objectives reflect progress in meeting wetland restoration objectives for San Joaquin Basin.*

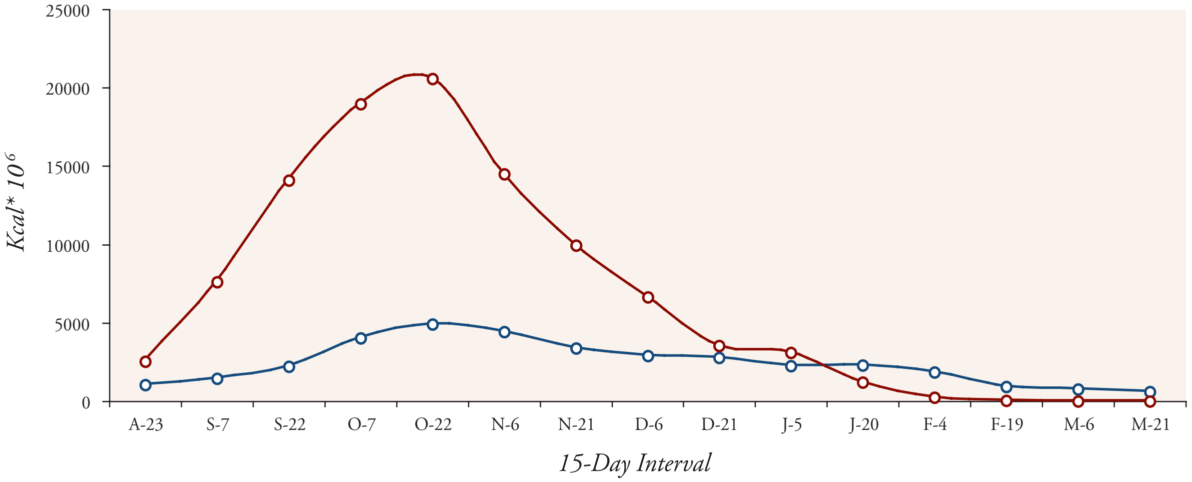


Figure 4-58. Population energy demand (blue) vs. food energy supplies (red) for ducks in San Joaquin Basin when duck populations are at NAWMP goals.

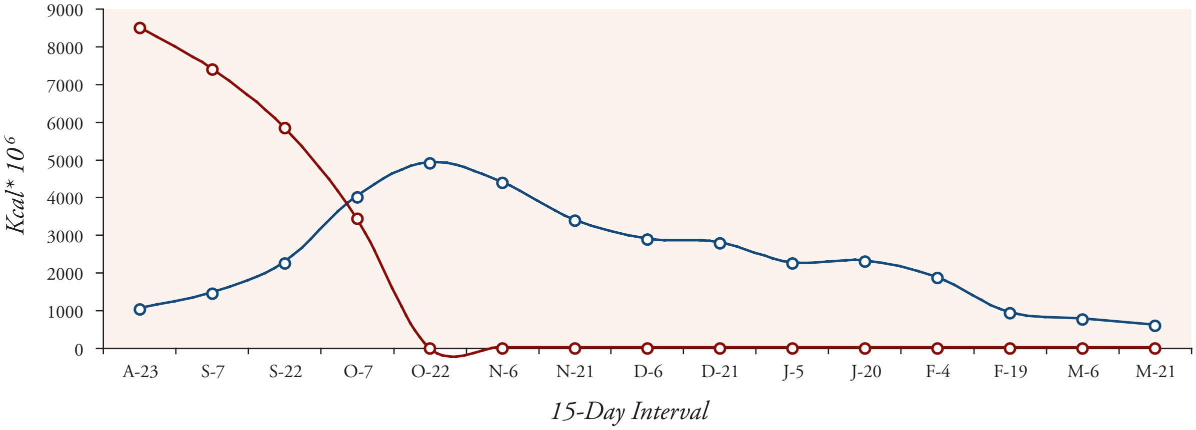


Figure 4-59. Population energy demand (blue) vs. food energy supply (red) for ducks in San Joaquin Basin if ducks are restricted to foraging on public lands.

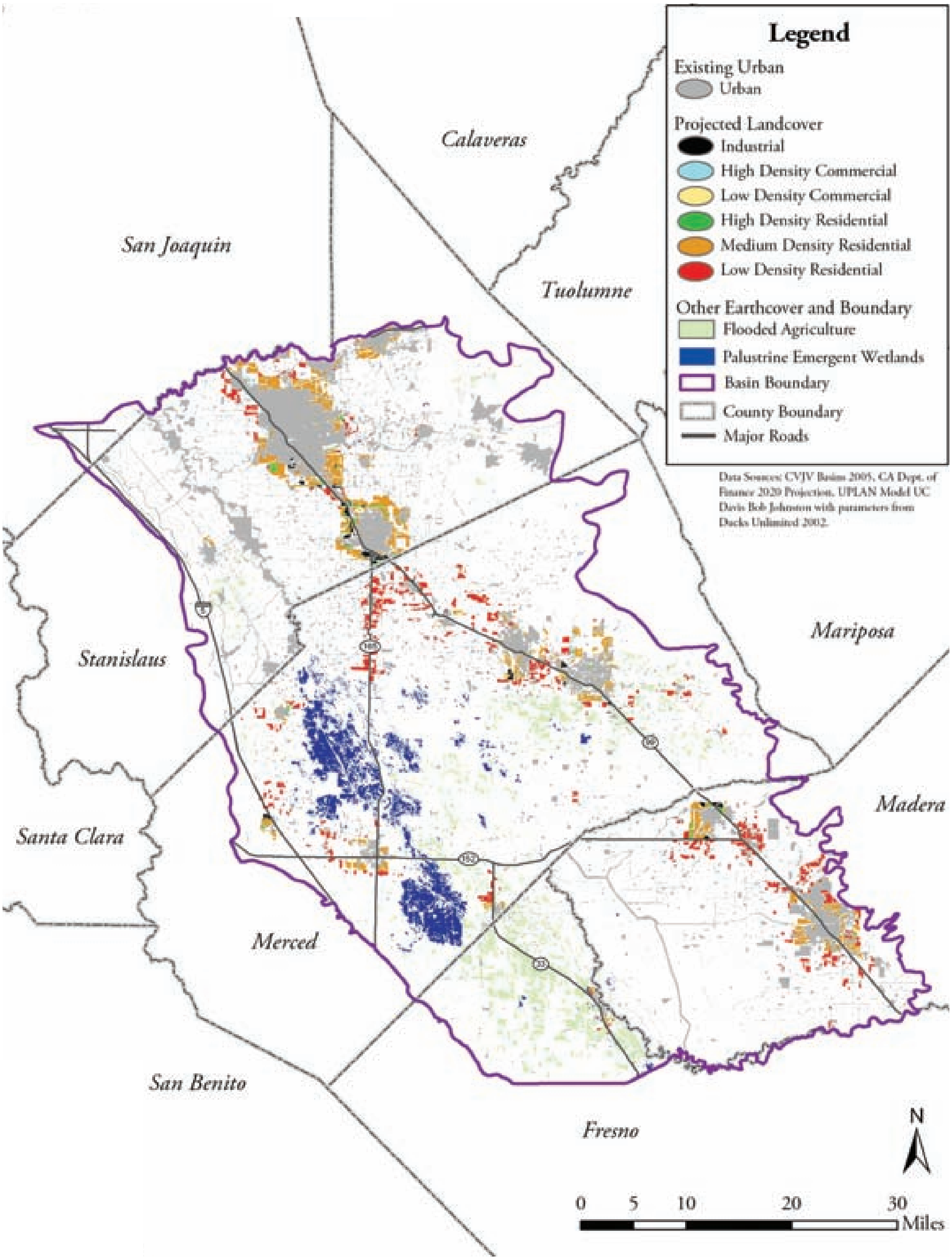
Conservation Objective Priorities

Conservation objectives for San Joaquin Basin are summarized in Table 4-31. The information used to prioritize these objectives is provided in Figure 4-61. Current food supplies are moderate because only 75% of duck needs are met by existing food resources when duck populations are at NAWMP goals. Habitat protection was also rated moderate at 75% (high ratings begin at 76%), as was progress in meeting wetland needs (61,013 present vs. 81,013 needed or 75% of need). High ratings in this category begin at 76%. Population growth and loss of irrigated farmland are both moderate for the basin.

Wetland restoration is a priority for San Joaquin Basin, because only 75% of the wetlands needed by ducks exist. However progress in meeting wetland needs is high which may allow increased emphasis on wetland enhancement. Finally, agricultural easement programs that buffer wetlands from growth should be considered.

Table 4-30. Water needs for seasonal wetlands in San Joaquin Basin when wetland restoration objective is met.

Month	*Water Need (Acre-Feet)*
January	16,203
February	16,203
March	16,203
April	0
May	64,810
June	20,253
July	0
August	64,810
September	162,026
October	32,405
November	32,405
December	16,203
Annual Need	441,521



Data Sources: CVJV Basins 2005, CA Dept. of Finance 2020 Projection, UPLAN Model UC Davis Bob Johnston with parameters from Ducks Unlimited 2002.

Figure 4-60. Projected growth in San Joaquin Basin to 2020.

Table 4-31. Conservation objectives for wintering waterfowl in San Joaquin Basin

Wetland Restoration (Acres)	*Wetland Enhancement (Acres)*	*Water Supplies (Acre-Feet)*	*Agricultural Enhancement (Acres)*	*Type I Agricultural Easements*	*Type II Agricultural Easements*
20,000	6,751[a]	441,521[b]	None	None	Needed

[a] Annual enhancement objective when the wetland restoration objective is met.
[b] Annual water supply need when the wetland restoration objective is met.

Current Food Supplies	*Habitat Protection*	*Progress in Meeting Wetland Need*	*Population Growth*	*Loss of Irrigated Farmland*	*Conservation Objective Priorities*
High	High	High	High	High	Wetland Restoration
Moderate	Moderate	Moderate	Moderate	Moderate	Wetland Enhancement
Low	Low	Low	Low	Low	Type II Agricultural Easements
	Very Low	Very Low	Very Low		

Figure 4-61. Information used to identify conservation objective priorities for San Joaquin Basin.

Sutter Basin

Population Energy Demand vs. Food Energy Supplies: Current Conditions

Population objectives for migrating and wintering waterfowl in Sutter Basin are presented in Figures 4-62 through 4-64. Duck population objectives are highest in December, while population objectives for dark and white geese peak during January and February respectively. Rice provides the majority of foraging habitat in the basin, while seasonal wetlands total less than 2,000 acres (Table 4-32).

Food supplies for ducks in Sutter Basin are adequate in all time periods with peak supplies occurring in December (Figure 4-65). Food supplies for dark and white geese also peak in December and are well above population needs from fall through spring (Figure 4-66). Agriculture provides 92% percent of the food energy available for ducks in the basin. Loss of these agricultural habitats foods would significantly reduce duck carrying capacity, as food supplies are exhausted by mid-November, if ducks are restricted to foraging in wetlands (Figure 4-67). Public wetlands alone can only meet duck energy needs through the end of October (Figure 4-68).

Conservation Objectives

Wetland Restoration

The amount of seasonal wetlands required to meet 50% of duck energy needs in Sutter Basin is estimated at 5,951 acres. There are currently 1,951 acres of seasonal wetlands in the basin, leaving a wetland restoration goal of 4,000 acres.

Wetland Enhancement

The annual enhancement objective for existing wetlands in Sutter Basin is 163 acres/year. Wetland enhancement objectives increase to 496 acres/year when wetland restoration objectives are met for the basin (Table 4-33).

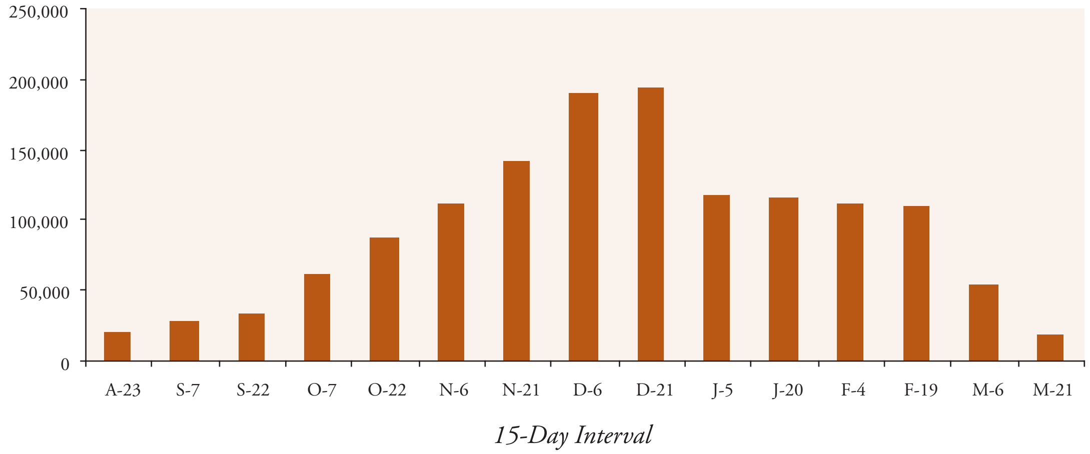


Figure 4-62. Population objectives by 15-day intervals for ducks in Sutter Basin.

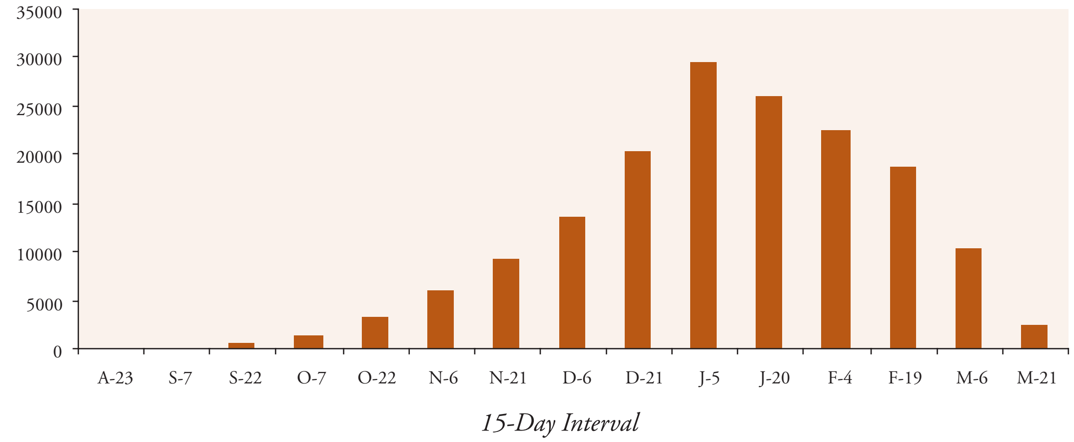


Figure 4-63. Population objectives by 15-day intervals for dark geese in Sutter Basin.

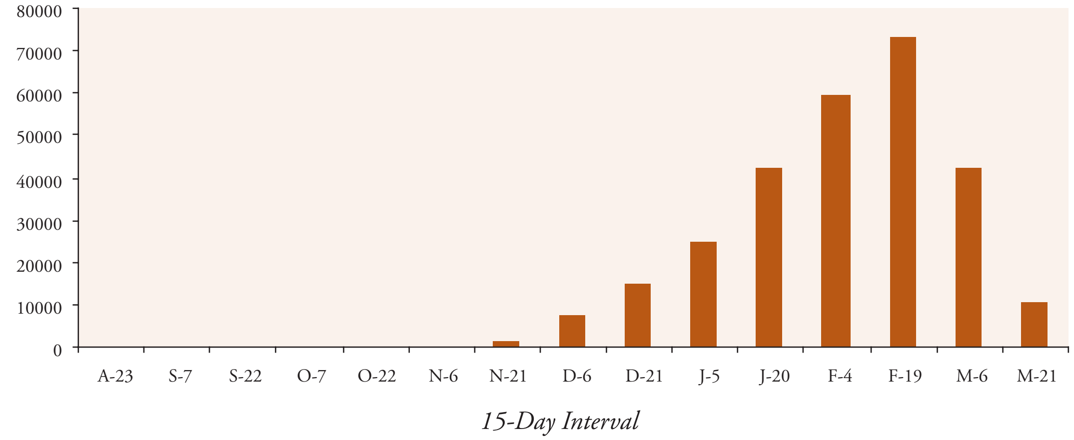


Figure 4-64. Population objectives by 15-day intervals for white geese in Sutter Basin.

Water Supplies for Wetland Management

Annual management of seasonal wetlands in Sutter Basin will require 29,755 acre-feet of water when wetland restoration objectives for the basin are met. These annual water requirements are further broken down by time period to reflect flooding schedules and summer irrigation needs (Table 4-34).

Agricultural Enhancement

The agricultural enhancement objective for Sutter Basin is 18,000 acres, all of which is assumed to be rice. This objective represents the amount of rice habitat that must be maintained in a waterfowl-friendly state when wetland restoration objectives have been met for the basin. Ten thousand of these acres must be winter-flooded to meet duck energy needs. Waterfowl-friendly rice habitat in the basin is currently estimated at nearly 43,000 acres. Over 33,000 of these acres are winter-flooded (Table 4-35). Agricultural enhancement objectives are currently exceeded the basin.

Agricultural Easements for Maintaining Waterfowl Foods

Agricultural habitats are extremely important to waterfowl in Sutter Basin and provide 92% of the food energy available to ducks (Figure 4-68). The loss of irrigated farmland in Sutter Basin by 2040 is estimated at 8,700 acres or 3.6% of existing lands (Figure 3-15). Approximately 1,700 of these acres are predicted to be rice (Table 3-4). Most wetland restoration occurs on rice ground, and meeting wetland restoration goals for the basin could reduce rice acreage by an additional 4,000 acres. Planted rice in the basin is now estimated at 46,000 acres. This acre base would be reduced by 5,700 acres if growth projections are accurate and wetland restorations are met.

Reducing Sutter Basin's rice acreage by 5,700 acres would not appear to prevent the JV's agricultural enhancement goal from being met, because over 40,000 acres of rice would remain to meet the 18,000 acre objective for waterfowl-friendly rice (Figure 4-69). However, some resource professionals believe that growth projections for the basin underestimate the future impacts on riceland, especially for the area between Yuba City and Sutter NWR (Figure 4-70). This rice currently buffers wetlands in the Sutter Bypass, the only major wetland complex in the basin. Thus, the JV may need to consider establishing agricultural easements in this portion of the basin.

Agricultural Easements to Buffer Urban Growth (Type II)

Growth west of Yuba City may ultimately reduce the quality of wetlands in Sutter NWR (Figure 4-70), and a Type II easement program could divert development away from this important wetland complex.

Conservation Objective Priorities

Conservation objectives for Sutter Basin are summarized in Table 4-36. The information used to prioritize these objectives is presented in Figure 4-71. Food supplies exceed 100% of duck needs and were rated high. The overall level of habitat protection is very low at 16%, while progress in meeting wetland needs is low (1,951 acres present (vs. 5,951 acres needed or 33% of need). Population growth and loss of irrigated farmland were both considered low. Wetland restoration is a conservation priority for the basin as only 33% of wetland needs have been met for ducks. Although projected losses of irrigated farmland are low, agricultural easements that specifically buffer Sutter NWR are needed.

Table 4-32. Foraging habitats available to wintering waterfowl in Sutter Basin.

Habitat Type	*Acres*
Seasonal Wetlands	1,951
Flooded Rice	33,168
Unflooded Rice	9,674
Corn	2,875

Table 4-33. Annual wetland enhancement objectives for Sutter Basin.

Wetland Acres	*Annual Enhancement Objective (Acres)*[c]
1,951[a]	163
3,951	329
5,951[b]	496

[a] Current acres of wetlands in Sutter Basin.
[b] Acres of wetlands in Sutter Basin when wetland restoration objectives are met.
[c] Annual enhancement objectives reflect progress in meeting wetland restoration objectives for Sutter Basin.

Table 4-34. Water needs for seasonal wetlands in Sutter Basin when wetland restoration objective is met.

Month	*Water Need (Acre-Feet)*
January	1,190
February	1,190
March	1,190
April	0
May	4,166
June	0
July	0
August	5,356
September	10,712
October	2,308
November	2,308
December	1,190
Annual Need	**29,755**

Table 4-35. Agricultural enhancement objectives for Sutter Basin.

	Waterfowl-friendly Rice[a]	*Flooded Rice*
Objective	18,000	10,000
Current	42,842[b]	33,168

[a] Waterfowl-friendly rice includes rice that is flooded and rice that is not deep plowed following harvest but which remains dry.
[b] Planted rice acreage in Sutter Basin is estimated at 46,066 acres (Table 3-6). The JV assumes that 42,842 of these acres provide waterfowl-friendly habitat.

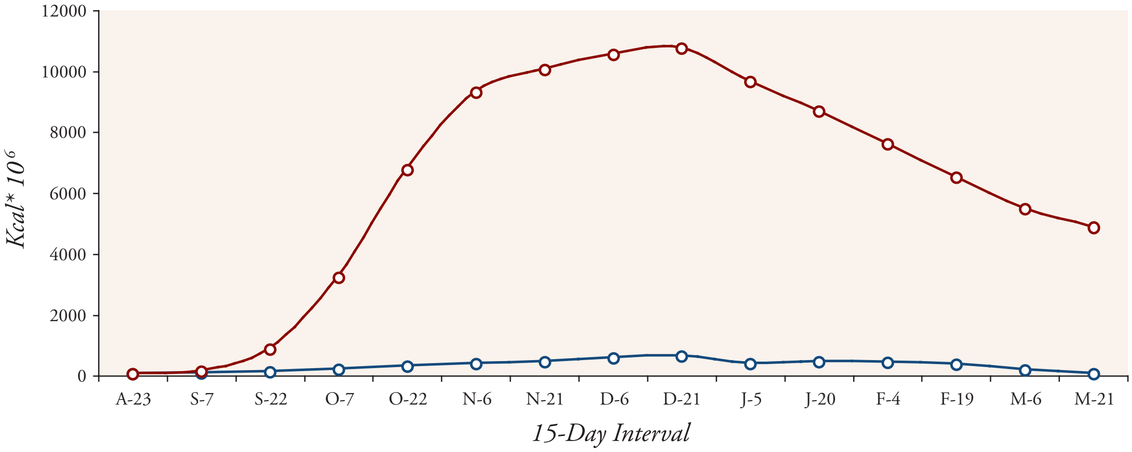


Figure 4-65. Population energy demand (blue) vs. food energy supply (red) for ducks in Sutter Basin when duck populations are at NAWMP goals.

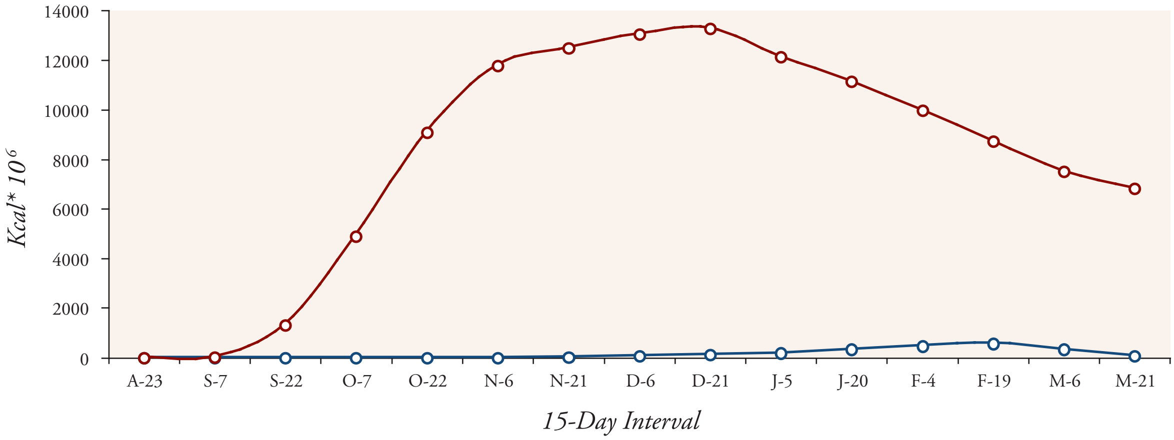


Figure 4-66 (a). Dark goose population energy demand (blue) vs. food energy supplies (red) in Sutter Basin.

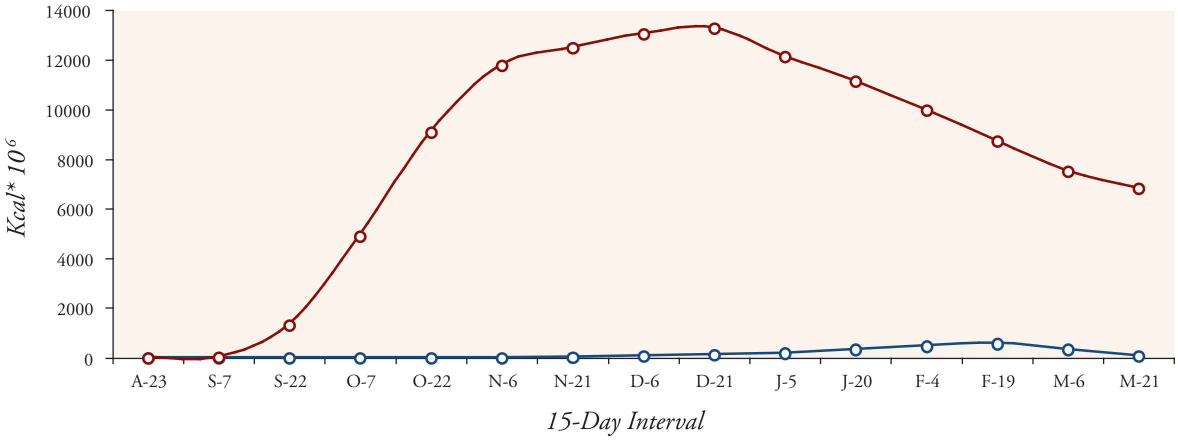


Figure 4-66 (b). White goose population energy demand (blue) vs. food energy supplies (red) in Sutter Basin.

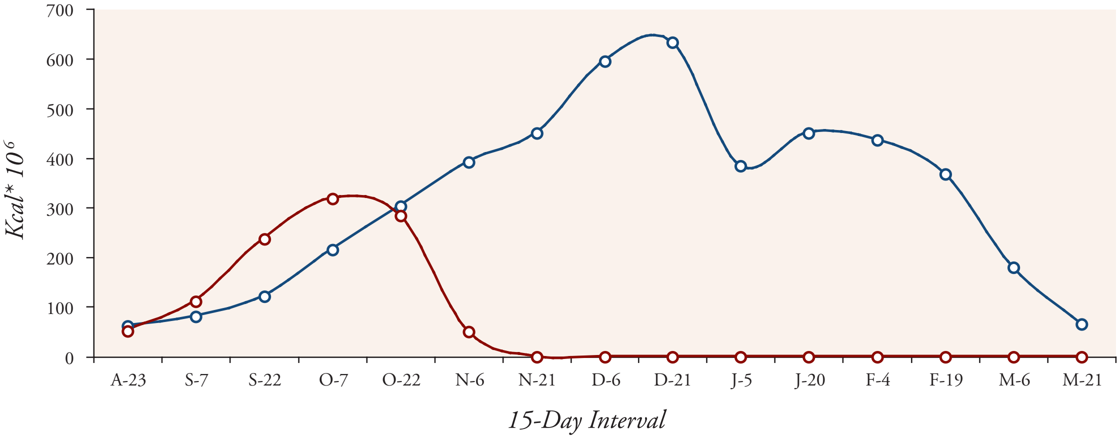


Figure 4-67. Population energy demand (blue) vs. food energy supply (red) for ducks in Sutter Basin when no agricultural food sources are available.

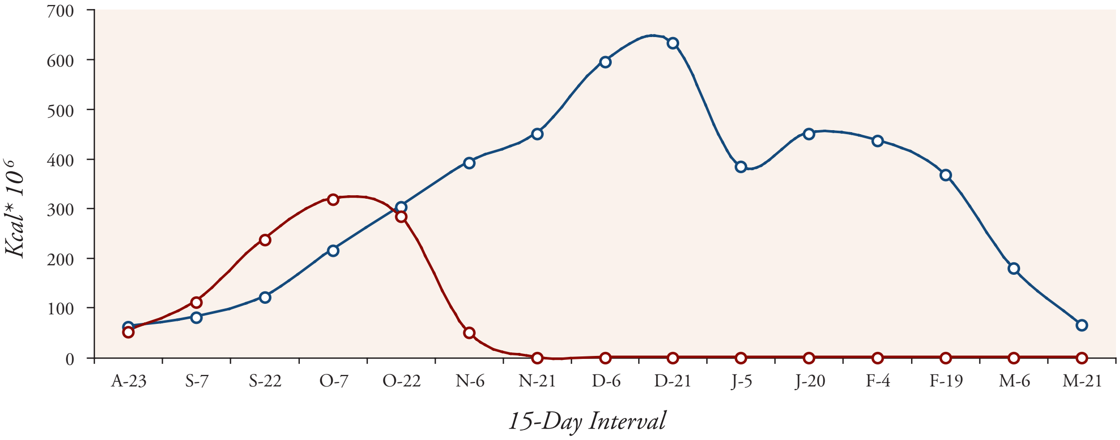


Figure 4-68. Population energy demand (blue) vs. food energy supply (red) for ducks in Sutter Basin if ducks are restricted to foraging on public lands.

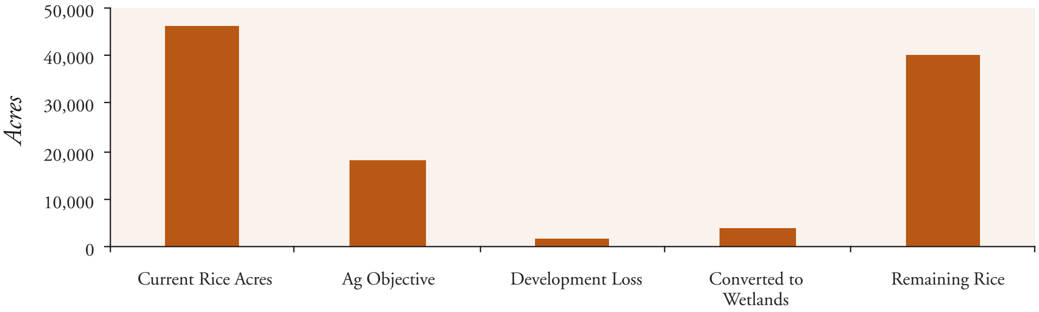
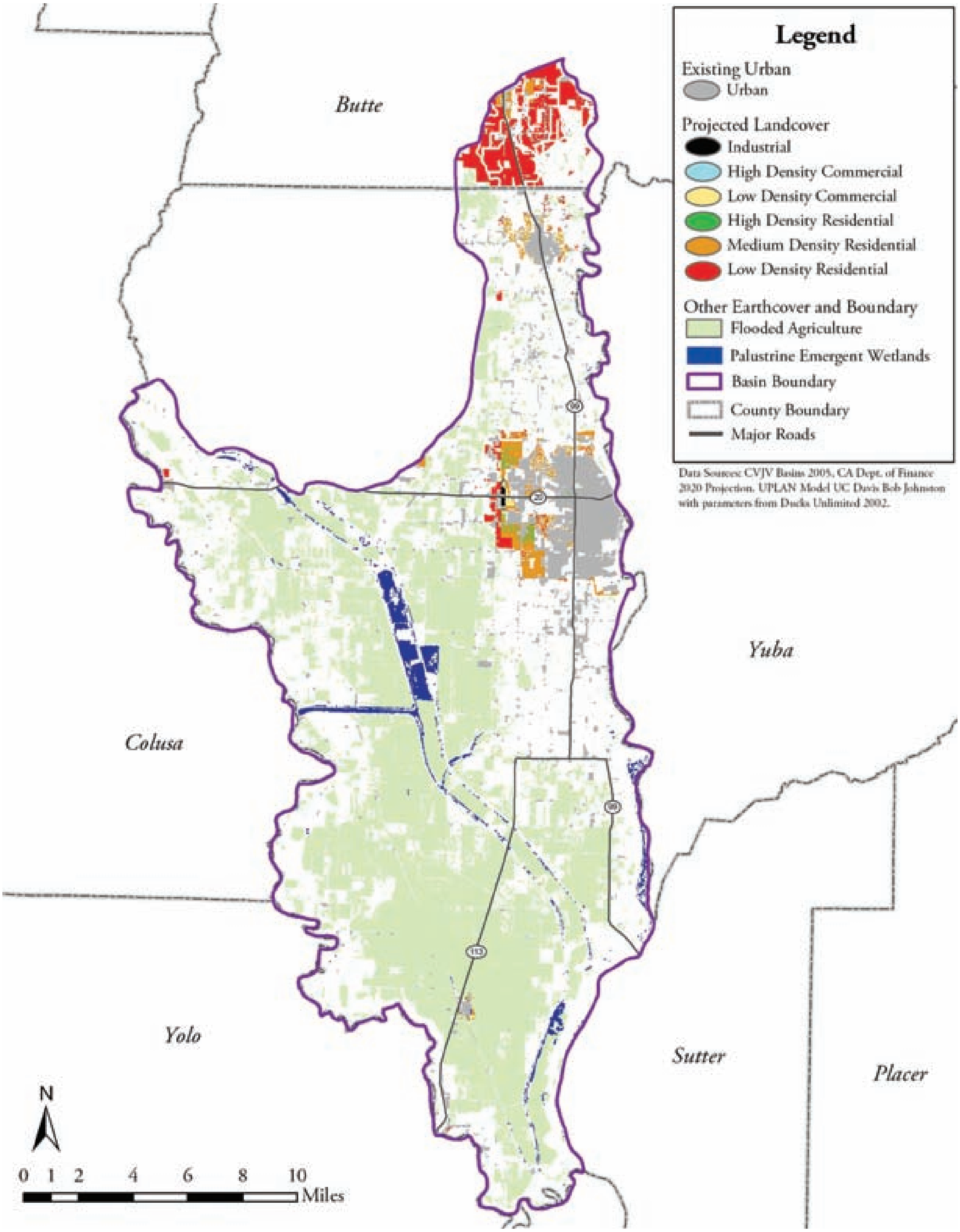


Figure 4-69. Forecasted changes in rice acreage for the Sutter Basin compared to the basin's agricultural enhancement objective.



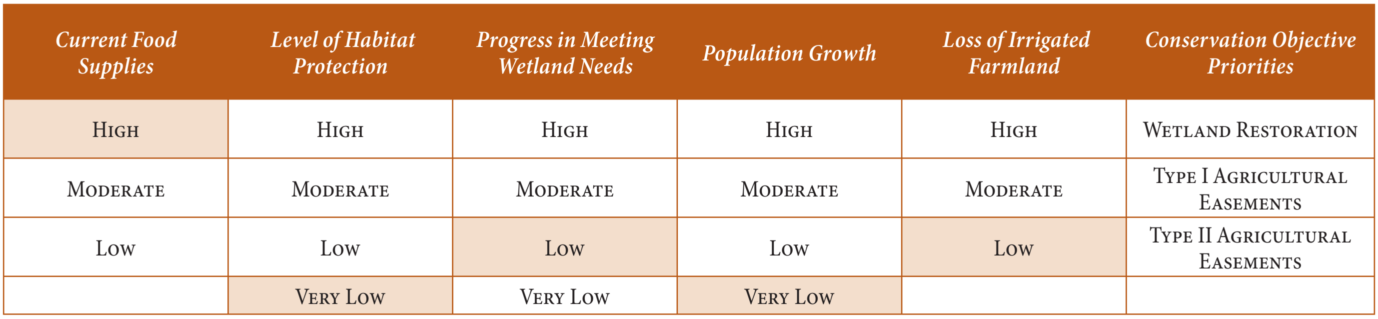
Data Sources: CVJV Basins 2005, CA Dept. of Finance 2020 Projection. UPLAN Model UC Davis Bob Johnston with parameters from Ducks Unlimited 2002.

Figure 4-70. Projected growth in Sutter Basin to 2020.

Table 4-36. Conservation objectives for wintering waterfowl in Sutter Basin.

Wetland Restoration (Acres)	*Wetland Enhancement (Acres)*	*Water Supplies (Acre-Feet)*	*Agricultural Enhancement (Acres)*	*Type I Agricultural Easements*	*Type II Agricultural Easements*
4,000	496[a]	29,755[b]	18,000[c] 10,000[d]	Needed	Needed

[a] Annual enhancement objective when the wetland restoration objective is met.
[b] Annual water supply need when the wetland restoration objective is met.
[c] Total acres of rice that must be maintained in a waterfowl-friendly state (includes 10,000 acres that must be flooded). Objective has been met.
[d] Total acres of rice that must be flooded out of the total enhancement objective of 18,000 acres. Objective has been met.



Current Food Supplies	*Level of Habitat Protection*	*Progress in Meeting Wetland Needs*	*Population Growth*	*Loss of Irrigated Farmland*	*Conservation Objective Priorities*
High	High	High	High	High	Wetland Restoration
Moderate	Moderate	Moderate	Moderate	Moderate	Type I Agricultural Easements
Low	Low	Low	Low	Low	Type II Agricultural Easements
	Very Low	Very Low	Very Low		

Figure 4-71. Information used to identify conservation objective priorities for Sutter Basin.

Suisun Basin

Population Energy Demand vs. Food Energy Supplies: Current Conditions

Population objectives for migrating and wintering waterfowl in Suisun Marsh are presented in Figures 4-72 through 4-74. Duck population objectives are highest for December, while population objectives for dark and white geese peak during January. However, dark and white goose populations in Suisun Marsh are very small relative to most other basins and no further results are presented for these birds. Wetlands provide all the food resources in Suisun Marsh, as there are no agricultural habitats in the basin (Table 4-37).

Table 4-37. Foraging habitats available to wintering waterfowl in Suisun Marsh.

Habitat Type	*Acres*
Seasonal Wetlands	32,232

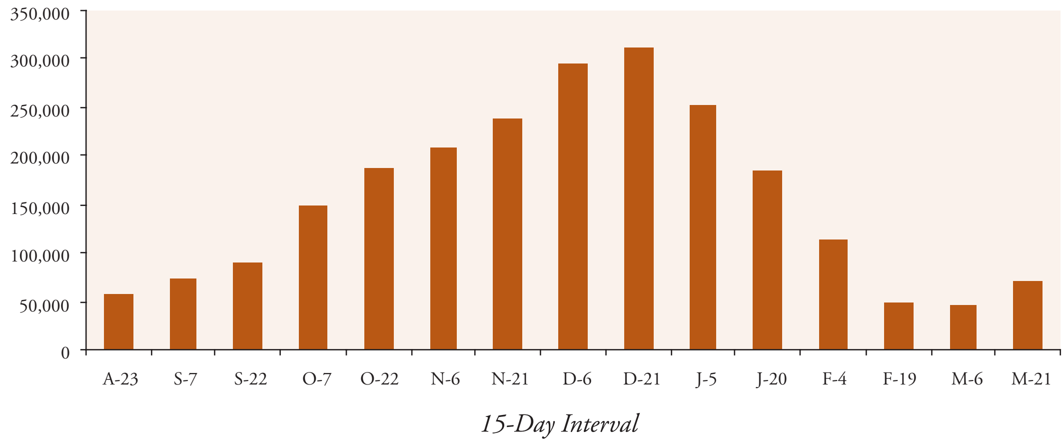


Figure 4-72. Population objectives by 15-day intervals for ducks in Suisun Basin.

Recent proposals to restore 5,000 acres of Suisun Marsh to tidal flow have raised some concern that carrying capacity will be reduced because food production in saline habitats may be lower than in freshwater environments. Duck food supplies are adequate in all time periods if seed production in Suisun wetlands is similar to other basins (566 lbs/acre) (Figure 4-75). Food supplies remain adequate from fall through spring, even if 5,000 acres of wetlands are restored to tidal flow and no food production is assumed for these tidally restored habitats (Figure 4-76).

Although much of the Suisun Marsh is isolated from tidal flows, wetland habitats are more saline than elsewhere in the Central Valley. Plant communities that are associated with high salinities often produce less seed than plants adapted to freshwater environments. As a result, the JV has assumed that seed production in Suisun Marsh is 50% of other Basins (283 lbs/acre). Food supplies for ducks are adequate even when seed production is assumed to be 283 lbs/acre (Figure 4-77). However, restoring tidal flow to 5,000 acres of existing habitat could result in food supplies being exhausted by early February, if few food resources are provided in these tidal areas and the remaining wetlands provide only 283 lbs of seed/acre (Figure 4-78).

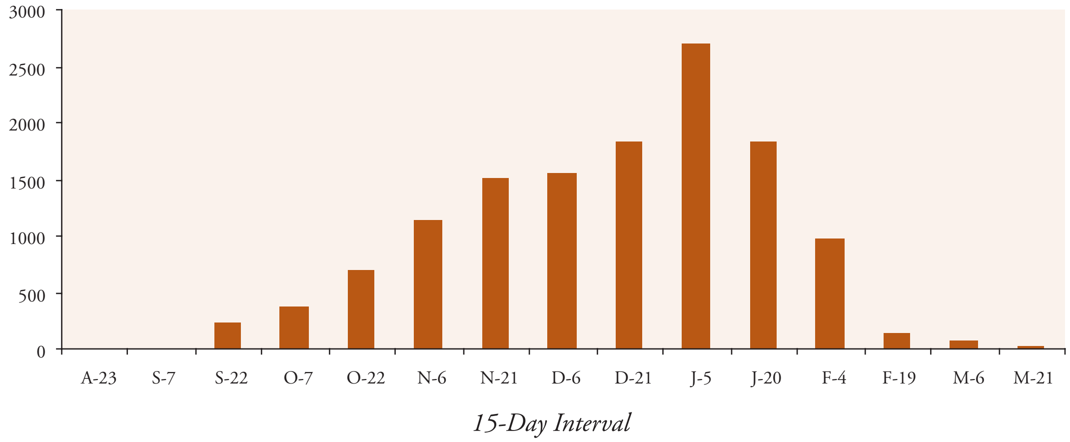


Figure 4-73. Population objectives by 15-day intervals for dark geese in Suisun Marsh.

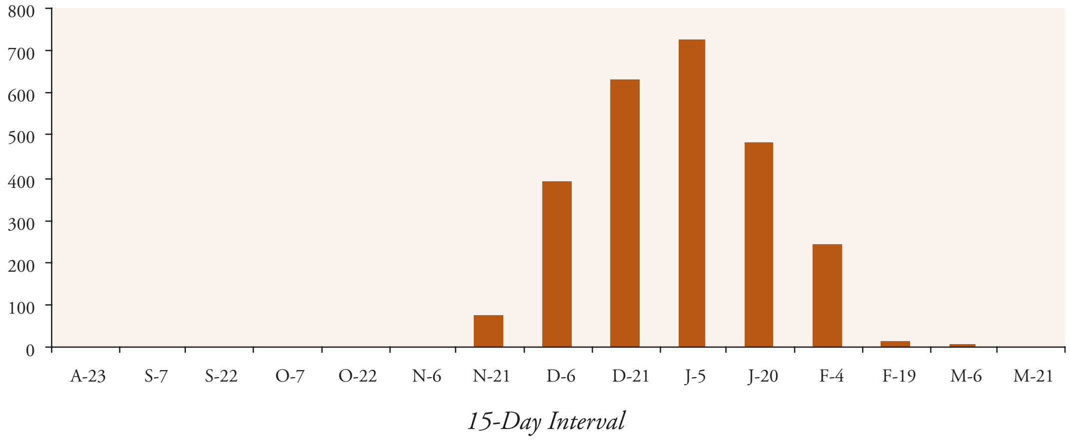


Figure 4-74. Population objectives by 15-day intervals for white geese in Suisun Marsh.

Uncertainty over the food resources provided by Suisun wetlands, and the possible effect of tidal restoration, make any assessment of food supplies difficult. Future studies to estimate food production in existing habitats and in tidally influenced areas would greatly improve the JV's ability to estimate duck carrying capacity in this basin.

Conservation Objectives

Wetland Restoration

There is no wetland restoration objective for Suisun Marsh. Wetlands currently meet 100% of duck energy needs even when seed production is assumed to be half that of other basins.

Wetland Enhancement

The annual enhancement objective for existing wetlands in Suisun Marsh is 2,686 acres/year.

Water Supplies for Wetland Management

Annual management of seasonal wetlands in Suisun Marsh requires 153,102 acre-feet of water. These annual water requirements are further broken down by time period to reflect flooding schedules and summer irrigation needs (Table 4-38).

Table 4-38. Water needs for seasonal wetlands in Suisun Marsh.

Month	*Water Need (Acre-Feet)*
January	6,446
February	6,446
March	6,446
April	8,058
May	0
June	0
July	0
August	29,008
September	64,464
October	12,898
November	12,898
December	6,446
Annual Need	**153,102**

Agricultural Enhancement

There is no agricultural enhancement objective for Suisun Marsh, as no crops are grown in the basin.

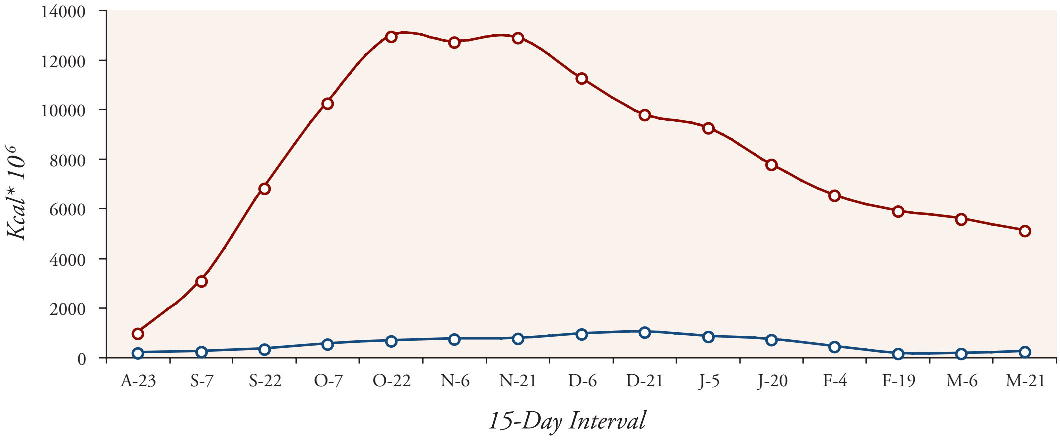


Figure 4-75. Population energy demand (blue) vs. food energy supply (red) for ducks in Suisun Marsh if wetland seed production is similar to other areas of the Central Valley (566 lbs/acre).

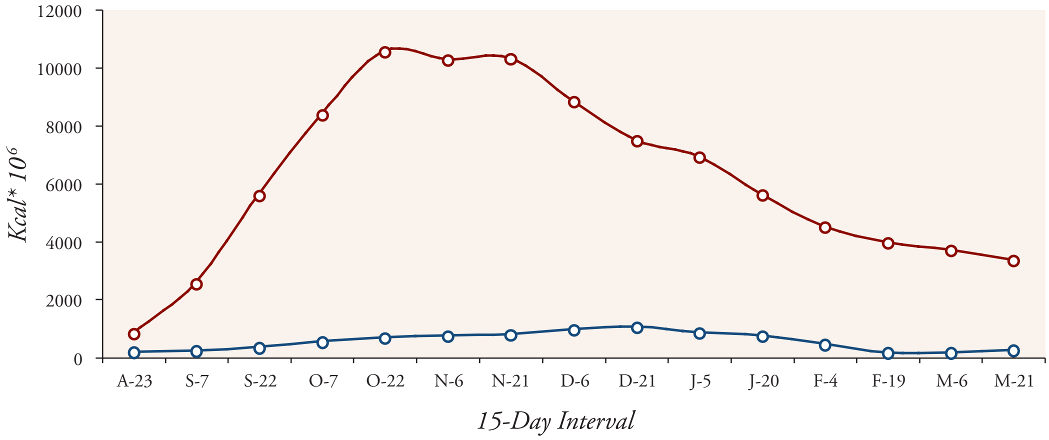


Figure 4-76. Population energy demand (blue) vs. food energy supply (red) for ducks in Suisun Marsh, if wetland seed production is similar to other areas of the Central Valley (566 lbs/acre), and tidal flow is restored to 5,000 acres of existing wetlands.

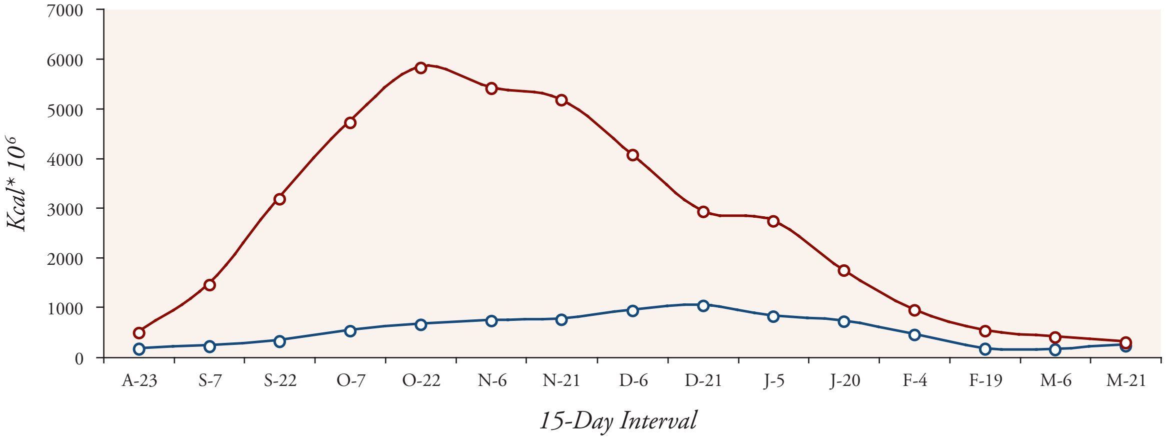


Figure 4-77. Population energy demand (blue) vs. food energy supply (red) for ducks in Suisun Marsh if wetland seed production is assumed to be 50% of other areas of the Central Valley (283 lbs/acre).

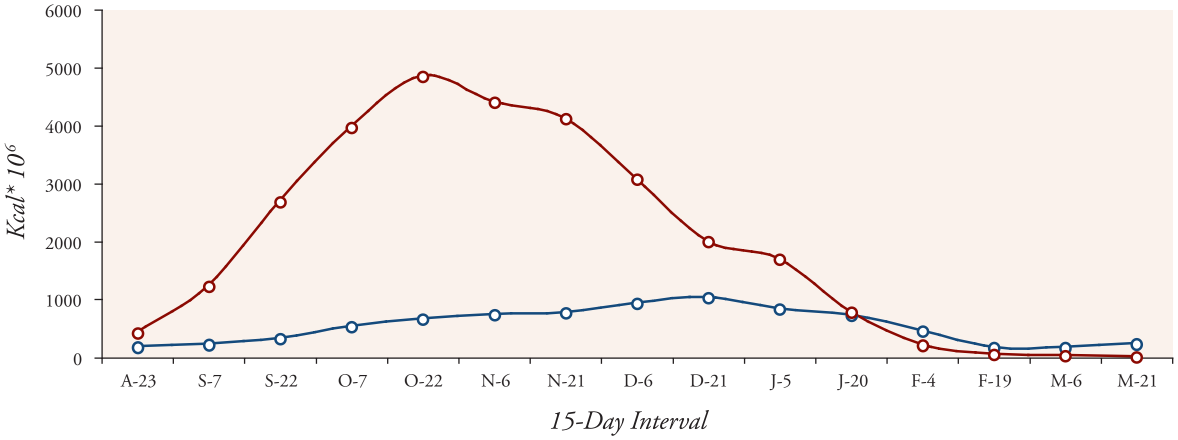


Figure 4-78. Population energy demand (blue) vs. food energy supply (red) for ducks in Suisun Marsh if wetland seed production is assumed to be 50% of other areas of the Central Valley (283 lbs/acre), and tidal flow is restored to 5,000 acres of existing wetlands.

Agricultural Easements for Maintaining Waterfowl Foods

No easements of this type are proposed, as there are no crops grown in the basin.

Agricultural Easements to Buffer Residential and Urban Growth

No easements of this type are proposed, as there are no crops grown in the basin and no projected residential or urban growth.

Conservation Objective Priorities

Conservation objectives for Suisun Marsh are summarized in Table 4-39. Information used to prioritize these conservation objectives is presented in Figure 4-79. Food supplies exceed 100% of duck needs and were rated high. The level of habitat protection is high (100%) as is progress in meeting wetland needs (no future wetland restoration proposed). No population growth or loss of irrigated farmland is anticipated for the basin. As a result, wetland enhancement is the only conservation priority identified for Suisun Marsh.

Table 4-39. Conservation objectives for wintering waterfowl in Suisun Marsh.

Wetland Restoration (Acres)	*Wetland Enhancement (Acres)*	*Water Supplies (Acre-Feet)*	*Agricultural Enhancement (Acres)*	*Type I Agricultural Easements*	*Type II Agricultural Easements*
0	2,686[a]	153,102[b]	0	None	None

[a] *Annual enhancement objective for existing wetlands.*
[b] *Annual water supply need for existing wetlands.*

Current Food Supplies	*Level of Habitat Protection*	*Progress in Meeting Wetland Needs*	*Population Growth*	*Loss of Irrigated Farmland*	*Conservation Objective Priorities*
High	High	High	High	High	Wetland Enhancement
Moderate	Moderate	Moderate	Moderate	Moderate	
Low	Low	Low	Low	Low	
	Very Low	Very Low	Very Low		

Figure 4-79. Information used to prioritize conservation objectives for Suisun Marsh.

Yolo Basin

Population Energy Demand vs. Food Energy Supplies: Current Conditions

Population objectives for wintering waterfowl in Yolo Basin are presented in Figures 4-80 through 4-82. Duck and white geese population objectives are highest in February, while population objectives for dark geese peak during January. Agriculture provides the majority of foraging habitat in the basin, although significant amounts seasonal wetlands are also present (Table 4-40).

Table 4-40. Foraging habitats available to wintering waterfowl in Yolo Basin.

Habitat Type	*Acres*
Seasonal Wetlands	8,558
Flooded Rice	7,020
Unflooded Rice	2,048
Corn	20,640

Food supplies for Yolo Basin ducks are adequate in all time periods, although supplies peak six to eight weeks before bird numbers reach their maximum (Figure 4-83). Food supplies for dark and white geese are also well above population needs and large food surpluses occur from fall through spring (Figure 4-84). Agriculture provides 79% of the food energy available for ducks in the basin. Loss of these agricultural foods would decrease duck carrying capacity, as food supplies are exhausted by early February if ducks are restricted to foraging in wetlands (Figure 4-85). Public wetlands are capable of meeting duck needs through mid-December (Figure 4-86).

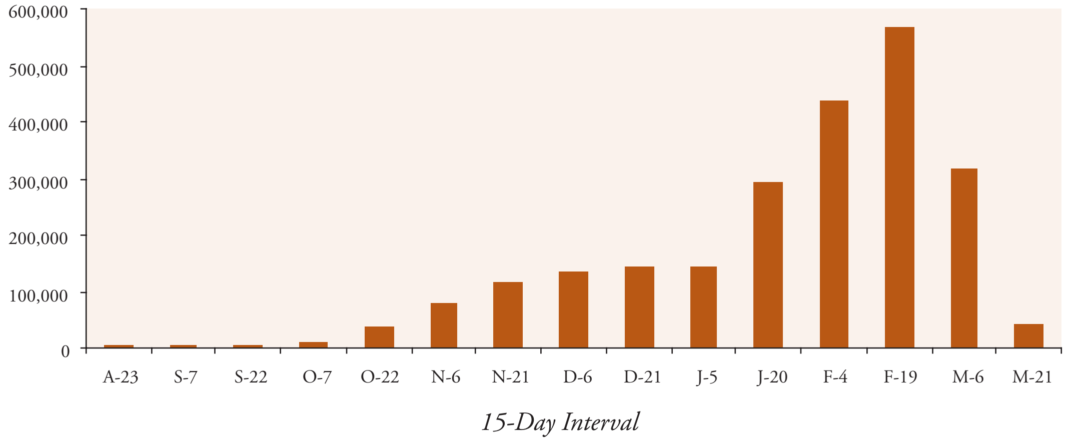


Figure 4-80. Population objectives by 15-day intervals for ducks in Yolo Basin.

Conservation Objectives

Wetland Restoration

The amount of seasonal wetlands required to meet 50% of duck energy needs in Yolo Basin is estimated at 11,558 acres. There are currently 8,558 acres of seasonal wetlands in the basin, leaving a wetland restoration goal of 3,000 acres.

Seasonal Wetland Enhancement

The annual enhancement objective for existing seasonal wetlands in Yolo Basin is 713 acres/year. Wetland enhancement objectives will increase to 963 acres/year when wetland restoration objectives are met for the basin (Table 4-41).

Water Supplies for Wetland Management

Annual management of seasonal wetlands in Yolo Basin will require 57,790 acre-feet of water when wetland restoration objectives in the basin have been met. These annual water requirements are further broken down by time period to reflect flooding schedules and summer irrigation needs (Table 4-42).

Agricultural Enhancement

The Yolo Basin contains significant amounts of both corn and rice, and agricultural enhancement objectives for the basin reflect the relative abundance of these two crop types. The enhancement objective for the basin is 11,000 acres, of which 8,000 is assumed to be corn. The remaining 3,000 acres is assumed to be flooded rice. This objective represents the amount of corn and rice that must be maintained in a waterfowl-friendly state when wetland restoration objectives have been met for the basin. Corn acreage is currently estimated at 20,640, while flooded rice totals 7,020 acres (Table 4-43). Agricultural enhancement objectives are currently exceeded for the basin.

Agricultural Easements for Maintaining Waterfowl Foods

Agricultural habitats are extremely important to waterfowl in Yolo Basin and provide 79% of the food energy now available to ducks (Figure 4-85). The loss of irrigated farmland in the basin by 2040 is estimated at nearly 50,000 acres or 8.3% of existing lands (Figure 3-15). Approximately 800 of these acres are predicted to be rice, while 3,400 acres of corn will be lost (8.3% loss rate applied to existing acres of corn). Most wetland restoration occurs on rice ground, and an additional 3,000 acres of rice may be converted to wetlands if wetland restoration objectives are met for the basin.

Forty-one thousand acres of corn and nearly 10,000 acres of rice are planted annually in Yolo Basin (Table 3-6). The loss of 3,400 acres of corn to development will not prevent agricultural enhancement objectives for corn being met, especially since objectives for corn are now exceeded by over 100% (Table 4-43). However, reducing the basin's 10,000 acre rice base by nearly 4,000 acres is a significant loss. While this loss may not prevent agricultural enhancement objectives being met for rice (Figure 4-87), changes in the rice base should be closely monitored to determine if a Type I easement program is needed in the future.

Agricultural Easements to Buffer Urban Growth

Growth projections for Yolo Basin indicate that little residential or urban development will occur near existing wetlands (Figure 4-88). As a result, no agricultural easements to buffer growth are proposed for the basin.

Table 4-41. Annual wetland enhancement objectives for Yolo Basin.

Wetland Acres	*Annual Enhancement Objective (Acres)*[c]
8,558[a]	713
10,558	880
11,558[b]	963

[a] Current acres of wetlands in Yolo Basin.
[b] Acres of wetlands in Yolo Basin when wetland restoration objectives are met.
[c] Annual enhancement objectives reflect progress in meeting wetland restoration objectives for Yolo Basin.

Table 4-42. Water needs for seasonal wetlands in Yolo Basin when wetland restoration objective is met.

Month	*Water Need (Acre-Feet)*
January	2,312
February	2,312
March	2,312
April	0
May	8,091
June	0
July	0
August	10,402
September	20,804
October	4,623
November	4,623
December	2,312
Annual Need	57,790

Table 4-43. Agricultural enhancement objectives for Yolo Basin.

	Waterfowl Friendly[a] Corn	*Flooded Rice*
Objective	8,000	3,000
Current	20,640[b]	7,020

[a] Waterfowl-friendly corn includes corn that is flooded and corn that is not deep plowed following harvest but which remains dry.
[b] Planted corn in Yolo Basin is estimated at 41,280 acres (Table 3-6). The JV assumes that 20,640 or 50% of these acres provide waterfowl-friendly habitat, most of which is dry.

Table 4-45. Foraging habitats available to wintering waterfowl in Tulare Basin.

Habitat Type	*Acres*
Seasonal Wetlands	20,212

Table 4-44. Conservation Objectives for wintering waterfowl in Yolo Basin.

Wetland Restoration (Acres)	*Wetland Enhancement (Acres)*	*Water Supplies (Acre-Feet)*	*Agricultural Enhancement (Acres)*	*Type I Agricultural Easements*	*Type II Agricultural Easements*
3,000	963[a]	57,790[b]	8,000[c] 3,000[d]	NONE	NONE

[a] *Annual enhancement objective when the wetland restoration objective is met.*

[b] *Annual water supply need when the wetland restoration objective is met.*

[c] *Total acres of corn that must be enhanced. Objective has been met.*

[d] *Total acres of rice that must be flooded. Objective has been met.*

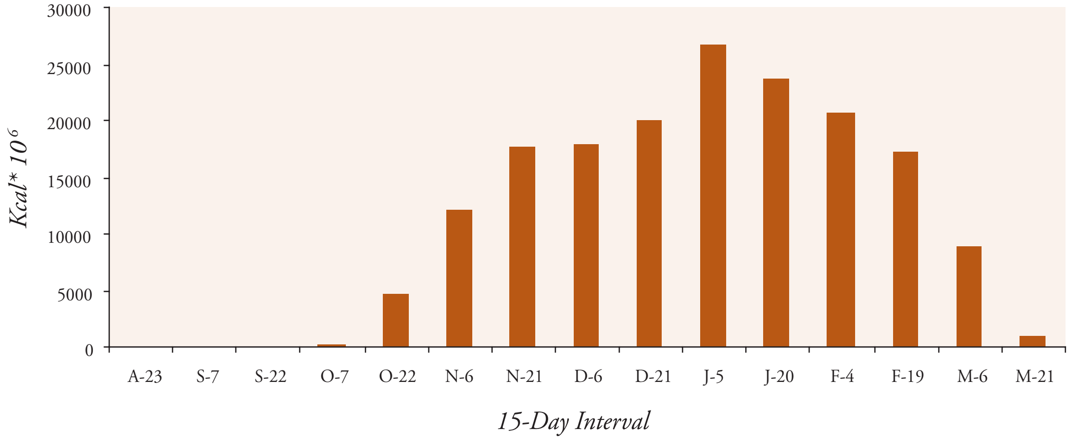


Figure 4-81. Population objectives by 15-day intervals for dark geese in Yolo Basin.

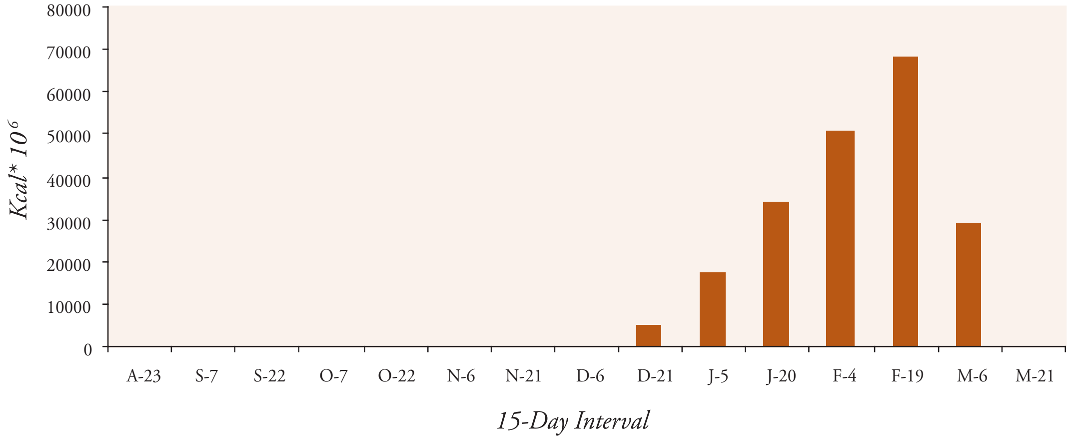


Figure 4-82. Population objectives by 15-day intervals for white geese in Yolo Basin.

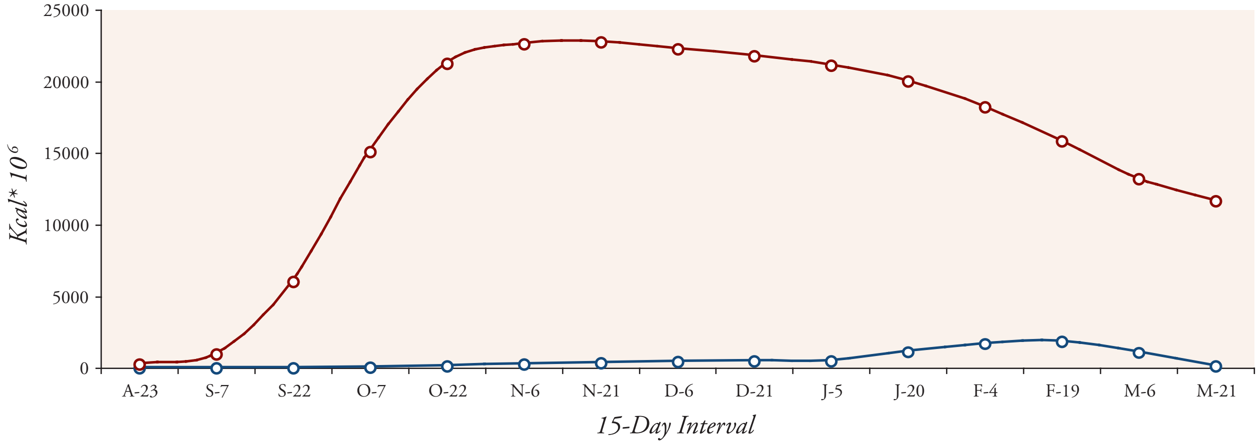


Figure 4-83. Population energy demand (blue) vs. food energy supply (red) for ducks in Yolo Basin when duck populations are at NAWMP goals.

Conservation Objective Priorities

Conservation objectives for Yolo Basin are summarized in Table 4-44. The information used to identify conservation objective priorities for the basin is presented in Figure 4-89. Food supplies exceed 100% of duck needs and were rated high. Habitat protection in the basin is low at 36%, while progress in meeting wetland needs is moderate (8,000 acres present vs. 11,000 acres needed or 72% of need). Human population growth for the basin was categorized as low, while the projected loss of irrigated farmland is moderate. Wetland restoration is a priority for the basin.

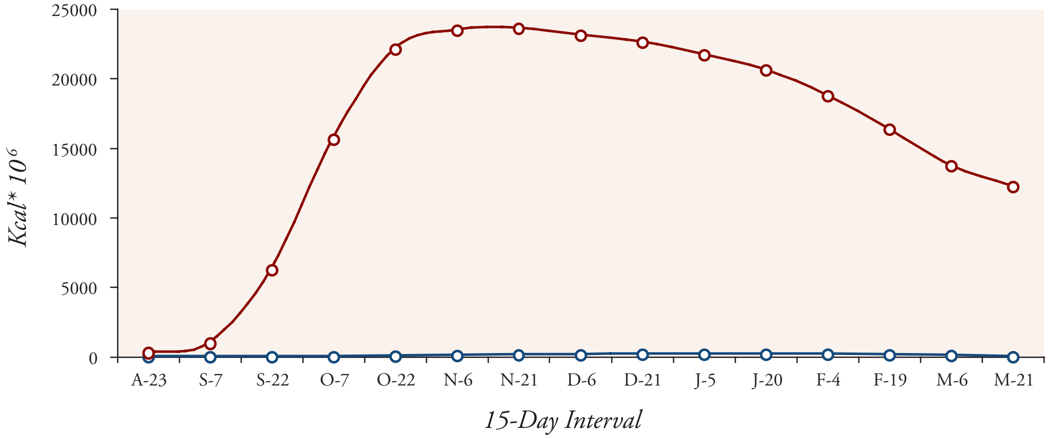


Figure 4-84 (a). Dark goose population energy demand (blue) vs. food energy supply (red) in Yolo Basin.

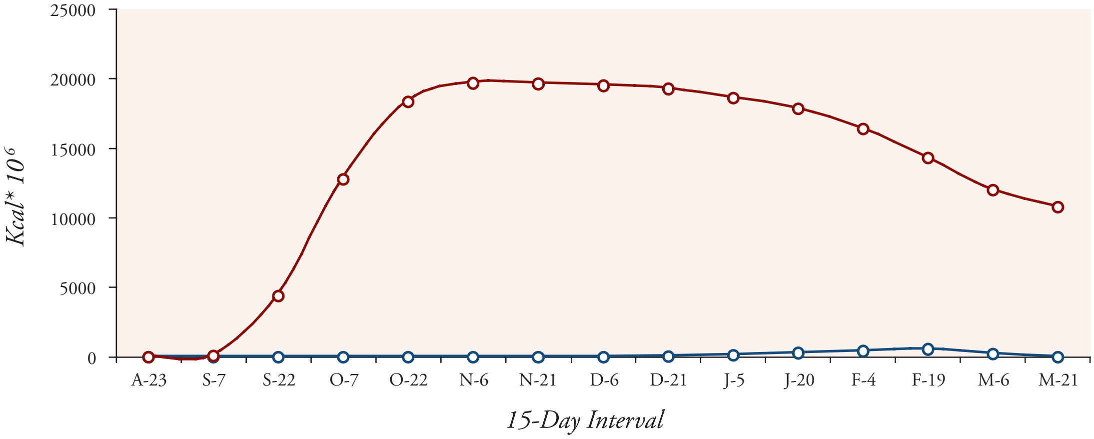


Figure 4-84 (b). White goose population energy demand (blue) vs. food energy supply (red) in Yolo Basin.

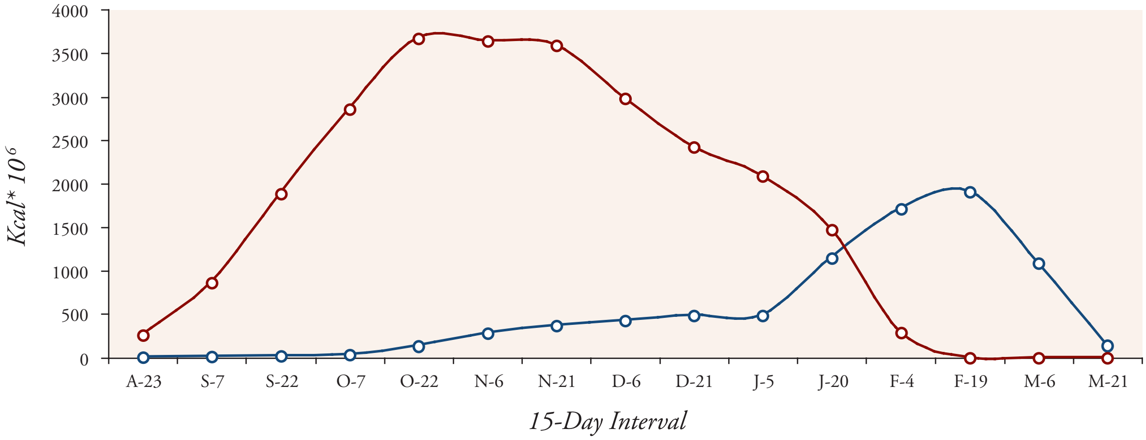


Figure 4-85. Population energy demand (blue) vs. food energy supply (red) for ducks in Yolo Basin when no agricultural food sources are available.

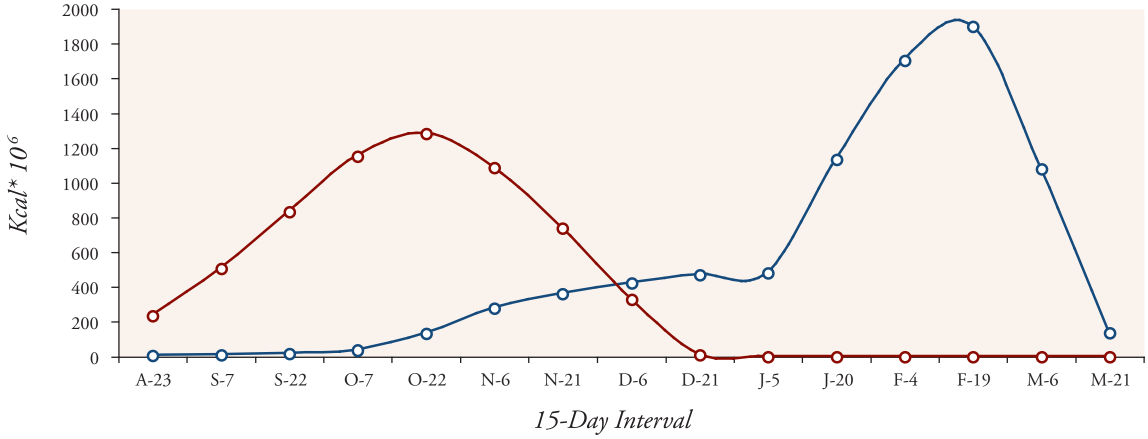


Figure 4-86. Population energy demand (blue) vs. food energy supply (red) for ducks in Yolo Basin when ducks are restricted to foraging on public lands.

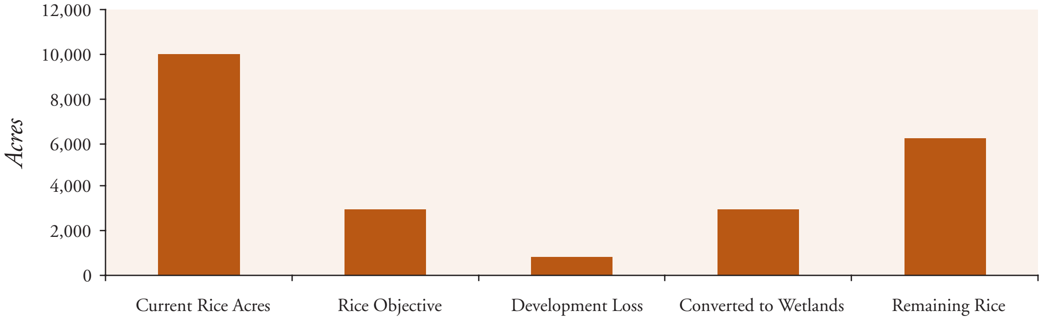
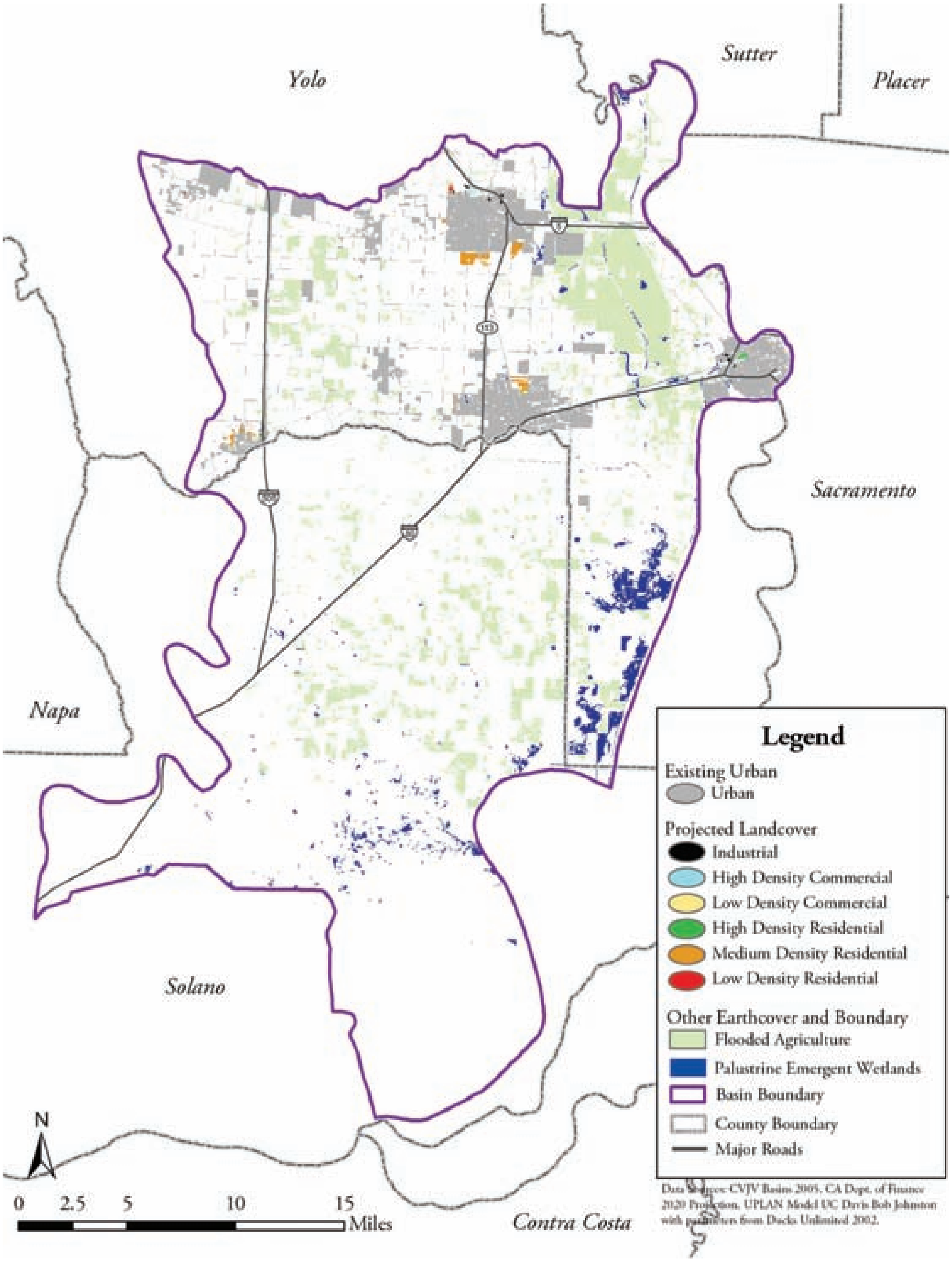


Figure 4-87. Forecasted changes in rice acreage for the Yolo Basin compared to the basin's rice habitat objective.

Current Food Supplies	*Level of Habitat Protection*	*Progress in Meeting Wetland Needs*	*Population Growth*	*Loss of Irrigated Farmland*	*Conservation Objective Priorities*
High	High	High	High	High	Wetland Restoration
Moderate	Moderate	Moderate	Moderate	Moderate	
Low	Low	Low	Low	Low	
	Very Low	Very Low	Very Low		

Figure 4-89. Information used to prioritize conservation objectives for Yolo Basin.



Data Sources: CVJV Basins 2005, CA Dept. of Finance 2020 Projection, UPLAN Model UC Davis Bob Johnston with parameters from Ducks Unlimited 2002.

Figure 4-88. Projected growth in Yolo Basin to 2020.

Tulare Basin

Population Energy Demand vs. Food Energy Supplies: Current Conditions

Canvasback
Photo: USFWS

Although most basins have lost the majority of their wetlands habitat, changes in the Tulare Basin have been especially detrimental for waterfowl. As a result, additional information was considered when evaluating current conditions for waterfowl in the basin and when establishing conservation objectives and priorities.

Tulare Basin once contained a series of shallow lake beds that provided 260,000 acres of seasonal wetlands and over 250,000 acres of permanent and semi-permanent Tule marshes (Wershkull 1984). Prior to being converted to agriculture, these marshes provided much of the late summer/early fall habitat available to waterfowl in the Central Valley. Most wetlands in other basins in the valley resulted from over-bank flooding that historically occurred well after fall migration had begun.

It is assumed that early migrants flew directly to Tulare Basin because the lake beds provided reliable habitat. In contrast, most wetlands north of the basin remained dry until late fall or early winter. When over-bank flooding and precipitation made these habitats available, waterfowl moved north out of the basin. In essence, birds were over-flying much of the Central Valley and then undergoing a south to north migration as winter progressed. This type of reverse migration has been documented for pintails in both the Central Valley (Fleskes et al. 2002) and Mississippi Flyway (Cox and Afton 1992).

The loss of late summer-early fall habitat in Tulare Basin has substantially altered waterfowl use of the basin. Recent surveys indicate that duck migration is similar to other basins, with peak numbers occurring in late December and early January (Fleskes et al 2002; Figure 4-90a). In contrast, surveys conducted in the early 1970's indicate that duck numbers in the basin were highest in late September and early October (Figure 4-90b). These earlier surveys are consistent with how ducks historically used the basin, while recent surveys are not. Moreover, duck populations in the early and mid-1970's had averaged 350,000 birds during September. By the 1980s that number had shrunk to 51,000 (Jones and Stokes 1988). Early season bird use of the basin has significantly declined over the past three decades.

Declines in early season use do not appear related to any recent loss of permanent wetlands. By 1945 the vast majority of the basin's lake beds had been converted to agriculture, yet early season use of the basin remained high until the 1970s (Jones and Stokes 1988). Instead, reduced duck numbers during September and October may be related to declines in pre-irrigation of agricultural crops.

Pre-irrigation is the application of water on agricultural lands outside of the growing season. Prior to the mid-1970s, much of the land farmed for wheat and other grain crops in Tulare Basin was pre-irrigated during early fall and winter to store soil moisture and to flush salts from the soil (Houghton et al. 1985). Waterfowl relied heavily on these pre-irrigated fields in early fall when few managed wetlands were flooded. However, the amount of pre-irrigated farmland began to decline in the mid-1970s, especially land that was pre-irrigated in August and September (Houghton 1985). This decline continued into the 1980s, though more recent work in the basin indicates that the amount of pre-irrigated habitat has stabilized (Fleskes 1999).

Recent research indicates that waterfowl continue to rely heavily on the pre-irrigated fields in Tulare Basin and that these habitats provide both waste grain and invertebrate food resources (Moss et al. 2005). These agricultural habitats are available from mid-August through mid-October and have the potential to meet the bulk of waterfowl needs during this early period. Early season flooding of seasonal wetlands in the basin is increasingly difficult due to both the rising cost of water and the general lack of available water. Pre-irrrigation flooding may substantially reduce the need for early season wetland habitat in the basin. Efforts are now ongoing to determine how much pre-irrigation habitat is needed from mid-August through mid-October to meet waterfowl needs. Although a pre-irrigation program to benefit waterfowl may not substantially reduce wetland objectives for the basin, it may reduce the need for costly early season flooding of seasonal wetland habitat.

Although pre-irrigated fields once supported large numbers of birds, it is not clear how much of this habitat remains or what food resources it provides. As a result, only existing seasonal wetlands were considered when evaluating food supplies for ducks in the basin. However, research to quantify the foraging quality of pre-irrigated fields is expected in the near future. If pre-irrigated fields still have the potential to support large numbers of early season birds, future conservation objectives for the basin will be modified to include this habitat type.

Tulare Basin presents difficult choices from both a planning and habitat delivery standpoint. Restoring early season waterfowl use of the basin will require a substantial increase in the amount of habitat available in August and September. Providing these early season habitats may be especially difficult because of the basin's chronic water shortages. Finally, the need to provide early season habitat in the basin has been questioned. Management efforts in the Central Valley now provide a substantial amount of early fall habitat, which may compensate for the loss of early season wetlands in Tulare Basin.

Table 4-46. Annual wetland enhancement objectives for Tulare Basin.

Wetlands Acres	*Annual Enhancement Objective (acres)*
20,212[a]	1,684
22,212	1,851
24,212	2,018
26,212	2,185
28,212	2,352
30,212	2,519
32,212	2,686
34,212	2,853
36,212	3,020
38,212	3,187
39,212[b]	3,268

[a] *Current acres of wetlands in Tulare Basin.*
[b] *Acres of wetlands in Tulare Basin when wetland restoration objectives are met.*

Table 4-47. Water needs for seasonal wetlands in Tulare Basin when wetland restoration objectives have been met.

Month	*Water Need (Acre-Feet)*
January	7,842
February	7,842
March	0
April	31,370
May	0
June	21,567
July	0
August	19,606
September	78,424
October	15,684
November	15,684
December	7,842
Annual Need	**205,861**

The JV's Tulare Basin Working Group (Working Group) considered these challenges as well as the need to maintain and improve hunting opportunities in the basin. Private landowners incur considerable costs to maintain wetland habitat in the basin and the number of duck clubs in the region has declined significantly over the past four decades (Jones and Stokes 1988). The Working Group concluded that increasing early season use of the basin was important, as was maintaining and improving hunting opportunities.

Increasing early season habitat and concerns over hunting opportunities were considered when assuming a migration pattern for Tulare Basin ducks. Migration chronology for other basins was based on recent waterfowl surveys in the Central Valley (Fleskes et al. 2000). However, those surveys do not reflect the basin's historical pattern of early season use (Figure 4-90a). In contrast, waterfowl surveys from the early 1970's indicate that most bird use occurred prior to November (Figure 4-90b). The Working Group decided to integrate these migration data from different time periods for use in the 2006 Plan. Although this "integrated" curve assumes high early season use of Tulare Basin, it also recognizes the need to support large numbers of waterfowl during the hunting season (Figure 4-90c). This integrated migration curve was used to establish duck population objectives by time period for the basin.

Population objectives for wintering waterfowl are presented in Figures 4-91 and 4-92. Duck population objectives are highest for late September and late December based on the integrated migration curve (Figure 4-90c). Dark goose population objectives peak during February, while there are no population objectives for white geese. No further results are presented for dark geese, because relatively few of these birds use the basin. Seasonal wetlands are assumed to provide all or most of the foraging habitat in Tulare Basin (Table 4-45; but see below). The JV assumes that food production in the basin is only 75% of other basins because a lack of water for summer irrigation of seasonal wetlands may reduce seed production.

The energetic model predicts that food supplies for ducks in Tulare Basin would be depleted by late January if duck populations are at NAWMP goals and duck use of the basin follows the integrated migration curve (Figure 4-93). Duck populations are not currently at NAWMP goals nor do ducks currently use the basin in a way consistent with the integrated curve of Figure 4-90c. However, the model indicates that habitat conditions in the basin are inadequate for achieving the seasonal pattern of bird use that the Working Group recommends, when duck populations are at NAWMP goals (i.e., traditional early season use and large numbers of birds during winter to maintain good hunting opportunities). Finally, the model result depicted in Figure 4-93 assumes that water is available to flood all 20,212 acres of seasonal wetlands that currently exist in the basin, and that flooding schedules follow that of Figure 4-9c.


Canada geese
Photo: USFWS

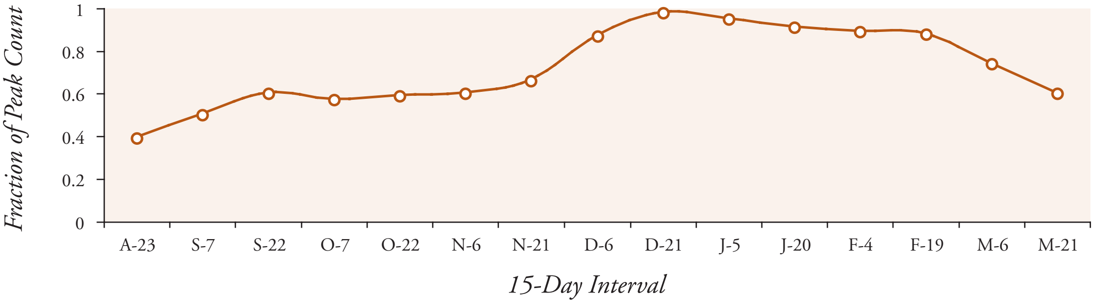


Figure 4-90 (a). Migration chronology of ducks in Tulare Basin as determined from waterfowl surveys conducted in 1998 and 1999.

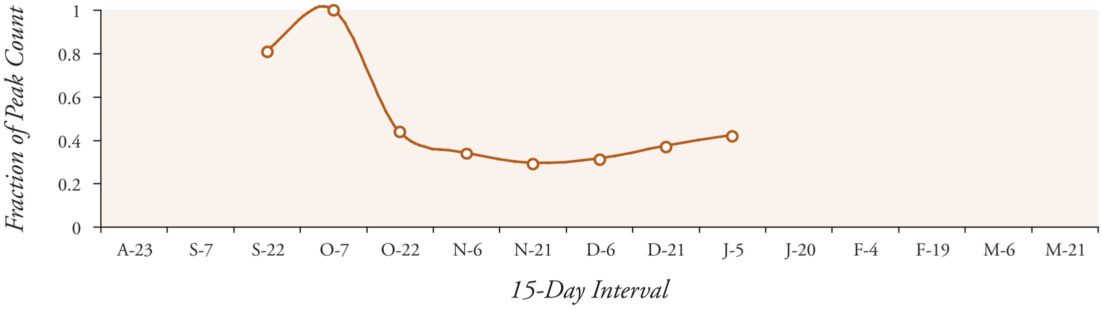


Figure 4-90 (b). Migration chronology of ducks in Tulare Basin as determined from waterfowl surveys conducted in 1973.

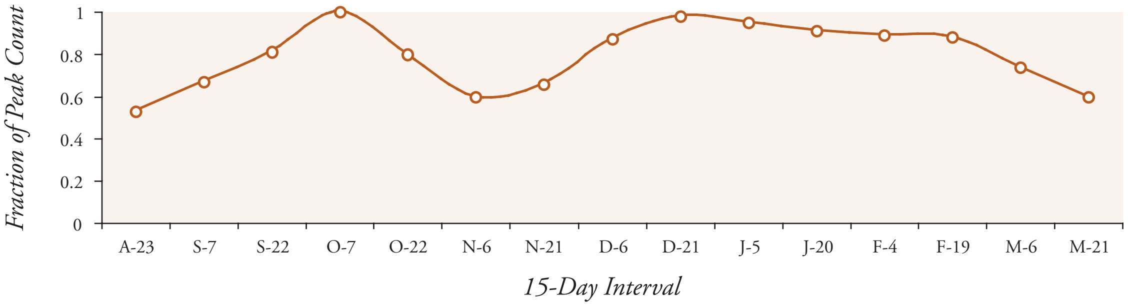


Figure 4-90c. Migration chronology of ducks in Tulare Basin that results from combining waterfowl surveys from 1998-1999 with surveys conducted in 1973.

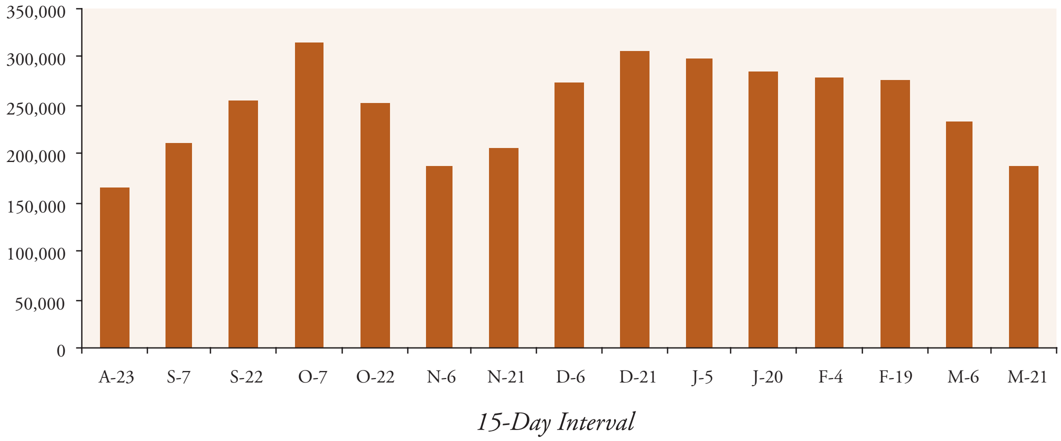


Figure 4-91. Population objectives by 15-day intervals for ducks in Tulare Basin.

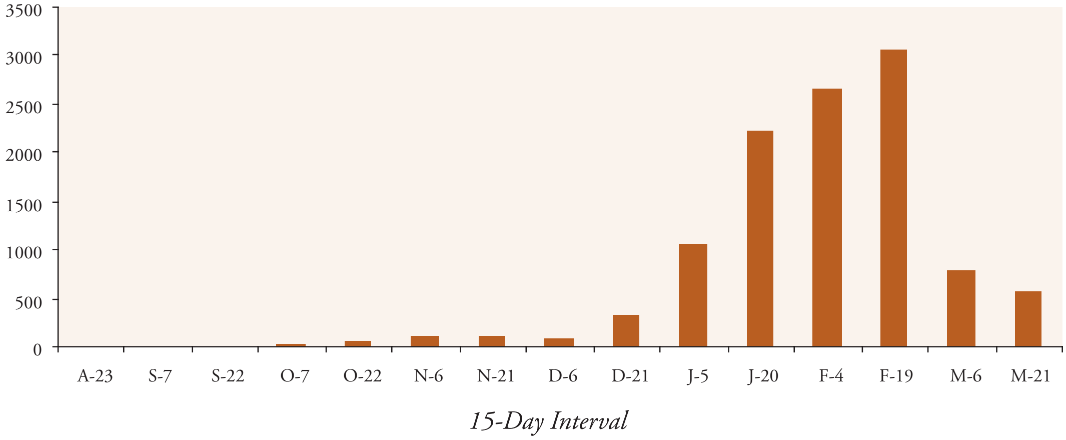


Figure 4-92. Population objectives by 15-day intervals for dark geese in Tulare Basin.

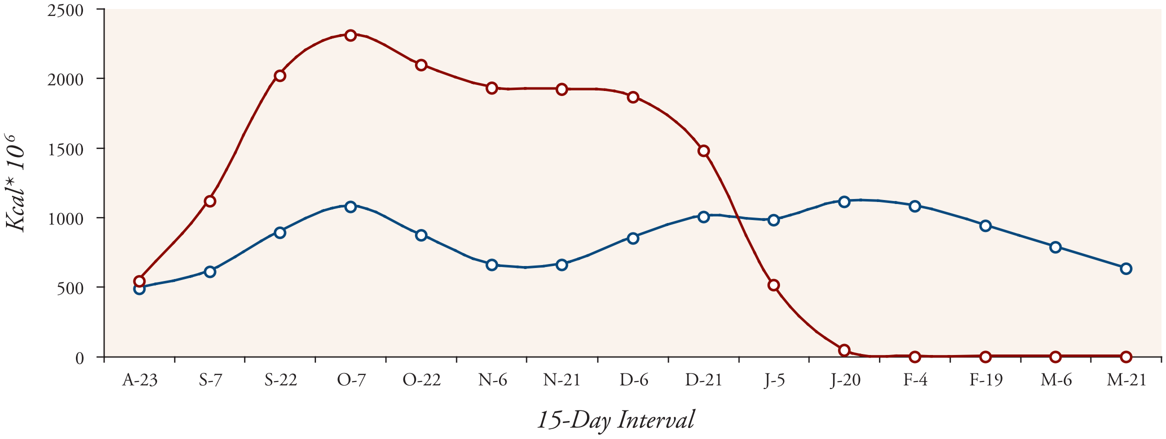


Figure 4-93. Population energy demand (blue) vs. food energy supply (red) for ducks in Tulare Basin when duck populations are at NAWMP goals.

Conservation Objectives

Wetland Restoration

The amount of seasonal wetlands required to meet duck energy needs in Tulare Basin is estimated at 39,212 acres. This estimate assumes that duck populations are at NAWMP goals, and that Figure 4-90c represents seasonal bird use of the basin. There are currently 20,212 acres of seasonal wetlands in the basin leaving a wetland restoration goal of 19,000 acres.

Seasonal Wetland Enhancement

The annual enhancement objective for existing seasonal wetlands in Tulare Basin is 1,684 acres/year. Wetland enhancement objectives will increase to 3,268 acres/year when seasonal wetland restoration objectives are met for the basin (Table 4-46).

Water Supplies for Seasonal Wetland Management

Annual management of seasonal wetlands in Tulare Basin will require 205,861 acre-feet of water when seasonal wetland restoration objectives in the basin have been met. These annual water requirements are further broken down by time period to reflect flooding schedules and summer irrigation needs (Table 4-47).

Agricultural Enhancement

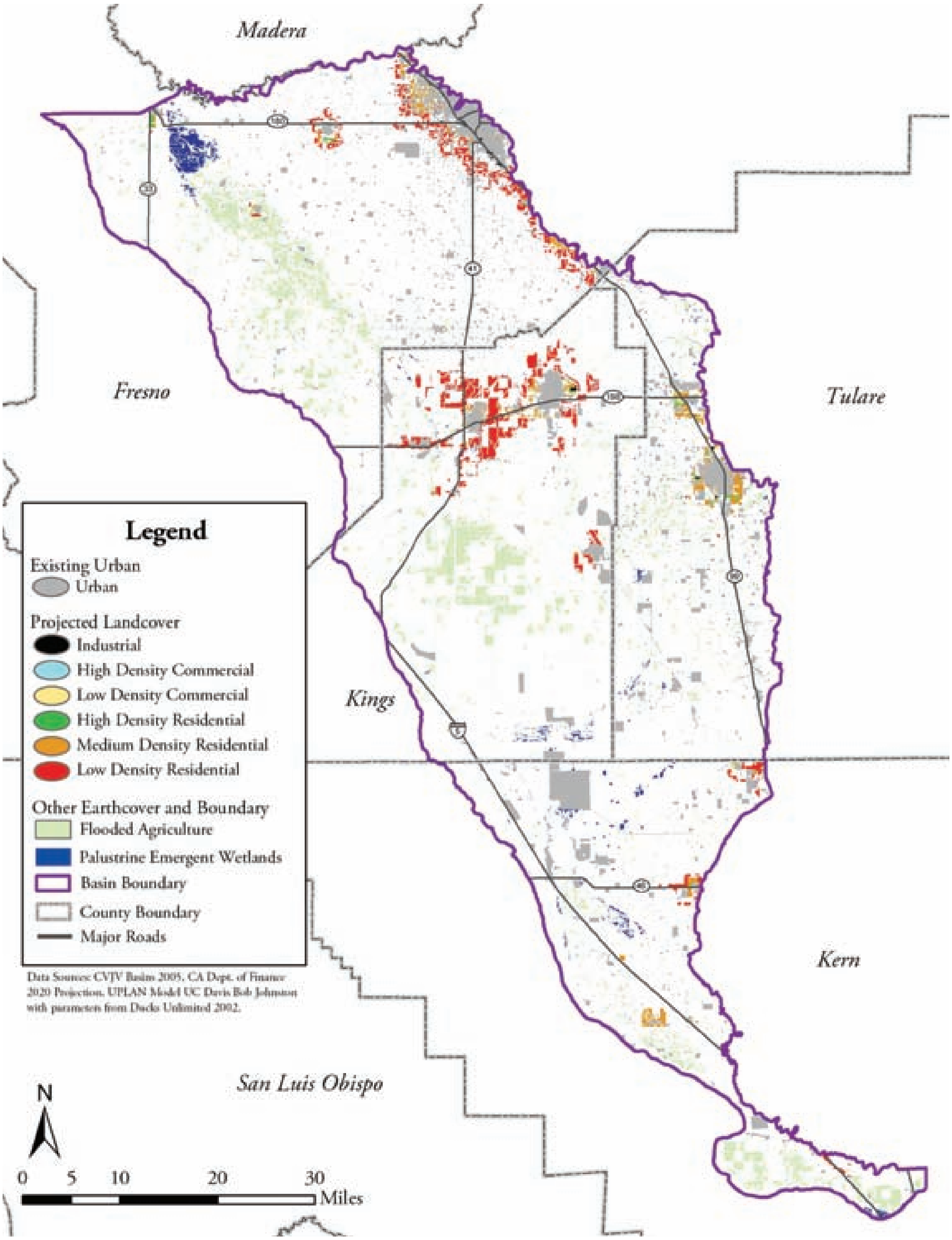
No agricultural enhancement objective currently exists for Tulare Basin. An agricultural enhancement objective may be developed, pending an assessment of the foraging value of pre-irrigated fields in the basin and an assessment of landowner interest in developing pre-irrigation practices that are beneficial to waterfowl.

Agricultural Easements for Maintaining Waterfowl Foods

No agricultural easements of this type are currently proposed for Tulare Basin.

Agricultural Easements to Buffer Urban Growth

Growth projections for Tulare Basin indicate that little residential and urban development will occur near existing wetlands (Figure 4-94). As a result, no agricultural easements to buffer growth are proposed for the basin.



Data Sources: CVJV Basins 2005. CA Dept. of Finance 2020 Projection. UPLAN Model UC Davis Bob Johnston with parameters from Ducks Unlimited 2002.

Figure 4-94. Projected growth in Tulare Basin to 2020.

Conservation Objective Priorities

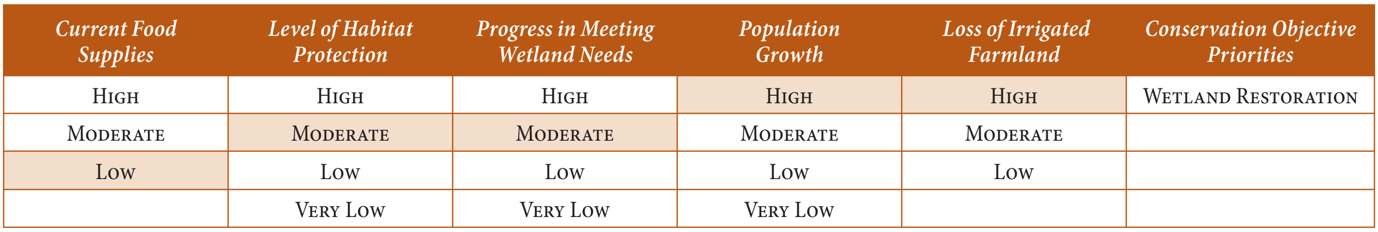
Conservation objectives for Tulare Basin are summarized in Table 4-48. The information used to prioritize conservation objectives is presented in Figure 4-95. Food supplies are less than 75% of duck needs and were therefore rated low. Habitat protection in the basin is moderate, as is progress in meeting wetland needs (20,212 acres present vs. 39,212 acres needed or 52%). Human population growth is categorized as high for the basin and is expected to exceed two million people. However, most of this growth will occur some distance from existing wetland habitats. Loss of irrigated farmland is rated as high; however a further assessment of the role of agriculture for ducks in the basin is needed before the effects of farmland loss can be evaluated.

Wetland restoration is a priority for Tulare Basin. The assessment of food energy supplies vs. food energy demands for ducks in the basin assumes that all wetlands, both existing and those to be restored, receive adequate water supplies. However, members of the Working Group currently believe that many existing wetlands are not flooded during fall and winter because of a lack of reliable and affordable water supplies. It is critical to recognize that the total seasonal wetland acreage need for the basin (39,212 acres) assumes that all these wetlands receive adequate water consistent with the flooding schedules for seasonal wetlands in the basin (Figure 4-9c). If wetland restoration objectives are met for the basin, but water is not available for these habitats, then duck population objectives for the basin will not be realized.

Table 4-48. Conservation objectives for wintering waterfowl in Tulare Basin.

Wetland Restoration (Acres)	*Wetland Enhancement (Acres)*	*Water Supplies (Acre-Feet)*	*Agricultural Enhancement (Acres)*	*Type I Agricultural Easements*	*Type II Agricultural Easements*
19,000	3,2698[a]	205,861[b]	None	None	None

[a] *Annual enhancement objective when the wetland restoration objective is met.*
[b] *Annual water supply need when the wetland restoration objective is met.*



Current Food Supplies	*Level of Habitat Protection*	*Progress in Meeting Wetland Needs*	*Population Growth*	*Loss of Irrigated Farmland*	*Conservation Objective Priorities*
High	High	High	High	High	Wetland Restoration
Moderate	Moderate	Moderate	Moderate	Moderate	
Low	Low	Low	Low	Low	
	Very Low	Very Low	Very Low		

Figure 4-95. Information used to prioritize conservation objectives for Tulare Basin.

Summary

Conservation objectives are summarized for each basin and for the entire Central Valley in Table 4-49. Wetland restoration remains a key conservation objective for most basins, with a total wetland restoration need of 104,000 acres. Figure 4-96 shows progress in meeting seasonal wetland restoration objectives in the Central Valley. Annual wetland enhancement objectives will exceed 23,000 acres when wetland restoration objectives are met for the Central Valley. Annual water needs for managing seasonal wetlands in the Central Valley will exceed 1.4 million acre-feet when wetland restoration objectives are met. Although some of this water is now guaranteed under the Central Valley Project Improvement Act of 1992, the JV will face significant challenges in helping secure reliable and affordable sources of water as human populations continue to increase in the Central Valley (Chapter 10). Agricultural enhancement objectives are currently exceeded for all basins, as most rice producers now use winter flooding to decompose straw. However, agricultural easements to maintain waterfowl food supplies and buffer existing wetlands from urban development may become increasingly important in basins where large increases in human populations are predicted.


Wood ducks
Photo: Brian Gilmore

Table 4-49. Conservation objectives for wintering waterfowl in the Central Valley of California.

Basin	*Wetland Restoration (Acres)*	*Wetland Enhancement (Acres)*[a]	*Water Supplies (AF)*[b]	*Agricultural Enhancement (Acres)*	*Type I Agricultural Easement*[e]	*Type II Agricultural Easement*[f]
American	20,000	1,932	115,890	69,000[c] 50,000[d]	Needed	Needed
Butte	17,000	3,362	225,904	104,000[c] 62,000[d]	Needed	Needed
Colusa	2,000	2,033	121,980	85,000[c] 45,000[d]	None	None
Delta	19,000	2,112	120,408	23,000[c]	Needed	Needed
San Joaquin	20,000	6,751	441,521	0	None	Needed
Sutter	4,000	496	29,755	18,000[c] 10,000[d]	Needed	Needed
Suisun	0	2,686	153,102	0	None	None
Yolo	3,000	963	57,790	8,000[c] 3,000[d]	None	None
Tulare	19,000	3,268	205,861	Undetermined	None	None
Total	104,000	23,603	1,472,211	307,000[c] 170,000[d]		

[a] *Annual wetland enhancement objective when wetland restoration objectives are met for a basin. The wetland enhancement objective assumes that wetlands undergo some maintenance or enhancement an average of every 12 years.*

[b] *Annual acre-feet of water needed to manage seasonal wetlands when wetland restoration objectives are met for a basin.*

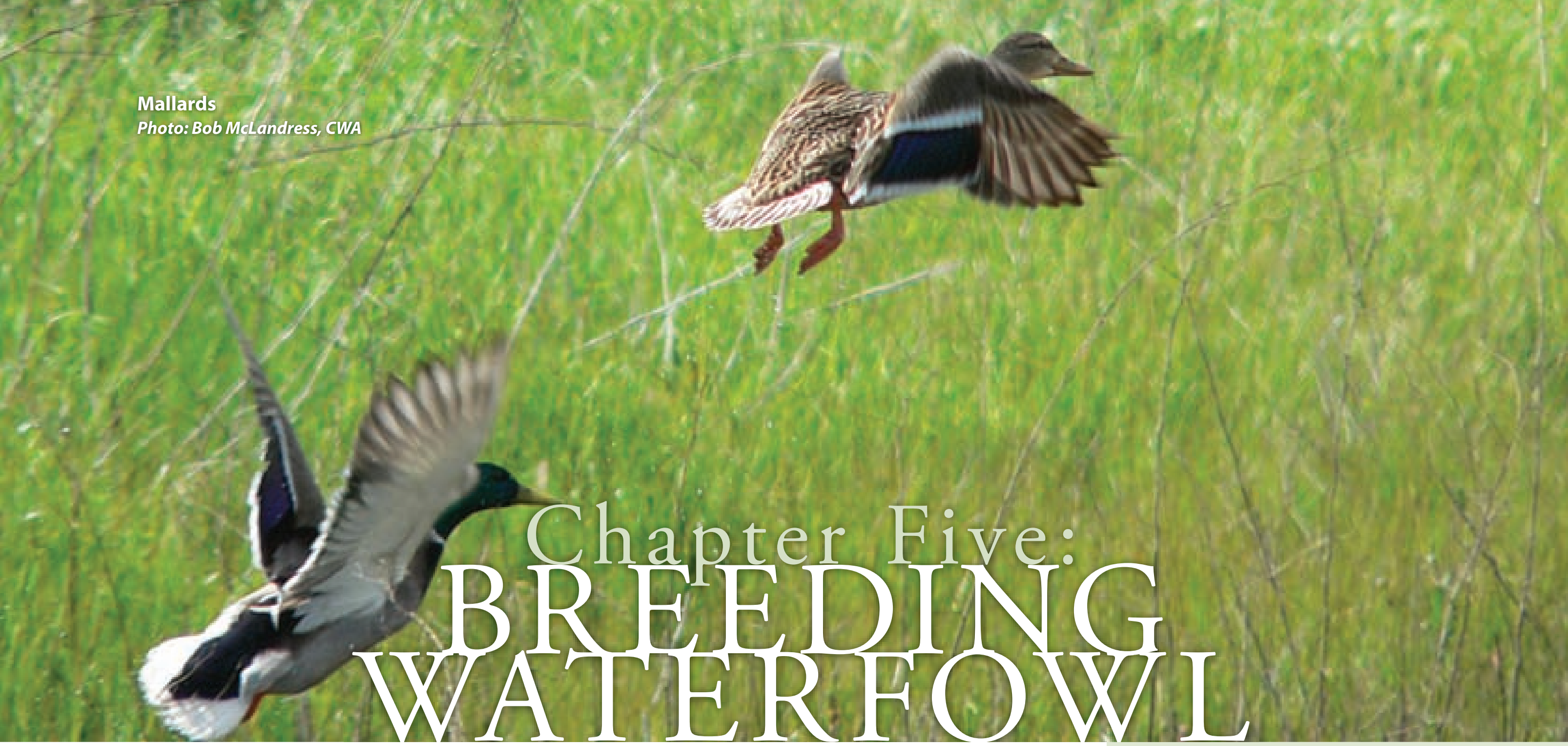
[c] *Agricultural enhancement objectives represent the amount of agricultural habitat needed to meet the needs of ducks and geese when wetland restoration objectives are met for a basin. Enhancement includes fields (rice or corn) that are not deep plowed following harvest or are winter-flooded. Agricultural enhancement in most basins include only rice, however, corn is an important habitat type in the Delta and Yolo Basins. Agricultural enhancement objectives are currently met for all basins.*

[d] *Acres of the agricultural objective that must be flooded to meet duck needs (e.g., a minimum of 50,000 acres of the American Basin's total agricultural enhancement objective of 69,000 acres must be flooded).*

[e] *Agricultural easements to maintain waterfowl food sources on agricultural lands.*

[f] *Agricultural easements to buffer wetlands from the impacts of residential and urban growth.*

Figure 4-96. Progress in meeting seasonal wetland restoration objectives in the Central Valley.



Mallards
Photo: Bob McLandress, CWA

Chapter Five:
BREEDING WATERFOWL

This chapter discusses the habitat needs and associated conservation efforts for breeding waterfowl in the Central Valley. Mallards *(Anas platyrhynchos)* comprise 80% of the breeding waterfowl in the valley and a significant amount of biological information is available for this species. As a result, recommendations for breeding waterfowl are largely based on the JV's understanding of mallard breeding ecology.

> "California's Central Valley is unique among waterfowl wintering grounds in North America in that it also provides habitat for healthy breeding populations of several duck species. The challenges of providing for the life requisites of local nesting as well as wintering waterfowl require innovative approaches and a variety of wetland and upland habitat management techniques unlike anywhere else."
>
> **Robert McLandress, Ph.D.**
> *President*
> *California Waterfowl Association*

Introduction

Although conservation planning for waterfowl in the Central Valley has largely focused on meeting the needs of wintering birds, significant numbers of ducks also breed in the valley. Habitat needs of breeding ducks differ substantially from that of wintering ducks and include the use of different wetland types and the need for upland nesting cover. As a result, the 2006 Plan has developed distinct conservation strategies for breeding waterfowl.

Locally produced ducks now comprise up to 20% of the total duck harvest in California with most of those birds being mallards. As a result, local mallard production has become increasingly important to hunter success. Most private wetland owners in the Central Valley manage their land with the purpose of hunting waterfowl. These private wetland owners provide nearly seventy percent of all wetland habitats and incur substantial costs in doing so. Providing a reasonable level of hunter success is critical to this continued private investment in wetlands. The JV's efforts to increase the size and success of breeding waterfowl populations can contribute to this goal.

The 1990 Plan identified a breeding population objective of 490,000 ducks, of which 300,000 were mallards. These objectives were based on a goal of producing a local fall flight of one million birds. However, breeding populations of waterfowl can vary considerably from one year to the next in response to environmental factors (i.e., rainfall) that effect breeding habitat conditions. Population objectives for breeding waterfowl in the 2006 Plan have been modified to accommodate annual variation in breeding habitat conditions. Specifically, the JV's breeding waterfowl objective is to "maintain, enhance, and restore sufficient habitats to increase mallard populations by 25% over the range of variation observed from 1992-2002." During this period, the Central Valley estimate of breeding mallards ranged from 186,000 to 389,000 (D. Yparraguirre, California Department of Fish and Game, personal communication). Meeting the 2006 objective would result in mallard populations ranging between 232,000 and 486,000 birds. Population objectives for wintering waterfowl are usually translated into quantifiable estimates of habitat need, as was the case in Chapter 4 (e.g., acres of foraging habitat). However, there is no clear link between population objectives for breeding waterfowl and the amount of habitat needed to support some range of breeding birds. One alternative for establishing habitat programs for breeding waterfowl in the Central Valley is the approach used in the U.S. Prairie Pothole Region (PPR). See Appendix 5-1. Breeding waterfowl objectives were established for the PPR in the 1986 North American Waterfowl Management Plan. However, planning efforts in the PPR have largely focused on identifying what vital rates limit breeding duck numbers and developing habitat programs to address these limitations. The JV defines vital rates as population parameters that potentially limit the growth of duck populations (Table 5-1). For example, nest success is believed to limit duck populations across much of the PPR and conservation efforts have focused on restoring and protecting upland cover. This approach assumes that population objectives for breeding waterfowl in the PPR will be met if the biological factors that limit duck numbers are identified and addressed.

Conservation planning for breeding waterfowl in the 2006 Plan is conceptually based on planning efforts for waterfowl in the PPR, and is further described in Appendix 5-1. Although planning efforts in the 2006 Plan focus on mallards, several species of ducks breed in the Central Valley including gadwall *(Anas strepera)*, cinnamon teal *(A. cyanoptera)*, ruddy duck *(Oxyura jamaicensis)*, redhead *(Aythya Americana)*, and wood duck *(Aix sponsa)*. Habitat needs of these species during the breeding season differ from mallards and may be addressed in future planning efforts. The remainder of this chapter is divided into 2 sections: (1) a review of planning information available for breeding mallards in the Central Valley; and (2) conservation objectives for breeding mallards in the Central Valley.

A Review of Planning Information Available for Breeding Mallards in the Central Valley

Habitat programs in the PPR address the biological factors that most limit duck numbers. Moreover, it is recognized that different conservation strategies are needed for different landscapes, and that habitat programs for breeding waterfowl should not be pursued in all areas.

Table 5-1. Vital rates that may limit the growth of duck populations including mallards that breed in the Central Valley of California.

Vital Rate	*Definition*
Breeding Incidence	Percent of females that initiate at least one nest attempt
Mean Clutch Size	Average number of eggs laid per nest
Nest Success	Percent of nest hatching one or more eggs
Egg Success	Percent of eggs that hatch in successful nests
Re-nesting Intensity	Probability that females will re-nest after the loss of a nest, and how this probability changes with successive nest attempts
Duckling Survival	Percent of hatched ducklings that successfully fledge
Breeding Survival	Survival of females during the breeding season
Non-Breeding Survival	Survival of females during the non-breeding season
Annual Survival[a]	Annual survival of females

[a] *Annual survival is the product of survival during the breeding season and survival outside of the breeding season.*

Implementing targeted habitat programs to efficiently increase duck populations is also a goal of the JV. However, all the information needed to duplicate the PPR planning effort is not yet available for the Central Valley. As a result, the JV reviewed: (1) vital rate information that is available for Central Valley breeding mallards; (2) habitat programs that address specific vital rates; and (3) available information that can be used to develop spatial planning tools for the Central Valley.

Vital Rate Information for Central Valley Mallards

Vital rate information is available for breeding mallards in the Central Valley from several published and unpublished sources (Table 5-2). Results of these studies are briefly summarized below.

Table 5-2. Vital rates estimates available for mallards breeding in the Central Valley of California.

Breeding Incidence				
Estimate	Age[b]	Year	Basin(s)	Source
0.692[a]	SY	2004	Colusa	Oldenburger 2005
0.755[a]	ASY	2004	Colusa	Oldenburger 2005
0.932[a]	SY	2005	Colusa	Oldenburger 2005
0.948[a]	ASY	2005	Colusa	Oldenburger 2005
Clutch Size				
Estimate	Age	Year(s)	Basin	Source
7.828	SY	1985-2003	Suisun	CWA, unpublished data
8.974	ASY	1985-2003	Suisun	CWA, unpublished data
Egg Survival				
Estimate		Year(s)	Basin(s)	Source
0.82		1985-2003	Suisun Marsh	CWA, unpublished data
0.68		1995-2001	Yolo	CWA, unpublished data
0.69		2002-2004	Colusa & Yolo	CWA, unpublished data
Re-nesting Intensity				
Estimate	Age	Year	Basin	Source
Note: None estmated, but MAX = 3 based on radioed females (Oldenburger, unpublished data)				
Duckling Survival				
Estimate	Age	Year	Basin	Source
0.38		1993	Butte	Yarris 1995
0.35		1994	Butte	Yarris 1995
0.36		1996	San Joaquin	2000–Chouinard
0.18		1997	San Joaquin	2000–Chouinard
Breeding Survival				
Estimate	Age	Year	Basin	Source
0.840[a]	SY	2004-2005	Colusa	Oldenburger 2005
0.909[a]	ASY	2004-2005	Colusa	Oldenburger 2005
Annual Survival				
Estimate	Age	Year	Basin	Source
0.48	HY	1948-1982	*	Reinecker 1990
0.58	AHY	1948-1982	*	Reinecker 1990
0.612	HY	1970-2002	*	Herzog (unpublished data)
0.607	AHY	1970-2002	*	Herzog (unpublished data)

Continued…

Nest Success			
Estimate	Year	Basin(s)	Source
0.617	1985	Suisun Marsh	CWA, unpublished data
0.453	1986	Suisun Marsh	CWA, unpublished data
0.329		Butte & Colusa	McLandress et al. 1996
0.490	1987	Suisun Marsh	CWA, unpublished data
0.228		San Joaquin	McLandress et al. 1996
0.227		Butte & Colusa	McLandress et al. 1996
0.257	1988	Suisun Marsh	CWA, unpublished data
0.504		San Joaquin	McLandress et al. 1996
0.365		Butte & Colusa	McLandress et al. 1996
0.098	1989	Suisun Marsh	CWA, unpublished data
0.373		San Joaquin	McLandress et al. 1996
0.630	1990	Butte & Colusa	CWA, unpublished data
0.426		Suisun Marsh	CWA, unpublished data
0.372		San Joaquin	McLandress et al. 1996
0.250	1991	Butte & Colusa	CWA, unpublished data
0.513		Suisun Marsh	CWA, unpublished data
0.212		San Joaquin	CWA, unpublished data
0.463	1992	Suisun Marsh	CWA, unpublished data
0.285	1993	Suisun Marsh	CWA, unpublished data
0.273	1994	Suisun Marsh	CWA, unpublished data
0.377	1995	Suisun Marsh	CWA, unpublished data
0.570		Yolo	CWA, unpublished data
0.174	1996	San Joaquin	deSzalay et al. 2003
0.225		Suisun Marsh	CWA, unpublished data
0.082	1997	San Joaquin	deSzalay et al. 2003
0.054		Suisun Marsh	CWA, unpublished data
0.068	1998	Suisun Marsh	Ackerman, unpublished data
0.560		Yolo	CWA, unpublished data
0.091	1999	Suisun Marsh	Ackerman, unpublished data
0.333	2000	Suisun Marsh	Ackerman, unpublished data
0.138	2001	Suisun Marsh	CWA, unpublished data
0.220	2002	Colusa & Yolo	CWA, unpublished data
0.145		Suisun Marsh	CWA, unpublished data
0.368	2003	Colusa & Yolo	CWA, unpublished data
0.139		Suisun Marsh	CWA, unpublished data
0.271	2004	Colusa & Yolo	CWA, unpublished data
0.068		Delta	CWA, unpublished data
0.031		Colusa	CWA, unpublished data
0.426	2005	Colusa & Yolo	CWA, unpublished data

[a] *Preliminary analysis*

[b] *Age: HY (hatch year); AHY (after hatch year); SY (second year); ASY (after second year)*

Breeding Incidence

Estimates of breeding incidence are limited to a single study in the Colusa basin (Table 5-2). While less than 80% of all females initiated nests in the first year of the study, over 90% of all marked females were known to nest in the study's second year (Table 5-2). Similar studies in the prairies and elsewhere have reported breeding incidence > 90% (Hoekman 1992). Lower breeding incidence is plausible for mallards in the Central Valley as most seasonal wetlands are drained prior to the breeding season, which greatly reduces wetland availability for breeding pairs. Density dependant factors (e.g., spacing behavior of breeding pairs) may prevent some females from breeding in areas where bird densities are high and wetlands are few. Additional spring wetland habitat in these areas may result in increased breeding incidence.

Nest Success

Nest success in the Central Valley appears to be high relative to other populations of mallards in North American. Twenty-nine of thirty-nine studies have reported nest success >15% (Table 5-2). Some nest success estimates for the Central Valley are site-specific (e.g., winter wheat, rice-set aside lands, or refuges and wildlife areas). These site-specific estimates may not reflect nest success at the population level if birds using these habitats experience abnormally high success. However, a recent study of mallards that were marked prior to the breeding season estimated 35% nest success (S. Oldenburger, unpublished data). This study does provide an unbiased estimate of nest success, and suggests that nest success estimates from earlier site-specific studies may be representative of nest success at the population level.

Duckling Survival

Duckling survival estimates that are available for mallards in North American typically range between 35% and 45% (Hoekman et al. 2002) though estimates from the Central Valley generally fall within the low end of this range. There is some indication that early-hatched ducklings in portions of the Central Valley may experience low survival rates (G. Yarris, California Waterfowl Association, personal communication). Ducklings that are hatched later in the breeding season often have access to actively growing rice fields that provide an abundance of emergent cover. However, early-hatched ducklings may have to rely solely on a limited numbers of wetlands. Although it is difficult to generalize the importance of duckling survival to overall mallard population growth, low duckling survival could be limiting mallard numbers in some areas of the valley.

Female Survival Rates

Breeding survival rates for female mallards in the Central Valley have varied between 0.84 and 0.909 (Table 5-2), which is generally higher than that reported for prairie breeding birds (Devries et al. 2003). Annual survival rates of adult and juvenile female mallards banded in the Central Valley are similar to those reported for the prairies (Table 5-2). Although female survival rates are not believed to limit mallard numbers on the prairies, it is not possible at this time to reach any conclusion about the role of female survival in limiting mallard populations in the valley. On-going research indicates that female survival during molt may be low in some Klamath Basin habitats, where a large portion (>60%; Yarris et al. 1994) of the valley population goes to molt, but data from other molting areas are lacking and population impacts have not been determined.

Demographic Modeling

Research efforts over the past two decades have provided valuable information on mallard vital rates in the Central Valley. However, it would be inappropriate to use this information in demographic models designed to identify what factors limit population growth. The vital rate estimates available for Central Valley mallards were obtained over different time periods, and from different regions (e.g., Sacramento vs. San Joaquin Valley). An ongoing study of breeding mallards in the Colusa Basin is providing vital rate estimates that are needed for demographic modeling (Oldenburger et al. 2005). This research is an important step in identifying factors that limit mallard populations in the Valley.

Habitat Programs That Address Specific Vital Rates

The use of targeted habitat prescriptions has been successful in addressing limiting factors for breeding waterfowl in a variety of areas across North America. Although the vital rate(s) that limit mallard populations in the Central Valley are relatively unknown, we do have some understanding of what habitat programs can be used to improve them. The following information can be used to develop preliminary conservation programs for mallards breeding in the Central Valley.


Mallard nest
Photo: Bob McLandress, CWA

Nest Success

Studies of nesting waterfowl in the Central Valley indicate that set-aside agricultural fields planted with a cover crop can support large numbers of mallards and promote high nest success (Loughman et al. 1991). If nest success does limit mallard populations, then programs that provide landowner incentives to set aside agricultural land (e.g., Conservation Reserve Enhancement Program [CREP]) may be effective in addressing this limiting factor.

Duckling Survival

Duckling survival may be heavily dependent on food availability, especially in the period immediately after hatch (Sedinger 1992). Reverse-cycle wetlands (i.e., wetlands flooded from spring through late summer) provide greater densities of invertebrates in May than do seasonal or permanent wetlands in the Central Valley (deSzalay et al. 2003). Most mallard ducklings hatch in May when they rely heavily on aquatic invertebrates. If duckling survival does limit mallard populations in the Central Valley, increasing the acres of reverse-cycle wetlands may be an effective tool for increasing duckling food supplies and ultimately survival.

Spatial Planning Tools for Breeding Mallards in the Central Valley

At a minimum, spatial planning tools developed for the Central Valley should include: (1) the spatial distribution of breeding mallards throughout the Central Valley; (2) the spatial distribution of wetland and rice habitats used by breeding mallards; and (3) the spatial distribution of potential nesting cover. In some cases (e.g., the PPR), the spatial distribution of wetlands and breeding waterfowl may be highly correlated. Information on the distribution of breeding mallards, wetlands, and nesting cover is available for the entire Central Valley and is summarized below.

Distribution of Breeding Mallards

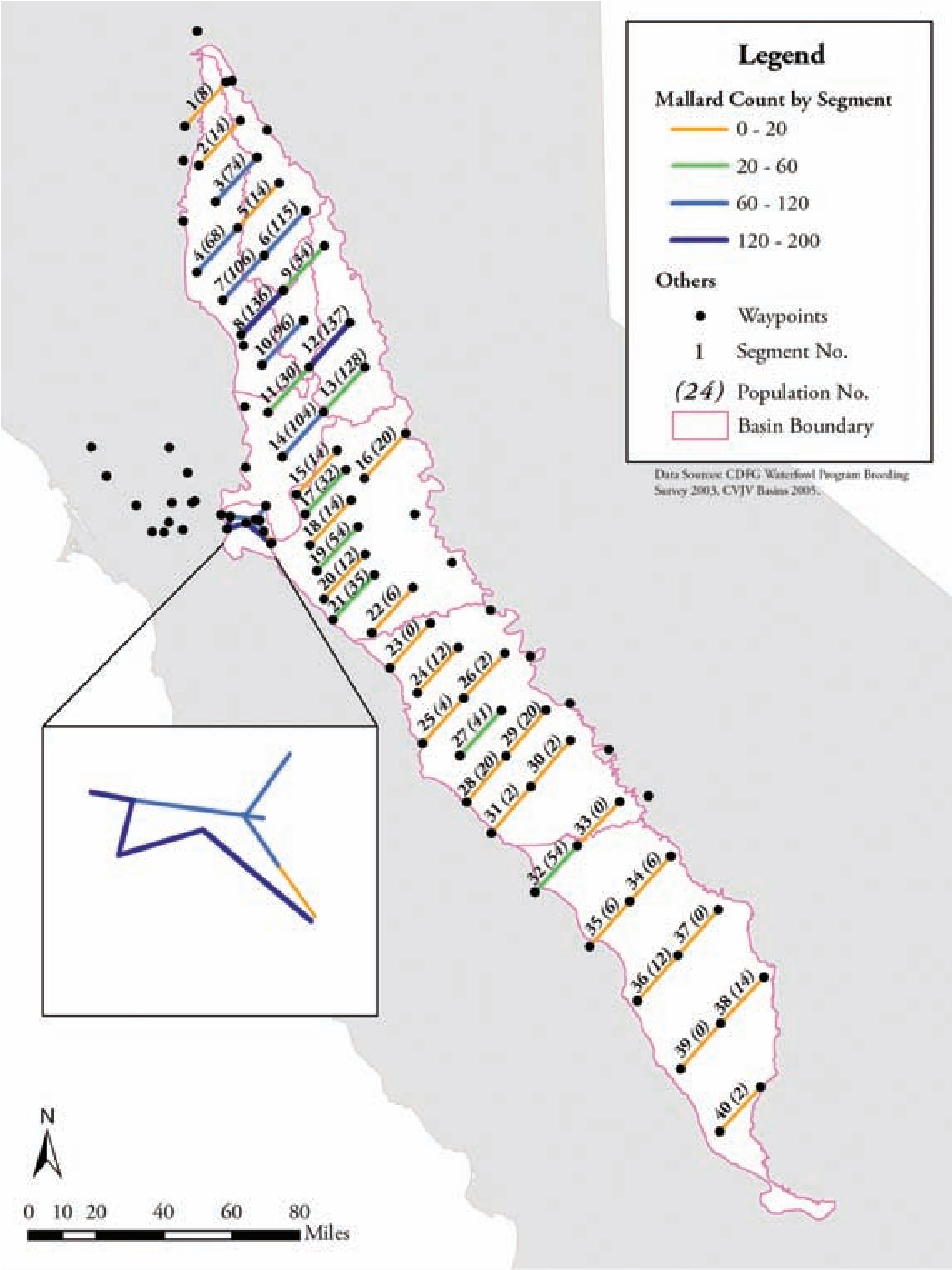
Biologists with the California Department of Fish and Game (CDFG) annually conduct surveys of breeding waterfowl in the Central Valley. These surveys were initiated in 1992, and include 43 transects that are orientated northeast to southwest. Transects are included in all nine of the valley's drainage basins. To better understand the distribution of breeding mallards throughout the Central Valley, mallard counts were averaged for each transect between 1992 and 2002. A comparison of these transects revealed substantial differences in mallard densities among basins. For example, mallard densities in the Colusa and Suisun Marsh Basins are high relative to densities in the Tulare Basin (Figure 5-1). Information on mallard densities between 1992 and 2002 was used to categorize mallard breeding densities in each basin as high, medium, or low (Figure 5-2).

Distribution of Wetlands for Breeding Waterfowl

Managed wetlands in the Central Valley are categorized as seasonal or semi-permanent. Most wetlands used by breeding mallards in the valley are assumed to be semi-permanent because seasonal wetlands are typically drained prior to the breeding season. Semi-permanent wetlands are defined as wetlands that are flooded from early fall through late July or August. Total managed wetlands in the valley are estimated at 205,554 acres (see Chapter 3), and the distribution of these wetlands is depicted in Figure 5-3. Although 85%-90% of these wetlands are seasonal, it is assumed that the distribution of total managed wetlands in Figure 5-3 reflects the distribution of semi-permanent wetlands as well. Differences in the distribution of semi-permanent wetland acres among basins are depicted in Figure 5-4.

Surveys of breeding waterfowl in 2003 used GPS technology to plot mallard distribution along transect routes. As a result, it is possible to associate mallard densities with landscape characteristics and to sub-divide transects that cross drainage basin boundaries. For example, mallard densities within and among transects may differ in response to differences in wetland acres along transect routes. A very preliminary analysis of mallard pair locations during the 2003 survey indicates that pair densities were higher in basins having greater amounts of semi-permanent wetlands.[1]

[1] *Regression of mallard pair densities and acres of semi-permanent wetland habitat within a basin suggests a linear relationship with an r2 value of 0.85 (K. Petrik, Ducks Unlimited, Inc., personal communication). This relationship is only based on results from five drainage basins because 2003 mallard locations are still being processed. However, mallard breeding densities do appear to be positively associated with wetland densities, as is the case in the PPR.*



Data Sources: CDFG Waterfowl Program Breeding Survey 2003, CVJV Basins 2005.

Figure 5-1. Aerial survey transects for breeding waterfowl in the Central Valley.

Data Sources: Derived from CDFG Waterfowl Program Breeding Survey 2003, CVJV Basins 2005.

Figure 5-2. Relative densities of breeding mallards among basins.

Data Sources: CVJV Basins 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 5-3. Wetland distribution in the Central Valley.

Data Sources: CVJV Basins 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999.

Figure 5-4. Acres of semi-permanent wetlands (breeding wetlands) by basin.

Distribution of Rice

Rice fields provide habitat for both breeding mallard pairs and ducklings during the brood rearing period (April through August). The distribution of existing rice land is depicted in Figure 5-5.

Distribution of Potential Nesting Cover

Potential waterfowl nesting cover in the Central Valley includes grain and hay crops, native vegetation, and pasture (Loughman et al. 1991). The distribution of these three cover types was mapped using data from the California Department of Water Resources for areas of the valley with less than four degrees of slope (Figure 5-6). This slope constraint was applied to potential nesting habitat to exclude areas of the valley that are unlikely to be used by breeding mallards. Grain and hay crops, native vegetation, and pasture were then combined to depict the total amount of available nesting cover (Figure 5-7).

Combining Data Layers

Figure 5-8 reflects the spatial distribution of managed wetlands and upland nesting cover throughout the Central Valley. These layers were subsequently combined with the distribution of planted rice to depict all the major habitats used by breeding mallards in the Central Valley (Figure 5-9). Although these spatial data provide a first step in developing conservation objectives for breeding mallards, it remains unclear how well these data depict the habitat resources that are available to breeding birds (e.g., To what extent do nesting birds make use of pasture in the Central Valley?). Understanding the spatial data that are needed for breeding waterfowl would contribute significantly to future conservation planning efforts.

Conservation Objectives for Breeding Mallards in the Central Valley

Possible conservation objectives for breeding waterfowl in the Central Valley may include: (1) increasing the acreage of semi-permanent wetlands (wetlands used by breeding waterfowl) by restoring semi-permanent wetlands or managing existing seasonal wetlands as semi-permanent habitats; (2) protection of existing semi-permanent wetlands; (3) restoration of upland nesting cover; and (4) protection of existing nesting cover. Conservation programs to restore or protect semi-permanent wetlands increase the amount of habitat for breeding mallard pairs, and for brood-rearing females. This may result in higher densities of breeding birds and in greater duckling survival. Similarly, conservation programs to restore or protect upland nesting cover may lead to increases in nest success.

Protecting existing unprotected wetlands will be a minor conservation objective for breeding mallards, because most wetlands are already under easement or are publicly owned (Chapter 2). However, restoring semi-permanent wetlands and providing incentives for landowners to maintain restored and existing wetlands in a semi-permanent condition may be an important conservation objective in some basins. Water costs for these wetlands are high and management of emergent vegetation is expensive. As a result, many landowners are reluctant to maintain semi-permanent wetlands. Private lands programs that have traditionally paid landowners to maintain wetland habitats (e.g., CDFG's California Waterfowl Habitat Program and the USDA Waterbank Program) would be crucial to this conservation objective.

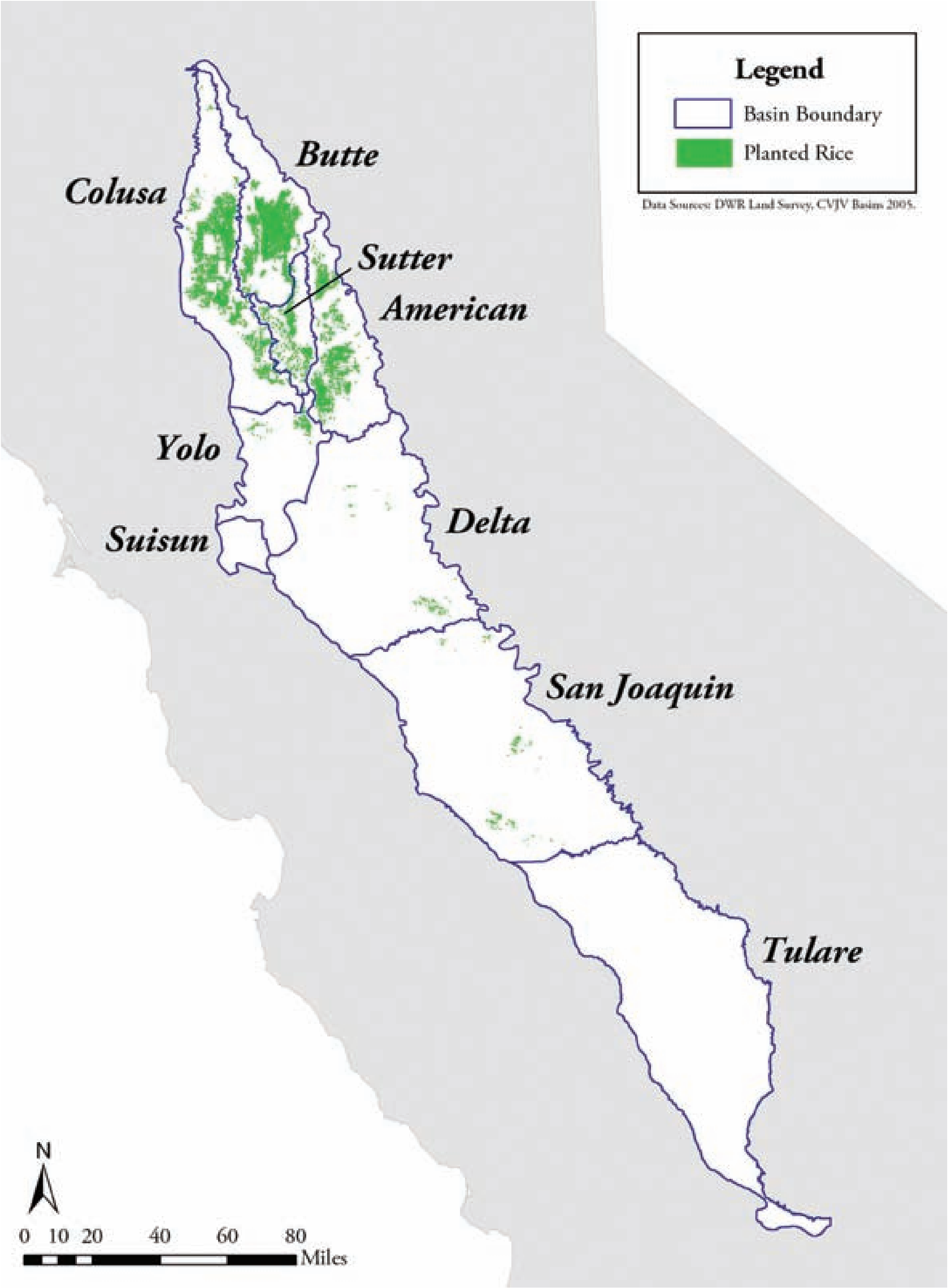
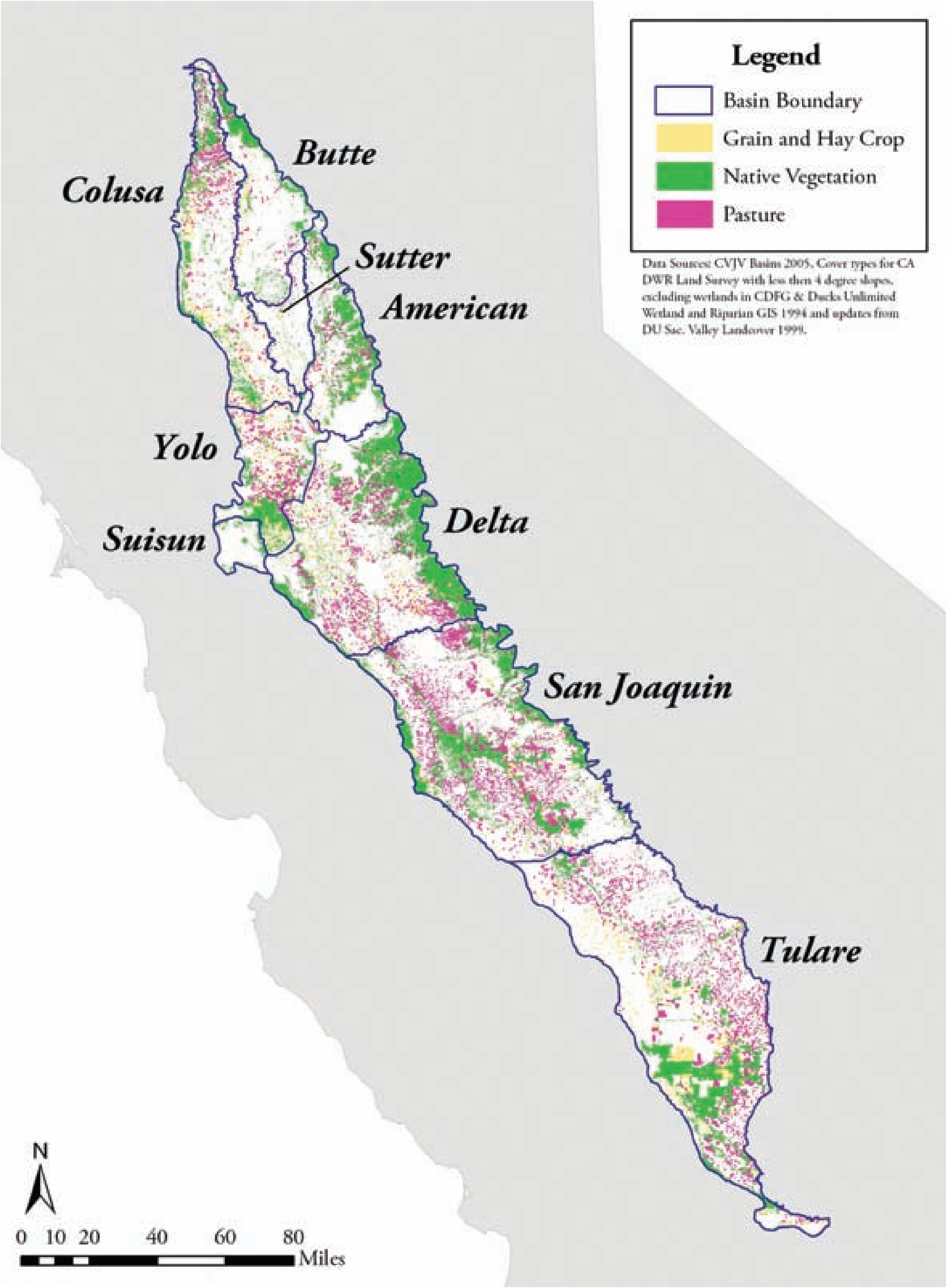
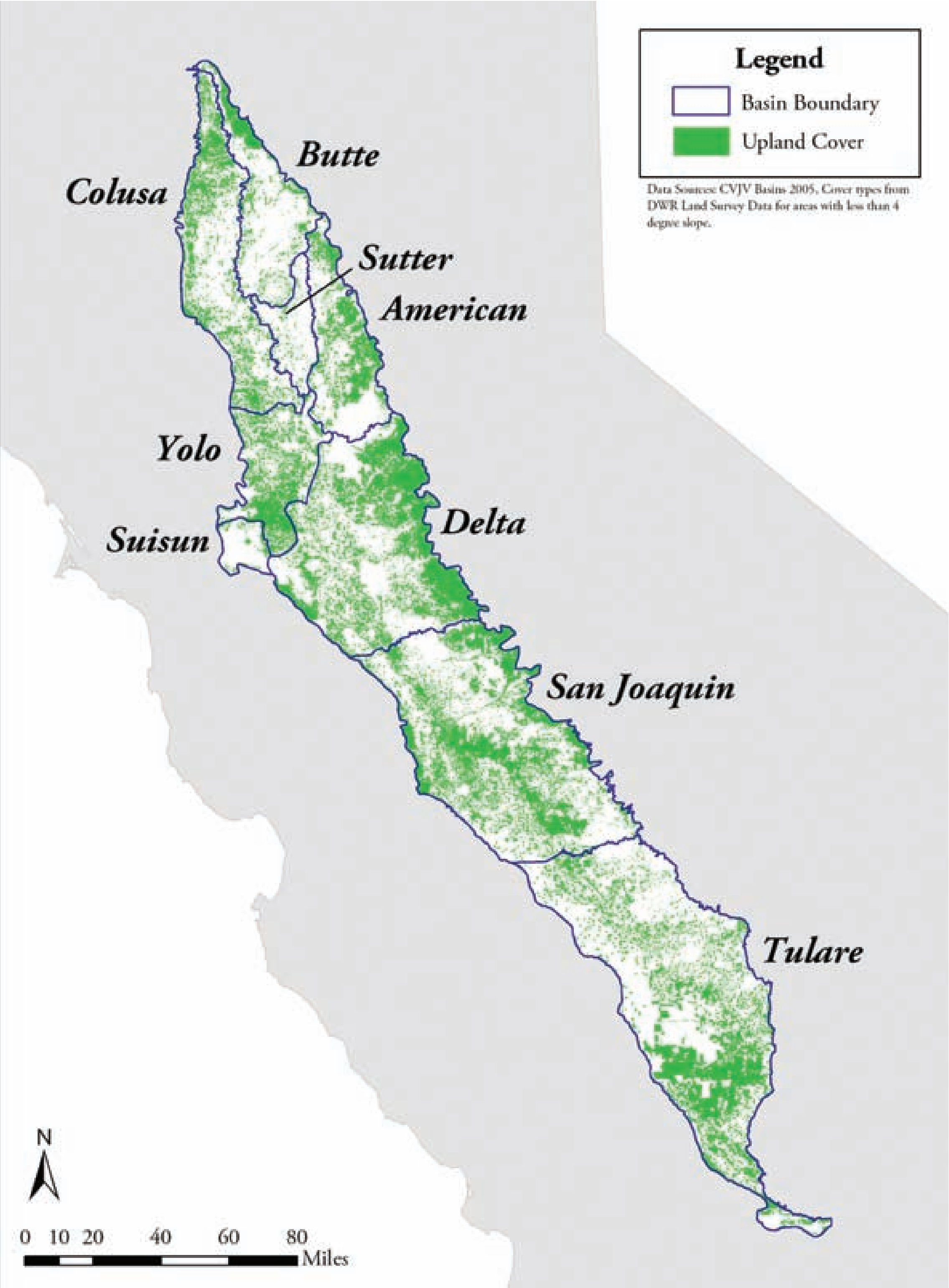


Figure 5-5. Distribution of planted rice in the Central Valley.



Data Sources: CVJV Basins 2005. Cover types for CA DWR Land Survey with less then 4 degree slopes, excluding wetlands in CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 and updates from DU Sac. Valley Landcover 1999.

Figure 5-6. Distribution of potential nesting cover types in the Central Valley.

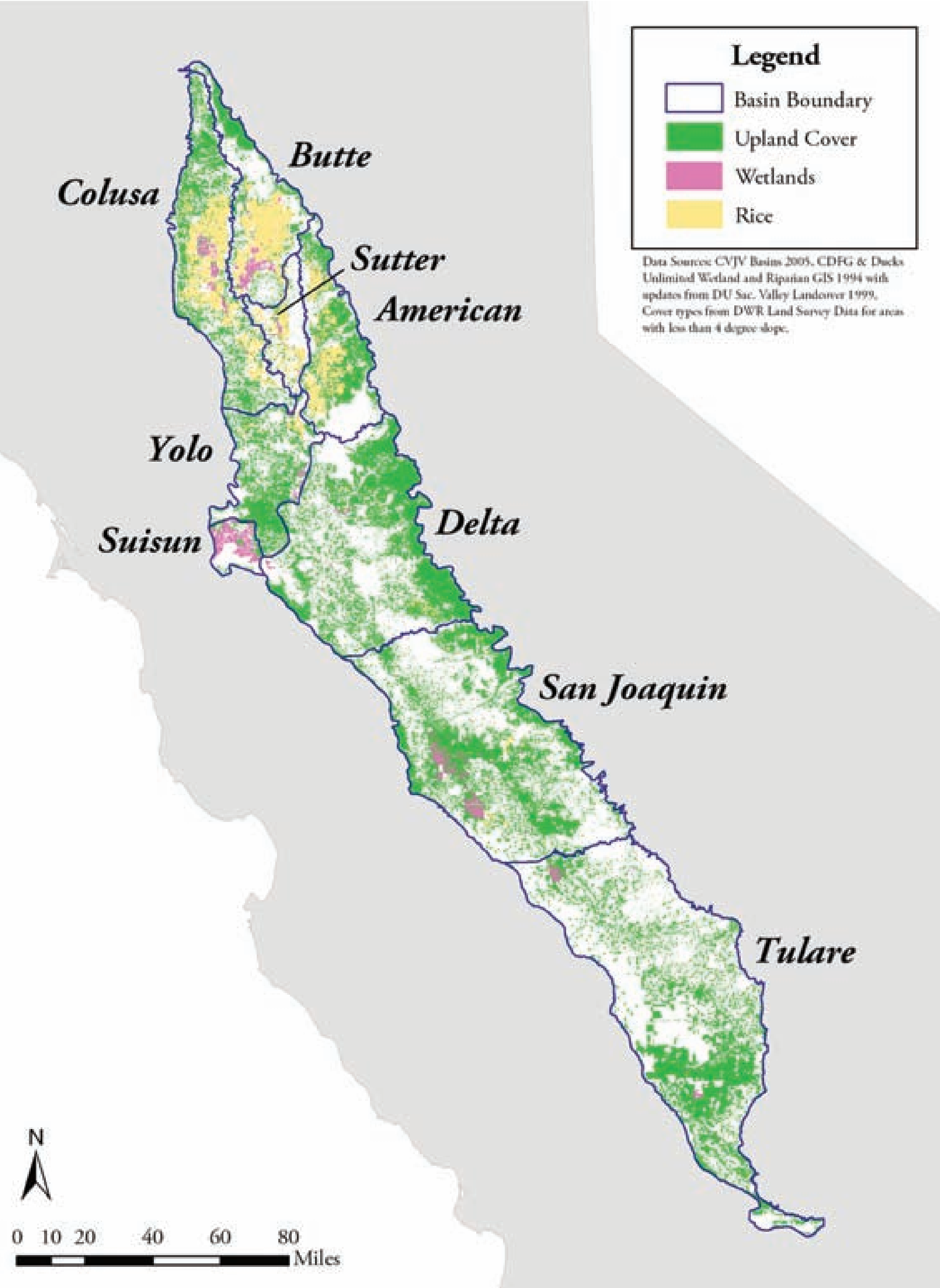


Data Sources: CVJV Basins 2005, Cover types from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-7. Distribution of potential nesting cover in the Central Valley.

Data Sources: CVJV Basins 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999, Cover types from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-8. Distribution of wetlands and upland cover in the Central Valley.



Data Sources: CVJV Basins 2005, CDFG & Ducks Unlimited Wetland and Riparian GIS 1994 with updates from DU Sac. Valley Landcover 1999. Cover types from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-9. Distribution of potential upland cover, rice, and wetlands.

Protecting nesting cover is unlikely to be a conservation objective for breeding mallards. Conservation programs to protect nesting habitat in the Central Valley would rely on farmland easements to protect existing cover, especially in areas where grains, hay land, and pasture provide the majority of nesting habitat. In the PPR, agricultural easements are inexpensive and nesting densities on these protected uplands are typically high. As a result, large numbers of birds are benefited at low costs. However, easement costs in the Central Valley would likely be too high, while nesting densities on these properties may be too low to justify the expense of a permanent easement. Accordingly, upland programs for nesting mallards are likely to focus on restoring upland cover in areas where breeding densities are high but the availability of nesting cover is low. These restoration programs will have to offer economic incentives that are competitive with commodity markets and Farm Bill Programs. In addition, they are likely to be short term in nature (e.g., 3-5 years) with farmers having an option to leave the program after the contract expires. The Sacramento Valley CREP pilot project, for example, provides landowners with an economic incentive to convert agricultural lands back to native cover for ten-year periods. If the CREP is delivered in areas where breeding densities are high it may benefit large numbers of birds at reasonable costs. The USDA Conservation Security Program is another new and well-funded program that could provide similar benefits for nesting waterfowl.

Based on available information, increasing and maintaining the amount of semi-permanent wetland habitat and expanding nesting cover in key areas appears to be the most appropriate conservation objectives for breeding mallards in the Central Valley. Moreover, the spatial distribution of existing wetland and upland resources can identify where these conservation objectives are best applied on the landscape.

Although the JV does not yet know what vital rates limit mallard populations in the Central Valley, it can make informed decisions about the types of programs to deliver for breeding mallards. In order to do so, the JV identified landscape types that may require different management prescriptions for breeding mallards. These landscapes were differentiated using three characteristics: (1) existing semi-permanent wetlands; (2) existing upland cover; and (3) existing planted rice. Within a landscape, each of these habitat components is categorized as high or low, where high and low categories reflect relative differences among landscapes. These categories result in eight classes of landscapes that may be encountered by breeding mallards (e.g., high availability of wetlands, high availability of upland cover, low availability of rice). The JV then developed a decision matrix that identified the appropriate conservation objective(s) for each landscape class (Figure 5-10). These eight conservation objectives - landscape class associations are described below.

Conservation Objective—Landscape Class Associations

Low Wetlands, Low Rice, Low Upland Cover

Increases in semi-permanent wetlands and upland cover are recommended for these landscapes. The lack of rice, wetlands, and nesting cover in these landscapes makes them a low priority for breeding habitat programs, at least in the short term. Existing mallard densities are likely to be low in these areas, as is reproductive success. Increasing the size and success of breeding mallard populations in these landscapes is not likely to be cost effective compared to landscapes where at least some habitat components are in place.

Low Wetlands, High Rice, Low Uplands

Increases in upland cover and semi-permanent wetlands are recommended for these landscapes. Increases in upland cover within rice growing areas may increase the nest success of mallards that rely on rice fields for pair habitat. Increases in semi-permanent wetlands may increase early season duckling survival, as they provide brood habitat at a time when rice does not yet provide adequate cover.

Low Wetlands, Low Rice, High Uplands

Increasing semi-permanent wetlands should be a conservation objective priority for these landscapes. Increases in wetland habitat should attract more birds to these landscapes and allow the birds to exploit large tracts of upland cover. This recommendation is dependant on these landscapes having areas that are suitable for wetland restoration.

Low Wetlands, High Rice, High Uplands

Increasing semi-permanent wetlands should be a conservation objective priority for these landscapes, as they may support large numbers of breeding mallards that experience high nest success. However, the absence of semi-permanent wetlands may result in low early-season brood survival.

High Wetlands, Low Rice, Low Uplands

Increases in upland cover are recommended for these landscapes, as this habitat may support high densities of breeding mallards that are limited by low nest success.

High Wetlands, High Rice, Low Uplands

Increasing upland cover in these landscapes should be a priority conservation objective. These landscapes likely support high densities of breeding mallards that may benefit significantly from additional nesting cover. Increasing semi-permanent wetlands could represent a secondary conservation objective as it may increase breeding incidence and duckling survival.

High Wetlands, High Rice, High Uplands

Increasing semi-permanent wetlands within these landscapes should be a conservation objective priority. These areas may support large numbers of breeding mallards that enjoy high reproductive success. Providing more wetland habitat in these landscapes may increase mallard densities, and allow additional birds to exploit existing upland and brood rearing resources.

High Wetlands, Low Rice, High Uplands

Increasing semi-permanent wetlands within these landscapes should be a conservation objective priority. These areas may support large numbers of breeding mallards that enjoy high reproductive success. Providing more wetland habitat in these landscapes may increase mallard densities, and allow additional birds to exploit existing upland and brood rearing resources.

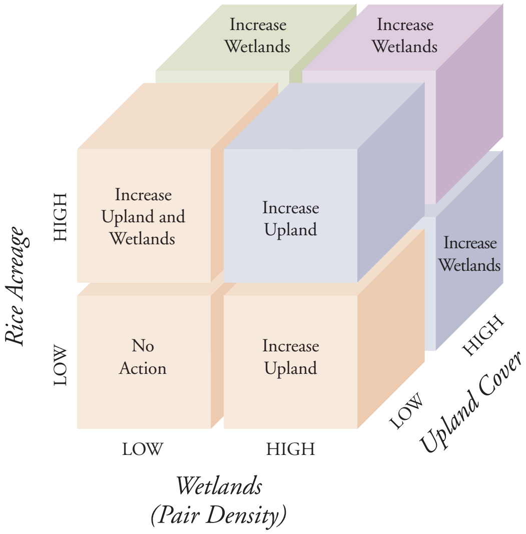
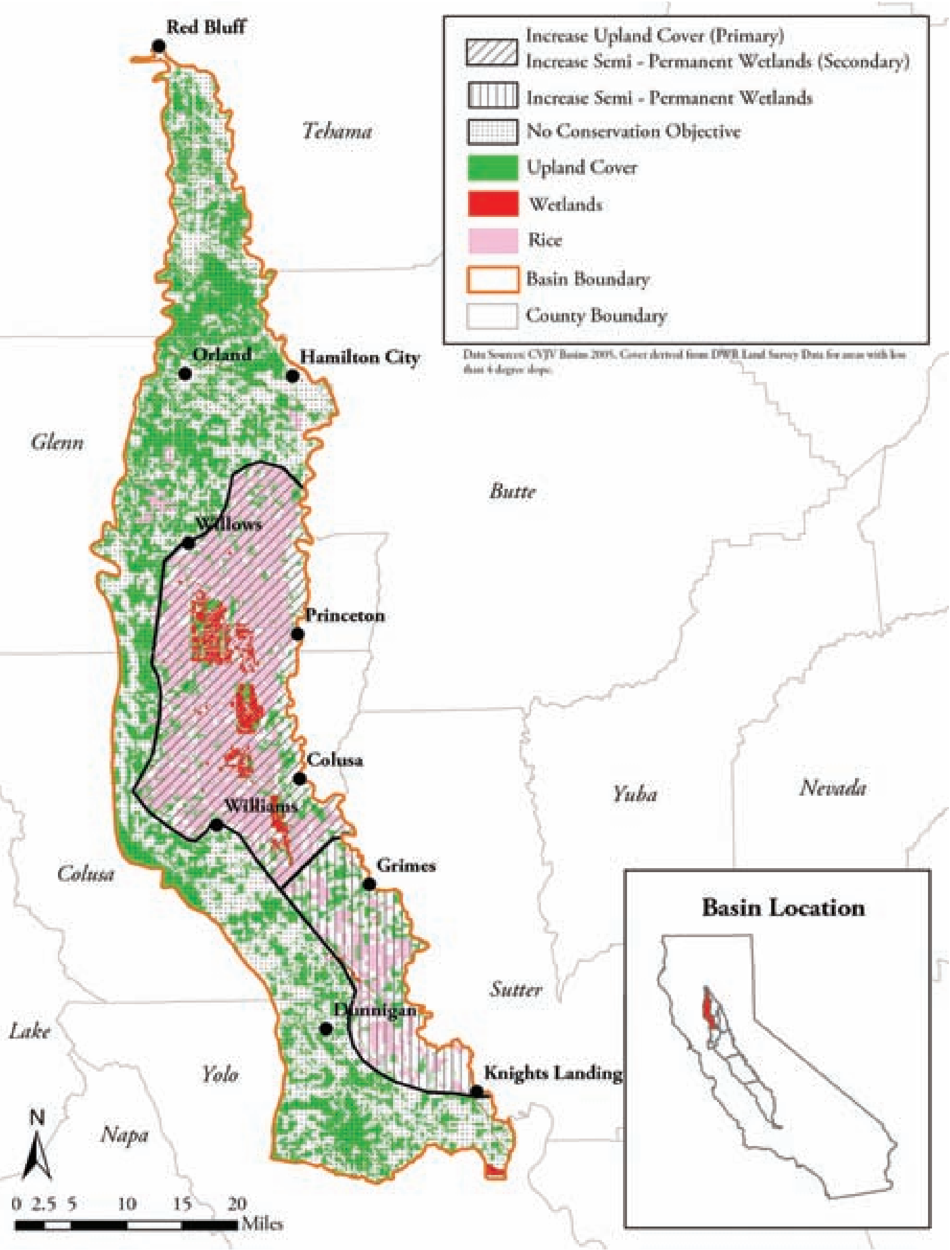


Figure 5-10. Decision matrix for breeding mallards in the Central Valley.

The remainder of this chapter reviews the spatial distribution of wetland, rice, and upland habitat in each basin. Although these data help distinguish the different landscape types in a basin, they are not sufficiently developed to allow site specific recommendations on what habitat programs to pursue for breeding mallards. For example, the Geographic Information System data in the PPR are sufficiently developed to identify habitat prescriptions at the four square mile scale. In the short term, decisions on what programs to deliver for breeding mallards in the Central Valley will require site by site assessment of existing habitat conditions using on the ground information and/or improved spatial data.

Basin Conservation Objectives

Although existing spatial data is inappropriate for identifying site specific management prescriptions, it can be used to broadly distinguish different landscape types and to suggest what habitat programs are suited to those landscapes. Figures 5-11 through 5-17 depict areas of each basin where habitat programs may be most beneficial to breeding waterfowl.

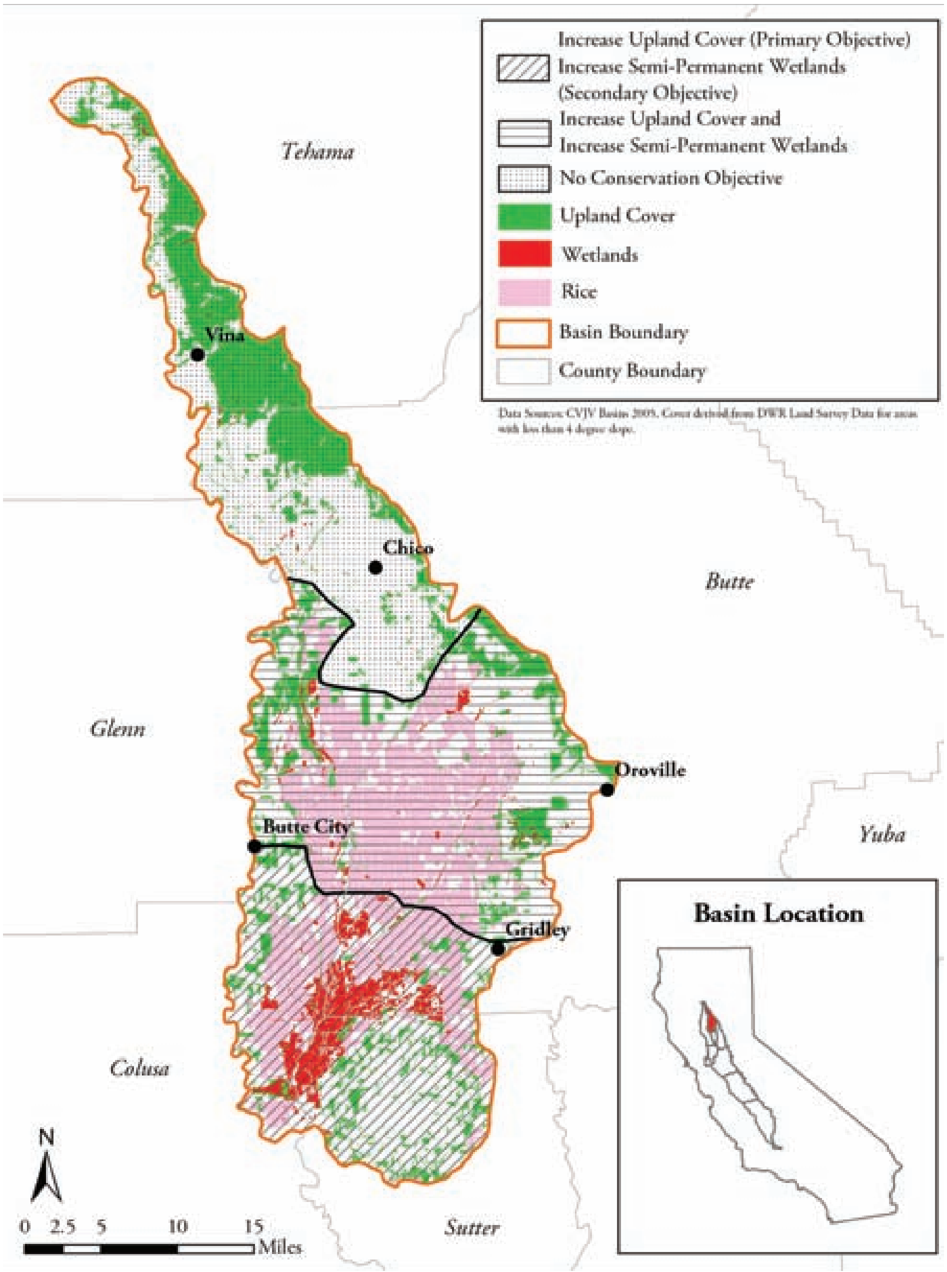


Data Sources: CVJV Basins 2005, Cover derived from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-11. Conservation objectives for breeding mallards in Colusa Basin.

Colusa Basin

The distribution of upland, wetland, and rice habitats in the Colusa Basin is depicted in Figure 5-11. The portion of the basin that lies north of Willows is characterized by an abundance of potential upland cover, as is the entire western edge of the basin. Increasing semi-permanent wetlands may be appropriate for at least portions of this landscape. Most wetland and rice habitat in the basin lies between Willows and Williams. However, upland habitat is generally lacking in this landscape. The restoration of upland cover may benefit breeding waterfowl in areas adjacent to these rice-wetland complexes. Increasing semi-permanent wetlands may also benefit breeding waterfowl as bird densities may already be high in this landscape, and increases in wetland habitat could increase breeding incidence and duckling survival.

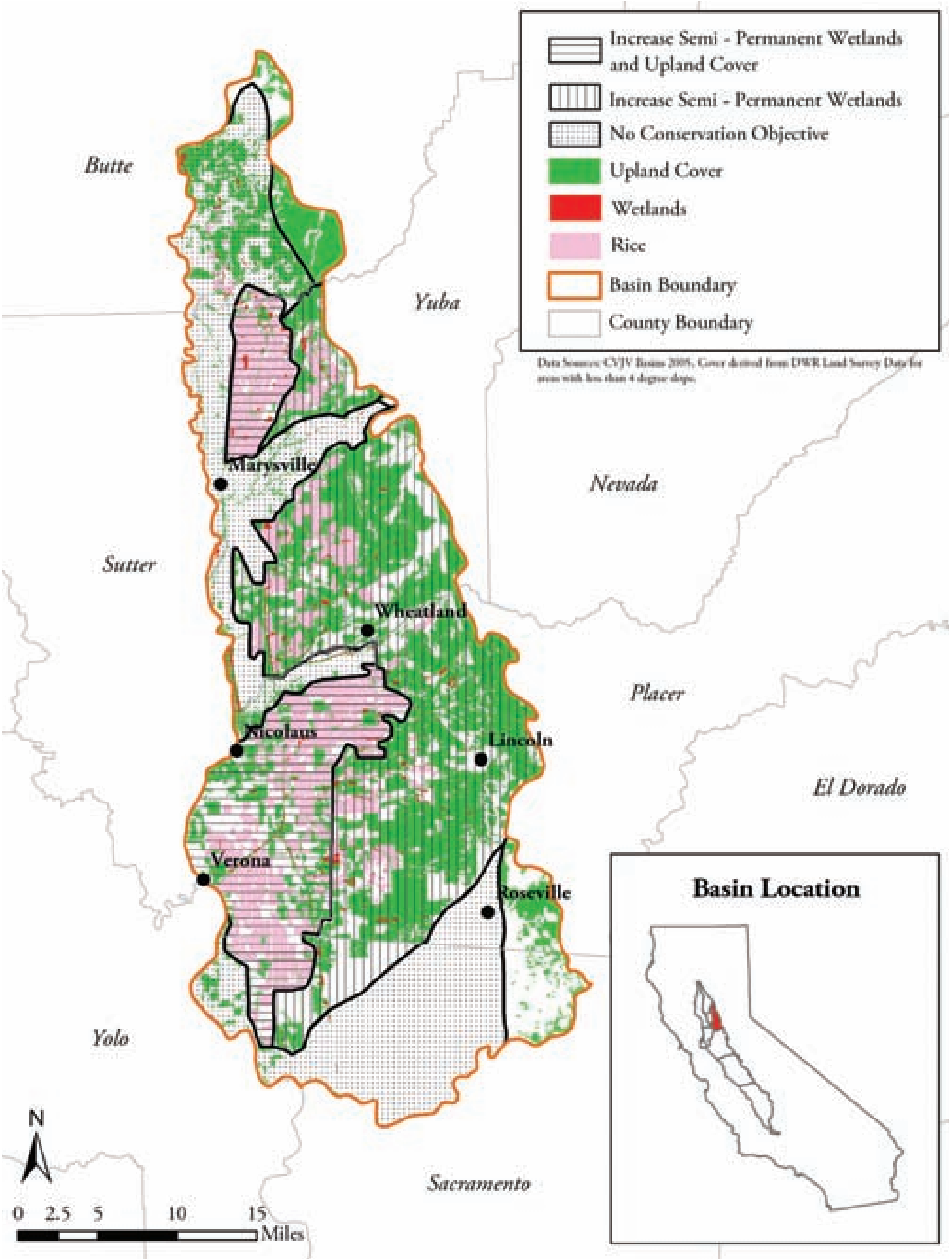


Data Sources: CVJV Basins 2005. Cover derived from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-12. Conservation objectives for breeding mallards in Butte Basin.

Butte Basin

The distribution of upland, wetland, and rice habitats in the Butte Basin is presented in Figure 5-12. The portion of the basin that lies north of Chico is characterized by an abundance of upland cover. Increasing semi-permanent wetlands may be appropriate for at least portions of this landscape. South of Butte City and north of the Sutter Buttes is a landscape characterized by high amounts of wetlands and rice. However, upland habitat is lacking in this landscape and restoration of upland cover may benefit breeding waterfowl. Increasing semi-permanent wetlands may also benefit breeding waterfowl as bird densities may already be high in this landscape, and increases in wetland habitat could increase breeding incidence and duckling survival. North of the Butte City-Gridley line is a landscape with high amounts of rice, but low amounts of both wetlands and uplands. Conservation objectives for this landscape could include an increase in both semi-permanent wetlands and upland habitat.

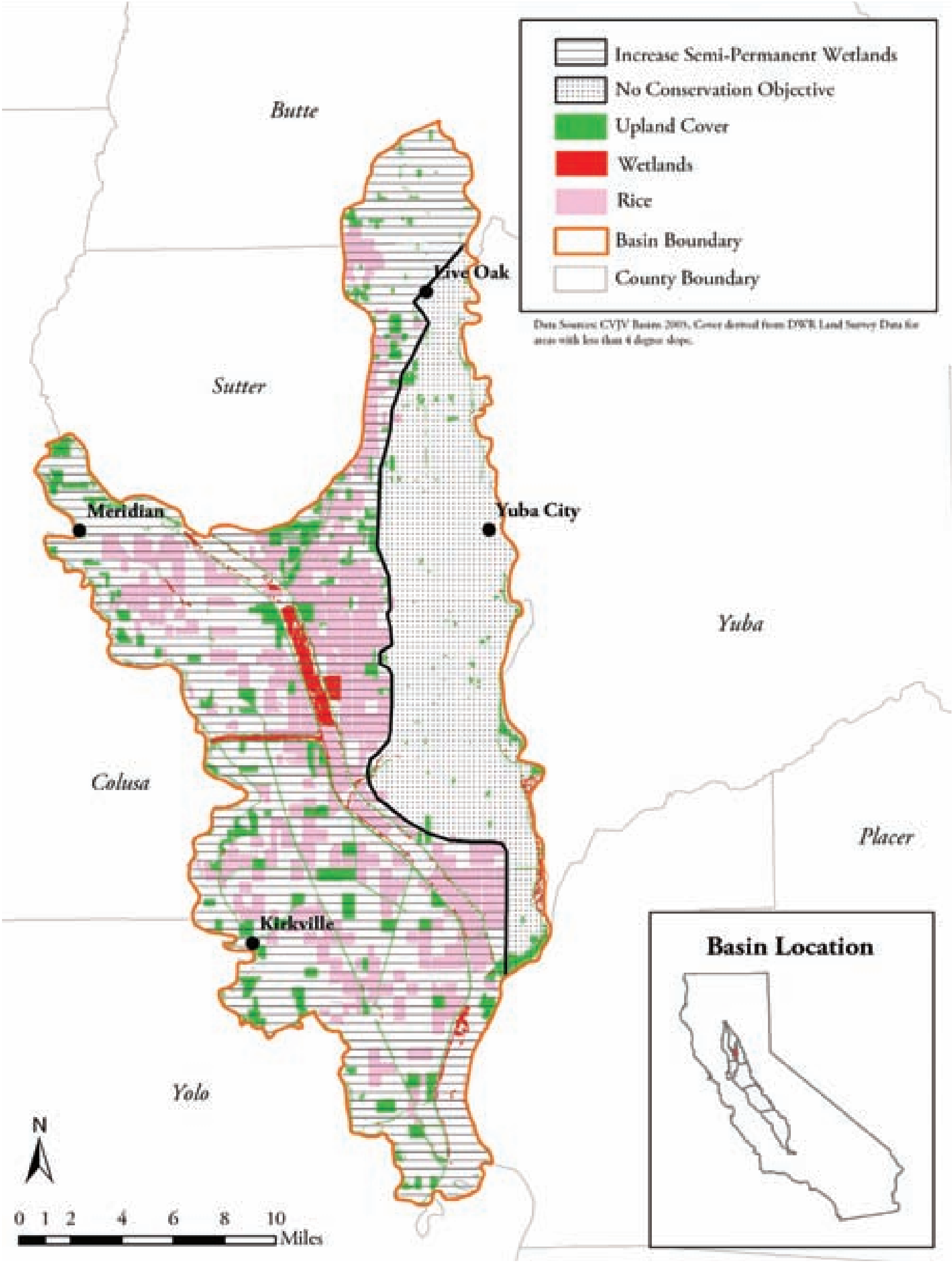


Data Sources: CVJV Basins 2005, Cover derived from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-13. Conservation objectives for breeding mallards in American Basin.

American Basin

The distribution of upland, wetland, and rice habitats in the American Basin is presented in Figure 5-13. Large acreages of rice and upland habitat, but few wetlands characterize much of the eastern and central landscapes of the basin. Increases in semi-permanent wetlands may benefit breeding waterfowl in these areas. High amounts of rice occur in the north and southwest portions of the basin. However, these landscapes contain low amounts of both wetland and upland habitat. Increases in semi-permanent wetlands and upland cover may provide the greatest benefits to breeding waterfowl in these areas.

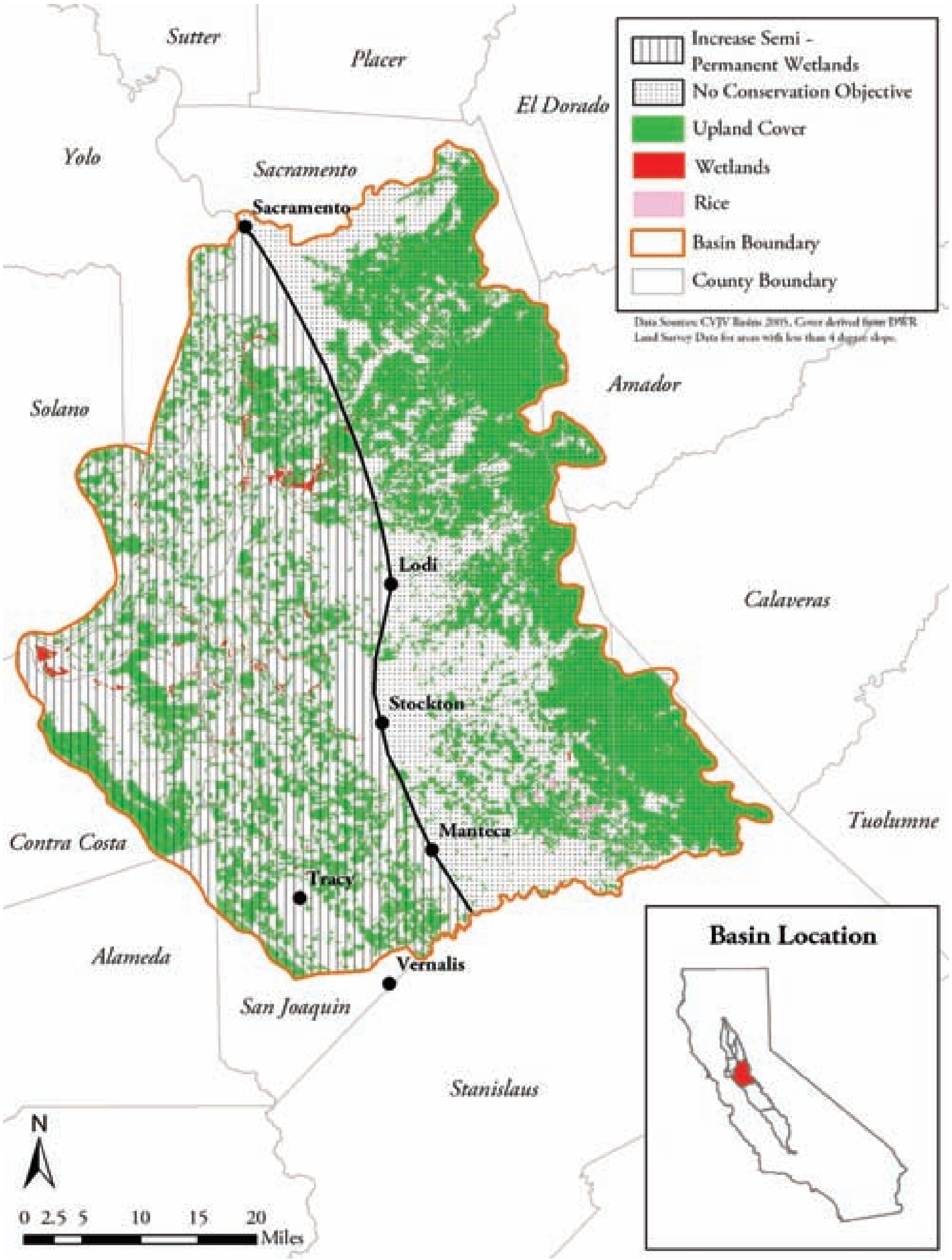


Data Sources: CVJV Basins 2005, Cover derived from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-14. Conservation objectives for breeding mallards in Sutter Basin.

Sutter Basin

The distribution of upland, wetland, and rice habitats in the Sutter Basin is presented in Figure 5-14. Rice occurs in large amounts throughout the western half of the basin, though wetlands are limited and largely restricted to the Sutter Bypass. Although some upland cover occurs throughout western parts of the basin, it is scattered and present in small amounts. Increases in semi-permanent wetlands and upland cover may benefit breeding waterfowl throughout the western half of the basin.

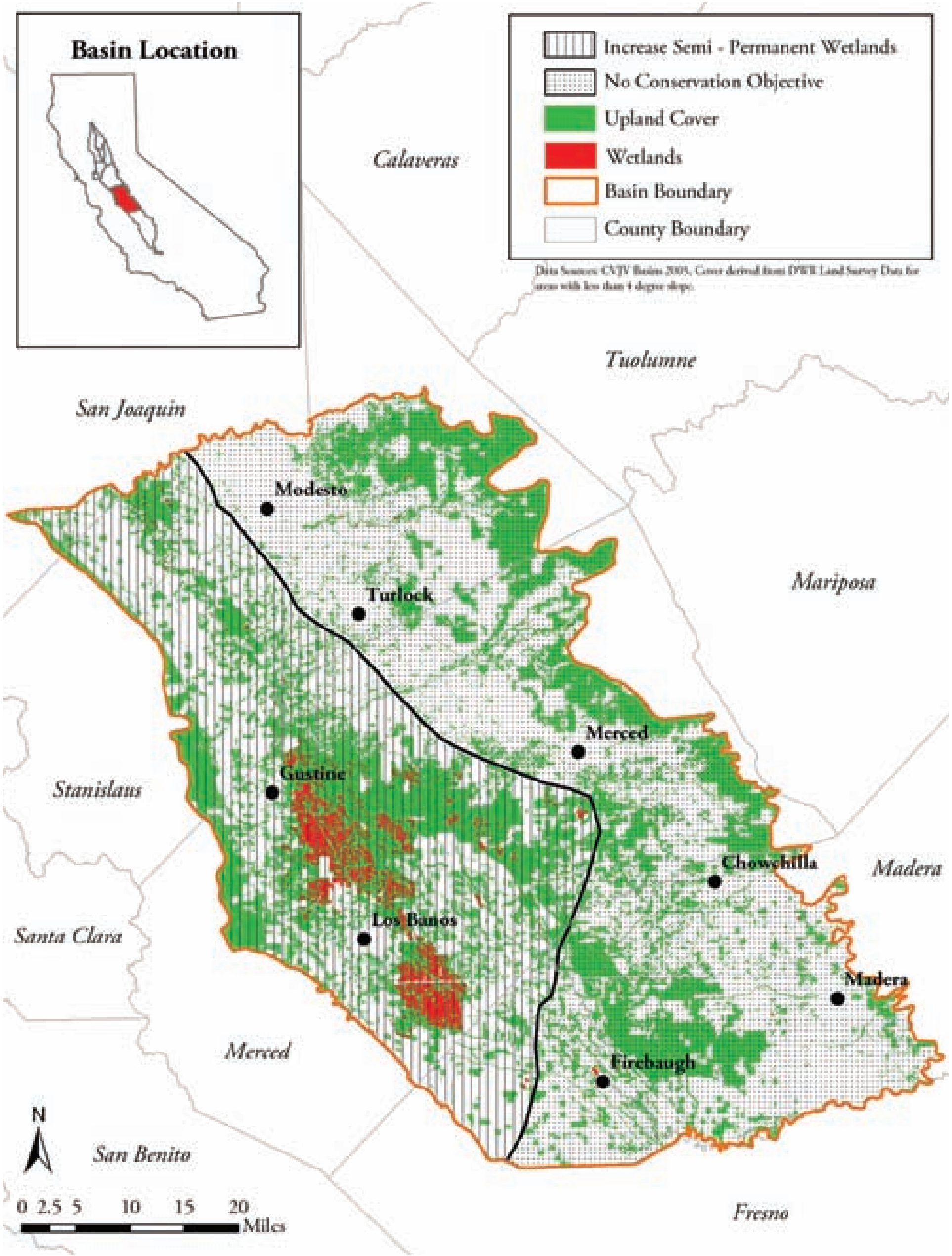


Data Sources: CVJV Basins 2005. Cover derived from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-15. Conservation objectives for breeding mallards in Delta Basin.

Delta Basin

The distribution of upland and wetland habitats in the Delta Basin is presented in Figure 5-15. Rice acreage in the basin totals less than 1,500 acres. Upland cover is high throughout the eastern half of the basin. Increases in semi-permanent wetlands may be appropriate for at least portions of this landscape. Upland cover is also high in the western half of the basin, though wetland abundance is generally low. Increases in semi-permanent wetlands may benefit breeding mallards in this landscape as well.



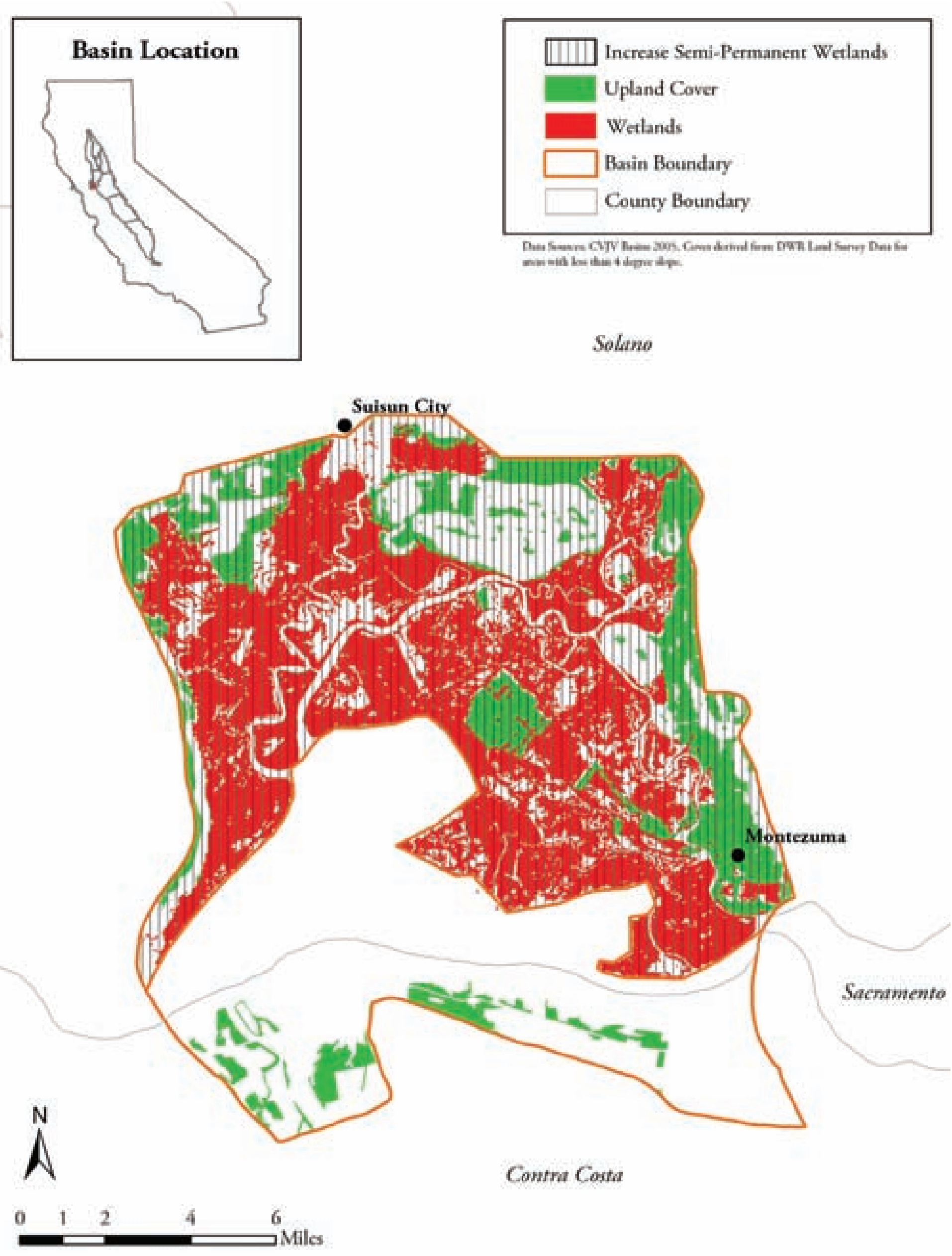
Data Sources: CVJV Basins 2005, Cover derived from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-16. Conservation objectives for breeding mallards in San Joaquin Basin.

San Joaquin Basin

The distribution of upland and wetland habitat in the San Joaquin Basin is presented in Figure 5-16. Although there is some rice grown in the basin it occurs in low amounts. Upland cover is high west of Modesto, Merced, Chowchilla, and Firebaugh. Increases in semi-permanent wetlands may be appropriate for at least portions of this landscape.

The remainder of the basin is characterized by high amounts of upland cover and large wetland complexes (i.e., West Grasslands). Increases in semi-permanent wetlands in these wetland-upland complexes may benefit breeding mallards (Figure 5-21).

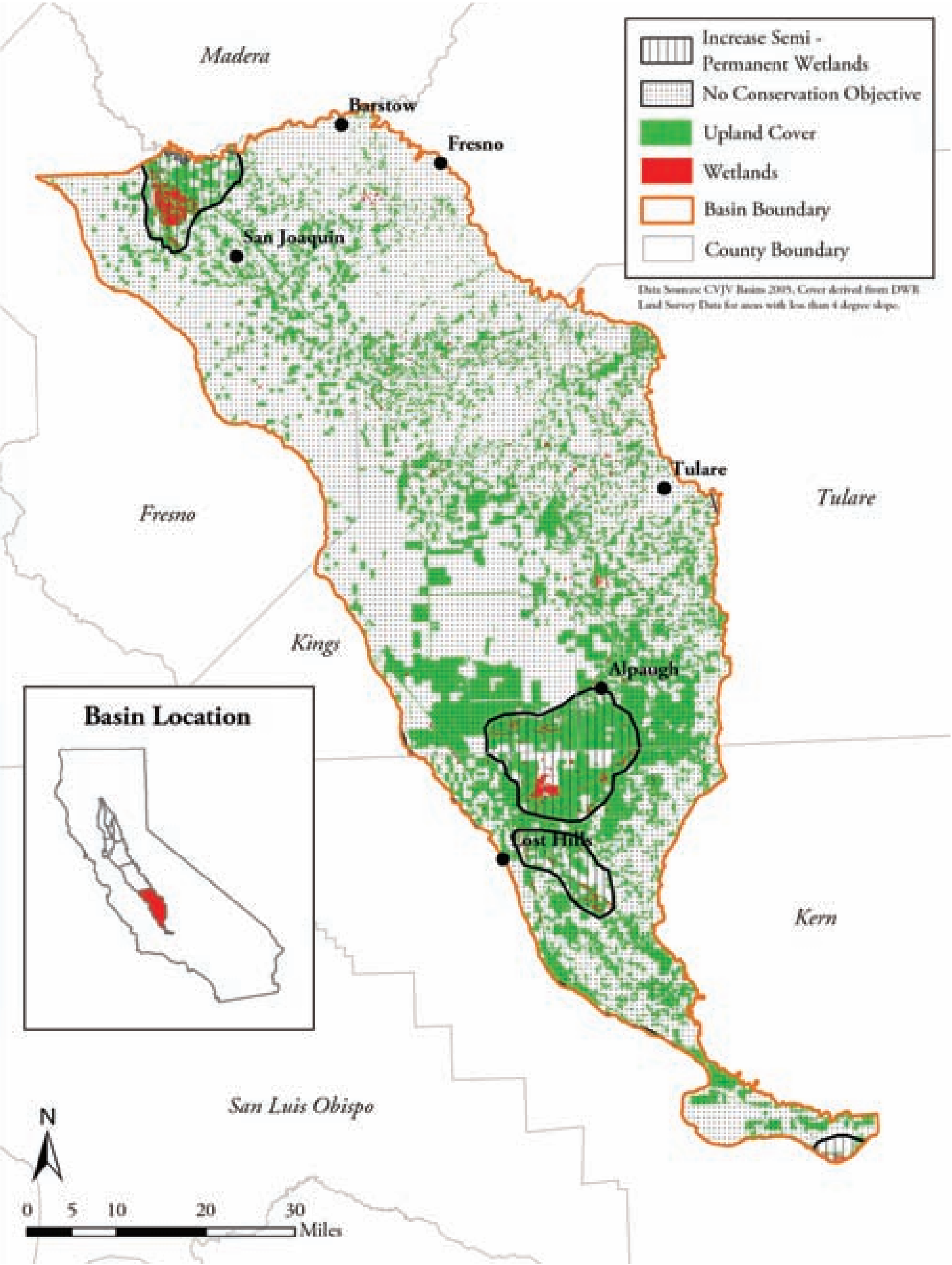


Data Sources: CVJV Basins 2005, Cover derived from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-17. Conservation objectives for breeding mallards in Suisun Marsh Basin.

Suisun Marsh Basin

The distribution of upland and wetland habitats in the Suisun Marsh Basin is presented in Figure 5-17. No rice is grown in this basin. The entire landscape of the Suisun Marsh is characterized by high amounts of upland cover and wetland habitat. As a result, increasing the amount of semi-permanent wetlands within the basin is likely to provide the greatest benefits to breeding mallards.

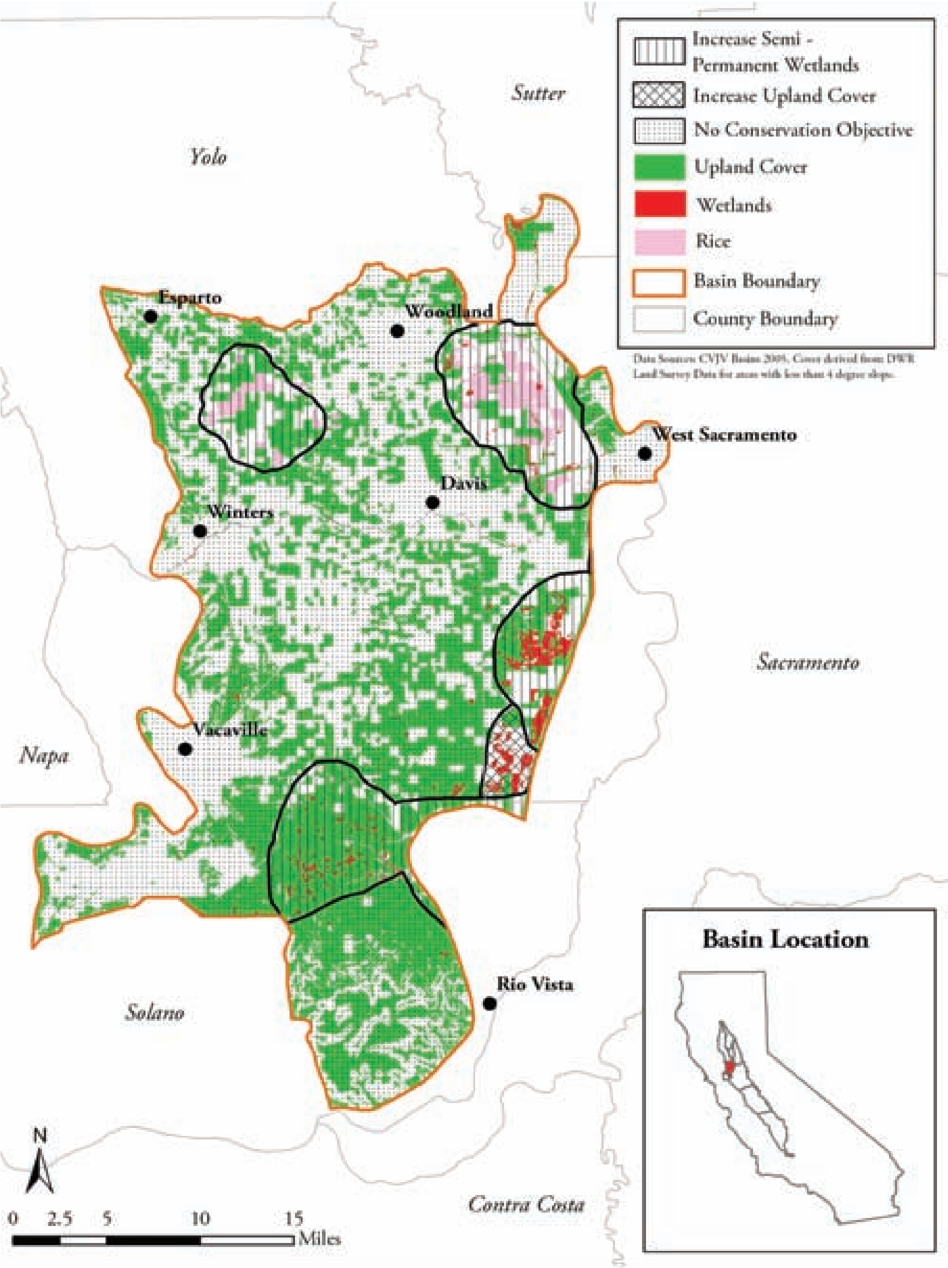


Data Sources: CVJV Basins 2005, Cover derived from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-18. Conservation objectives for breeding mallards in Tulare Basin.

Tulare Basin

The distribution of upland and wetland habitats in the Tulare Basin is presented in Figure 5-18. No rice is grown in this basin. Significant amounts of cover occur in the north-central and southeastern parts of the basin, and increasing semi-permanent wetlands in these areas may benefit breeding mallards.



Data Sources: CVJV Basins 2005, Cover derived from DWR Land Survey Data for areas with less than 4 degree slope.

Figure 5-19. Conservation objectives for breeding mallards in Yolo Basin.

Yolo Basin

The distribution of upland, wetland, and rice habitats in Yolo Basin is presented in Figure 5-19. Most wetlands occur in one of three distinct blocks on the eastern edge of the Basin, and south of the Davis - West Sacramento line. The two most northern of these wetland blocks are interspersed with large areas of upland cover. Increasing semi-permanent wetlands within this landscape may benefit breeding mallards. The wetland complex south of this landscape is not interspersed with large amounts of upland cover, and restoring upland habitat, in conjunction with efforts to increase semi-permanent wetlands, may be appropriate (Figure 5-19).

Southeast of Vacaville is a series of small wetlands that are adjacent to large amounts of upland cover. Increasing semi-permanent habitat within this wetland complex could benefit breeding mallards by allowing larger number of birds to exploit this existing upland cover. Rice is grown in the northeast and northwest corners of the basin. Although some upland cover is associated with both of these rice complexes, wetland habitats are generally lacking. Increasing semi-permanent wetlands in each of these areas may increase mallard breeding densities, and may increase early season duckling survival.

Summary

The 2006 Plan represents a further step in developing conservation objectives for breeding waterfowl in the Central Valley. Future efforts would benefit from a better understanding of what limits population growth of breeding mallards, and how these limiting factors vary geographically within the Valley. Finally, improved spatial data that depicts the habitat resources available to breeding ducks should permit JV partners to refine the delivery of conservation programs for breeding waterfowl beyond that presented here.

Appendix 5-1

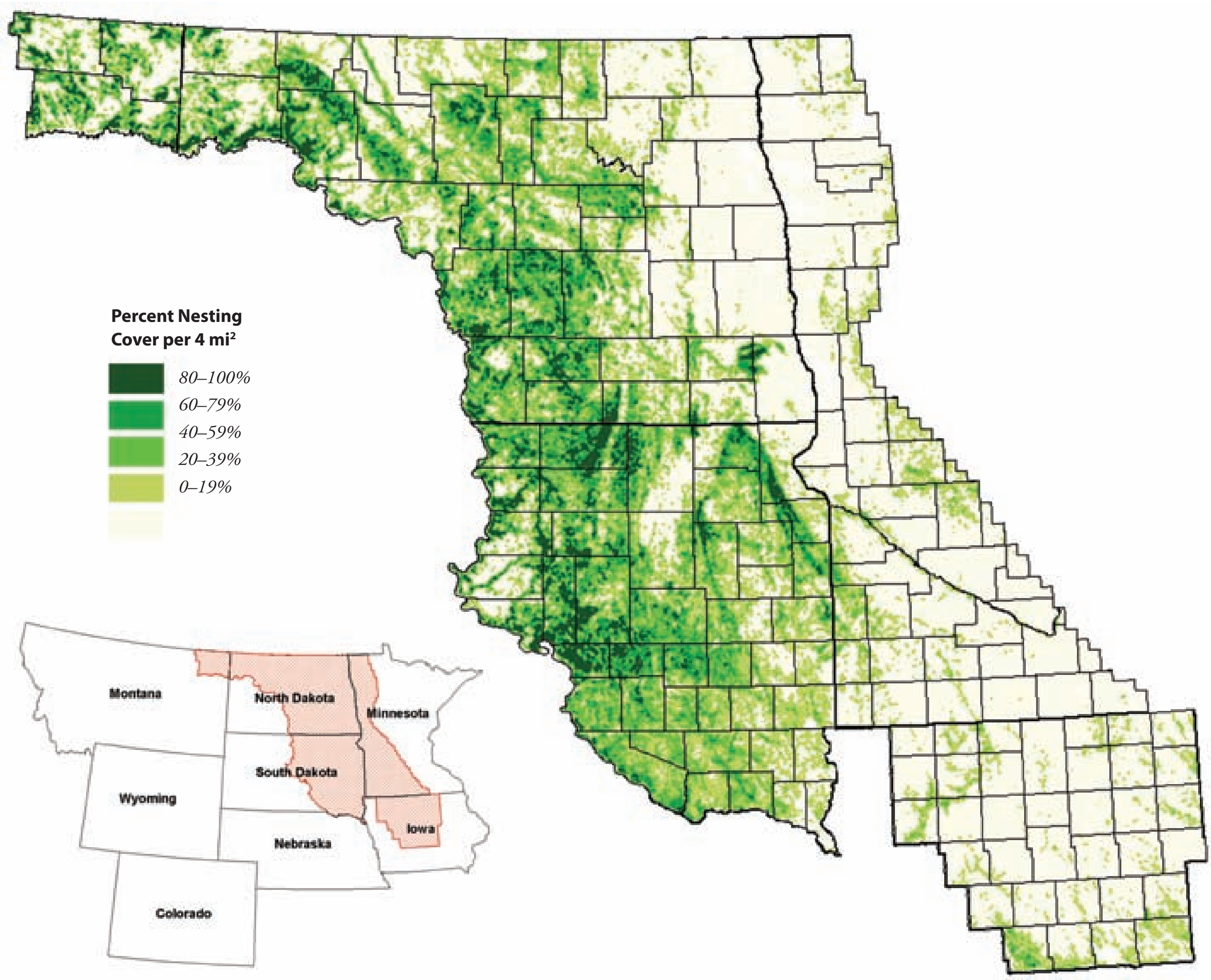
A Review of Conservation Planning for Breeding Waterfowl in the U.S. Prairie Pothole Region

Conservation planning for breeding mallards in the Central Valley should result in habitat programs that increase the size and success of breeding duck populations in a cost effective manner. One option is to develop demographic models that identify the vital rates that limit population growth (e.g., Hoekman et al. 2002). These models require vital rate estimates that are representative of mallard populations breeding in the Central Valley (Table 5-1). In some cases, mallard populations may vary in terms of what vital rates limit population growth. For example, nest success might limit populations in the Suisun Marsh but not the Tulare Basin.

Demographic models alone cannot be used to target site-specific habitat efforts. Spatial planning tools that include information on breeding waterfowl densities and the distribution of wetland and upland habitats can be combined with demographic modeling to identify specific areas for acquisition, restoration, or enhancement of breeding habitat.

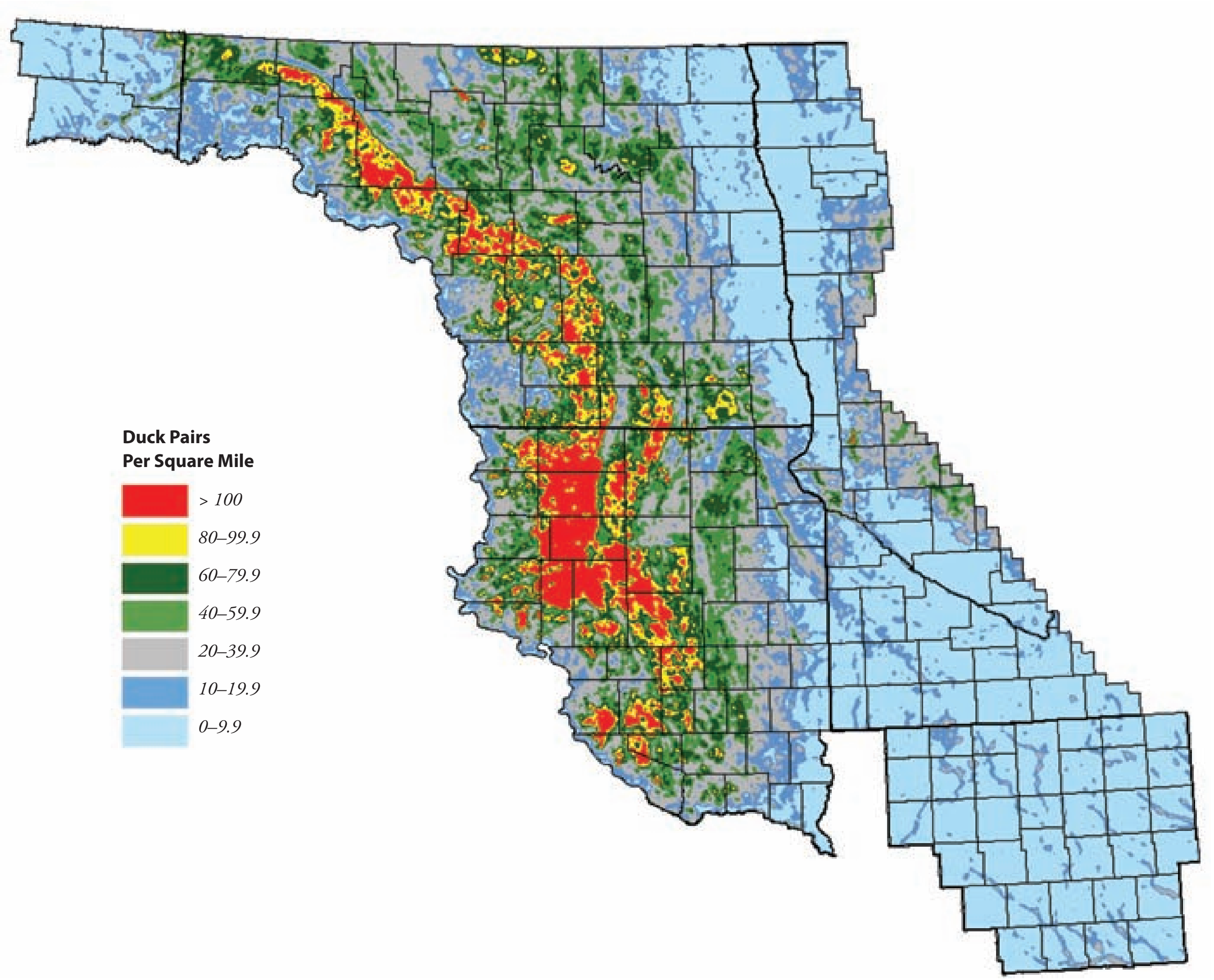
Conservation planning for breeding waterfowl in the U.S. portion of the Prairie Pothole Region (PPR) provides one example where demographic models are combined with spatial planning tools to develop site-specific habitat prescriptions for breeding waterfowl. Demographic modeling indicates that prairie waterfowl are most limited by nest success (Hoekman et al. 2002). As a result, habitat efforts to restore or protect upland nesting habitat are given priority in the PPR. To help guide these programs, perennial nesting cover was mapped for much of the PPR (Figure 5-20). The distribution of perennial cover was combined with information on breeding waterfowl densities (Figure 5-21) to develop a spatial planning tool that helped address the problem of low nest success (Figure 5-22). The red areas depicted in Figure 5-22 are regions where duck densities are high, and greater than 40% of the landscape is grassland. Conservation programs in these areas focus on protecting existing habitats because waterfowl numbers are high and upland cover is already sufficient to grow duck populations. Areas that have low bird densities and low amounts of grassland are designated in beige and include much of the eastern portion of the PPR. These areas are a low conservation priority because the resources needed to restore these areas for breeding waterfowl are currently too great. In between the extremes of red and beige are landscapes that require different conservation strategies. For example, areas that are depicted in green have high wetland densities but only moderate amounts of grassland (i.e., < 40% cover). Within these landscapes, grassland restoration is an important conservation objective, as increases in upland cover should result in increased nest success.

The planning approach described for the PPR is only one example of how habitat programs could be targeted for breeding waterfowl in the Central Valley. There are an ever increasing number of sophisticated species-habitat modeling approaches that could be used to develop spatially explicit species-habitat models for identifying priority areas and conservation needs.



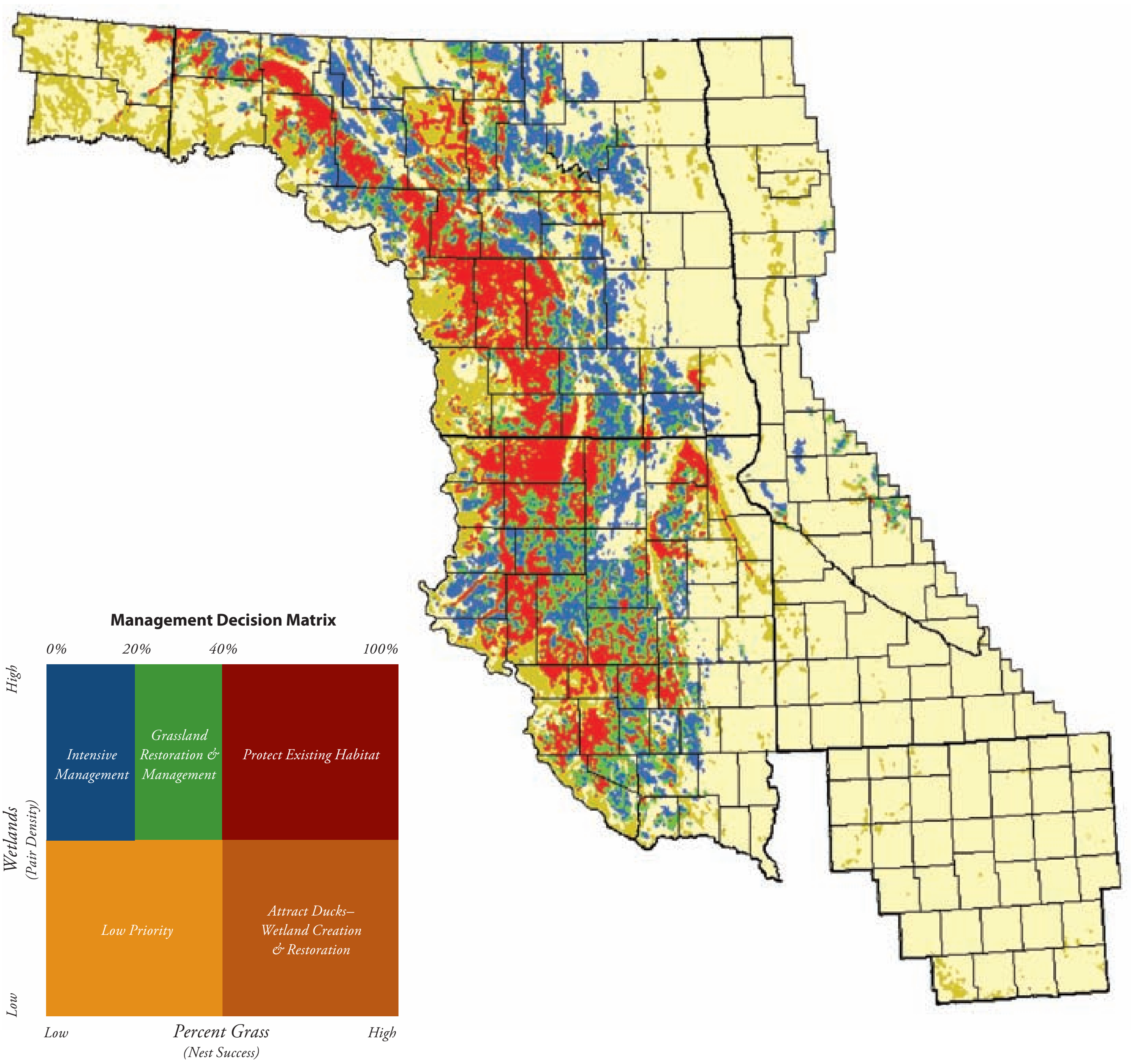
Data source: U.S. Fish and Wildlife Service/Ducks Unlimited, Inc.

Figure 5-20. Perennial nesting cover in the U.S. Prairie Pothole Region.



Data source: U.S. Fish and Wildlife Service/Ducks Unlimited, Inc.

Figure 5-21. Breeding waterfowl densities in the U.S. Prairie Pothole Region.



Data source: U.S. Fish and Wildlife Service/Ducks Unlimited, Inc.

Figure 5-22. Spatial planning tool for breeding waterfowl in the Prairie Pothole Region.

Shorebirds
Photo: Dave Feliz, CDFG

Chapter Six:
WINTERING SHOREBIRDS

This chapter addresses the needs of wintering shorebirds, herein defined as non-breeding shorebirds that occupy the Central Valley between July and May, each year. The chapter is divided into five sections: (1) Need and approach; (2) Biological inputs used in the TRUEMET model; (3) Overall assessment of habitat conditions in the Central Valley; (4) Methods for establishing conservation objectives for wintering shorebirds; and (5) Conservation objectives for wintering shorebirds within planning regions.

> "In western North America, the Central Valley supports more shorebirds than any other inland site in the winter and spring, and in the fall, it is second only to Utah's Great Salt Lake."
>
> **Catherine Hickey**
> *Shorebird Conservation Coordinator*
> *PRBO Conservation Science*

Need and Approach

The Central Valley of California's wintering shorebird populations are among the largest of any inland site in western North America. The Manomet Center's Western Hemisphere Shorebird Reserve Network (WHSRN) has designated the Grasslands Ecological Area of the San Joaquin Basin and the ricelands and wetlands of the Sacramento Valley as sites of international importance to shorebirds. The Central Valley also provides critical wintering habitat for two species of shorebirds that have recently been proposed as Bird Species of Special Concern in California, the mountain plover *(Charadrius montanus)* and the snowy plover *(Charadrius alexandrinus)* (Hickey et al. 2003).

The 2006 Plan assumes that food is the primary need of shorebirds during migration and winter, and providing adequate foraging habitat at appropriate water depths will enhance survival outside of the breeding season. Conservation planning for wintering shorebirds in the Mississippi Alluvial Valley has also emphasized foraging habitat (Loesch et al. 2000). The TRUEMET food energy model (introduced in Chapter 4) was used to establish habitat objectives for wintering waterfowl, and has also been used for wintering shorebirds in the Central Valley. Figure 6-1 depicts this basic model. Shorebird energy needs are a product of population objectives and the daily energy requirement of an individual shorebird, while food supplies are a product of habitat acres and the amount of food provided by each acre. Foraging habitat is assumed to be adequate when food supplies equal shorebird energy needs.

The food energy approach adopted for shorebirds in the 2006 Plan is based on the TRUEMET model. The model calculates population energy demand and population energy supplies for specific time periods, and can incorporate effects like flooding and de-watering (drawdown) schedules to account for temporal variation in habitat availability. The model was used to estimate shorebird habitat needs and to develop conservation objectives for wintering shorebirds for each Shorebird Planning Region. Additional information on the TRUEMET model is provided in Chapter 4.

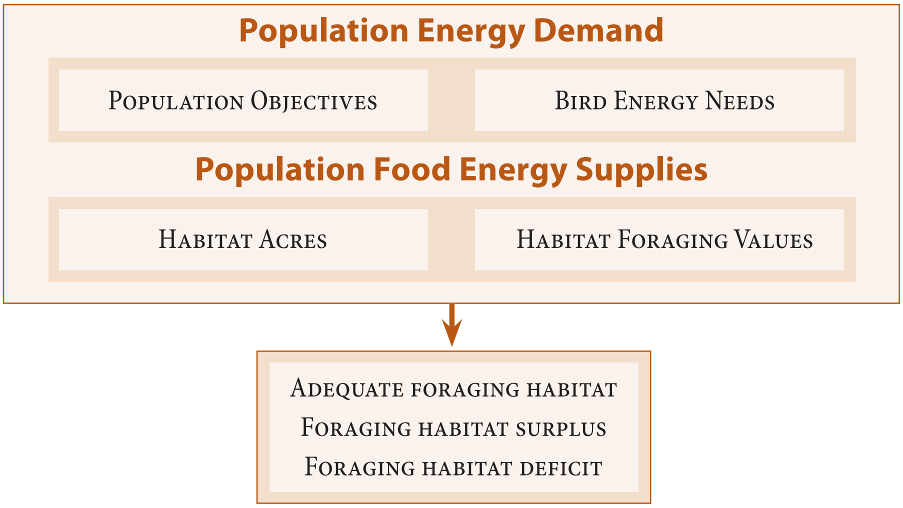


Figure 6-1. Basic energy model used to assess the availability of foraging habitat relative to shorebird need.

Biological Inputs Used in the TRUEMET Model

Four categories of biological inputs were used in the TRUEMET model: (1) population objectives; (2) daily energy requirements; (3) habitat acreage; and (4) habitat foraging values. This section describes how these inputs were derived, and it details many of the assumptions made for wintering shorebirds in the 2006 Plan.

Population Objectives

Unlike waterfowl, no process of stepping down continental population goals for wintering shorebirds has been established under the U.S. Shorebird Conservation Plan. Instead, population objectives were developed from Central Valley-wide surveys of wintering shorebirds that were conducted between April and August 1992 to 1994 (Shuford et al. 1998).

Average shorebird counts between 1992 and 1994 were available for August, November, January, and April (Table 6-1). However, wintering shorebirds rely on Central Valley habitats from July through early May. In addition, shorebird survey results do not equate to population objectives because of missed birds and/or depressed shorebird numbers during the years that surveys were conducted. The JV's Shorebird Working Group adjusted survey results upward when establishing population objectives and developed objectives for months outside the survey periods, based on their understanding of shorebird migration. Shorebird population objectives by 15-day intervals between July 1 and May 10 are presented for the entire Central Valley in Table 6-2.

Table 6-1. Average shorebird counts in the Central Valley from 1992-1994 (from Shuford et al. 1998).

Month	*Count*
August	134,000
November	211,000
January	303,000
April	335,000

Table 6-2. Non-breeding shorebird population objectives for the Central Valley.

Interval	*Population Objective*
J-7 (July 1-July 15)	50,000
J-22 (July 16-July 31)	50,000
A-8 (Aug 1-Aug 16)	200,000
A-23 (Aug 17-Aug 31)	200,000
S-7 (Sept 1-Sept 15)	200,000
S-22 (Sept 16-Sept 30)	200,000
O-7 (Oct 1-Oct 15)	250,000
O-22 (Oct 16-Oct 30)	250,000
N-6 (Oct 31-Nov 14)	400,000
N-21 (Nov 15-Nov 29)	400,000
D-6 (Nov 30-Dec 14)	400,000
D-21 (Dec 15-Dec 29)	400,000
J-5 (Dec 30-Jan 13)	400,000
J-20 (Jan 14-Jan 28)	400,000
F-4 (Jan 29-Feb 12)	400,000
F-19 (Feb 13-Feb 27)	400,000
M-6 (Feb 28-Mar 14)	450,000
M-21 (Mar 15-Mar 29)	450,000
A-5 (Mar 30-Apr 13)	600,000
A-20 (Apr 14-Apr 28)	600,000
M-4 (Apr 29-May 10)	50,000

Planning Regions

Where possible, conservation objectives for bird groups included in the 2006 Plan were established at the basin scale. However, several basins were combined into two planning regions: (1) Sacramento Valley (SV) consisting of Colusa, Butte, American, and Sutter Basins; and (2) Delta, consisting of Yolo and Delta Basins. The Suisun Marsh was not included, as counts do not exist for this region. However, the Suisun Marsh does provide valuable habitat for wintering shorebirds, and the following conservation actions identified in the *Southern Pacific Shorebird Conservation Plan* may benefit this bird group: (1) incorporate shorebird habitat components in tidal marsh restorations; (2) increase tidal circulation and water quality in marshes to enhance invertebrate productivity and shorebird foraging areas; (3) manage vegetation in some ponds to provide expanses of open habitat; and (4) create one to six inch water depths in some ponds. (Hickey et al. 2003). The San Joaquin and Tulare Basins were maintained as separate planning regions (Figure 6-2). These planning regions reflect the scale at which shorebird population information is available.

Data Source: Consolidated CJVJ Basins 2005.

Figure 6-2. Planning regions for wintering shorebirds in the Central Valley.

It was necessary to distribute shorebird population objectives for the entire Central Valley among the four planning regions in Figure 6-2. However, shorebird surveys conducted in August, November, January, and April 1992 to 1994 indicate that shorebird distribution in the Central Valley varies seasonally. For example, 50% of all shorebirds counted in August were observed in the Tulare Basin, while only 10% of all shorebirds were seen in Tulare Basin during January surveys (Table 6-3).

Table 6-3. Distribution of wintering shorebirds in the Central Valley by region and time period (from Shuford et al. 1998).

Region	*August*^{a}	*November*^{a}	*January*^{a}	*April*^{a}
SV Planning Region	0.35	0.38	0.45	0.39
Delta Planning Region	0.075	0.12	0.17	0.03
San Joaquin Basin	0.075	0.32	0.28	0.41
Tulare Basin	0.50	0.18	0.10	0.17

^{a}*Fraction of all shorebirds present in the Central Valley.*

To develop population objectives for each of the four planning regions by 15-day periods, the JV assumed that shorebird surveys conducted in August, November, January, and April corresponded to 15-day intervals as follows: (1) shorebird surveys conducted in August correspond to the distribution of shorebirds between July 1 and October 31; (2) shorebird surveys conducted in November correspond to the distribution of shorebirds between November 1 and December 31; (3) shorebird surveys conducted in January correspond to the distribution of shorebirds between January 1 and March 31; and (4) shorebird surveys conducted in April correspond to the distribution of shorebirds between April 1 and May 12.

This information on temporal changes in shorebird distribution was combined with population objectives for the entire Central Valley to generate population objectives by 15-day periods for each of the four planning regions. These population objectives are presented later when establishing conservation objectives for each region.

Daily Energy Requirements for Individual Birds

Shorebird energy needs are assumed to be dependant on body mass, and equations exist to calculate food energy needs using body mass estimates. Shorebird populations in the Central Valley include several species. Because species composition of these populations varies seasonally, a weighted body mass was calculated for each of the four survey periods (August, November, January, April 1992-1994; Table 6-4). These weighted body mass estimates were then applied to the appropriate 15-day period. The following equation was used to estimate the daily energy requirements (DER) of an individual shorebird in each 15-day period (kj/day):

DER (kj) = 912 (Body Mass (kg)) 0.704 where kj's were converted to kcal's by dividing by 4.18. Finally, the DER estimated for shorebirds from this equation was increased by 33% for all 15-day intervals between March 1 and May 12 to account for increased energy needs associated with fat deposition prior to spring migration.

Table 6-4. Weighted body mass for shorebirds in the Central Valley in each of the four survey periods.

Survey Period	*Weighted Body Mass (g)*
August	126
November	102
January	96
April	82

Habitat Acreages

Shorebirds in the Central Valley currently rely on a variety of habitats to meet their food energy needs, including evaporation and sewage ponds (Shuford et al. 1998). However, the use of evaporation and sewage ponds may expose shorebirds to concentrated contaminants like selenium, or increase the probability of disease transmission (Hickey et al. 2003). As a result, only "desirable" habitat types were considered in the 2006 Plan when establishing habitat objectives for shorebirds. These include: (1) managed seasonal wetlands; (2) managed semi-permanent wetlands; and (3) harvested rice fields that are intentionally flooded to provide wildlife benefits and/or promote straw decomposition.

Table 6-5. Acres of managed wetlands and intentionally flooded rice in the Central Valley.

Habitat Type	*Acres*
Seasonal Wetland	179,232
Semi-permanent Wetland	26,322
Flooded Rice	354,633

Table 6-5 provides a summary of wetland and agricultural habitats in the Central Valley (information on how these estimates were derived was presented in Chapter 3). Foraging ecology studies indicate that shorebirds require water depths <10 cm (~4 inches) deep (Safran et al. 1997). However, wetland and agricultural habitat estimates for the Central Valley are not stratified by depth. Consequently, Table 6-5 only represents the amount of habitat that is potentially available to shorebirds if all these acres were managed at depths <10 cm. In reality, only a small fraction of these acres may meet these depth requirements, as management efforts for waterfowl usually result in depths greater than 10 cm. Within the 2006 Plan, habitat objectives for wintering shorebirds assume that 100% of these habitats are maintained <10 cm deep.

Comparing shorebird habitat objectives to estimates of existing wetland and agricultural acres may provide some insight into whether shorebird needs are being met. For example, shorebird food needs are more likely to be met where shorebird habitat objectives are small compared to the acres of existing wetland or rice habitat. This issue is explored further in this chapter when assessing current conditions for wintering shorebirds throughout the Central Valley.

In addition to water depth, temporal variation in habitat availability can strongly influence available food supplies. To better understand the availability of shorebird foraging habitat. Flooding and drawdown schedules were developed for public and privately managed wetlands in the Central Valley (Figure 6-3), as well as for flooding of rice habitat during the post harvest season (Figure 6-4). Flooding and drawdown schedules were also developed for each of the four shorebird planning regions.

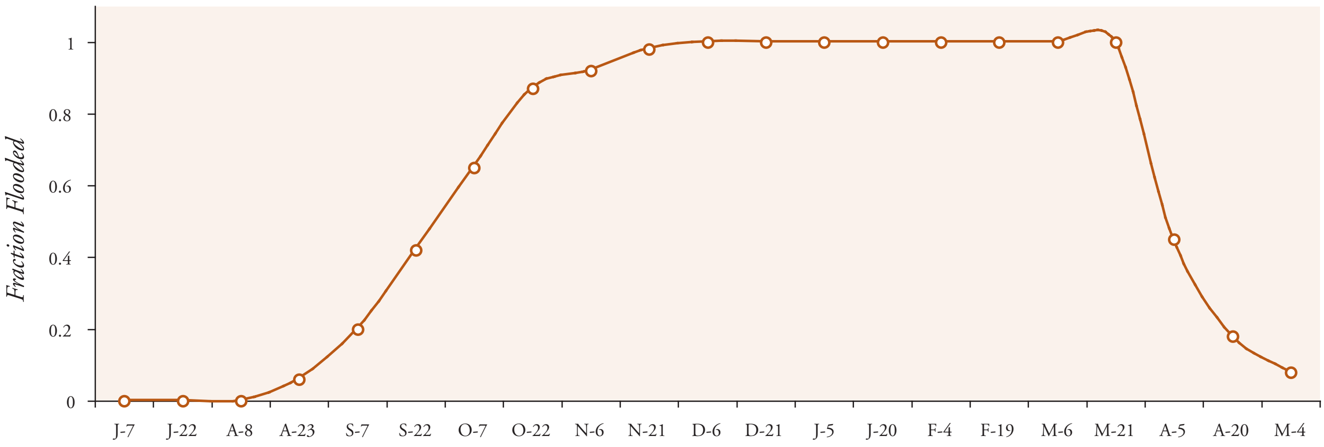


Figure 6-3. Flooding and draw down schedules for managed seasonal wetlands in the Central Valley (private and public wetlands combined).

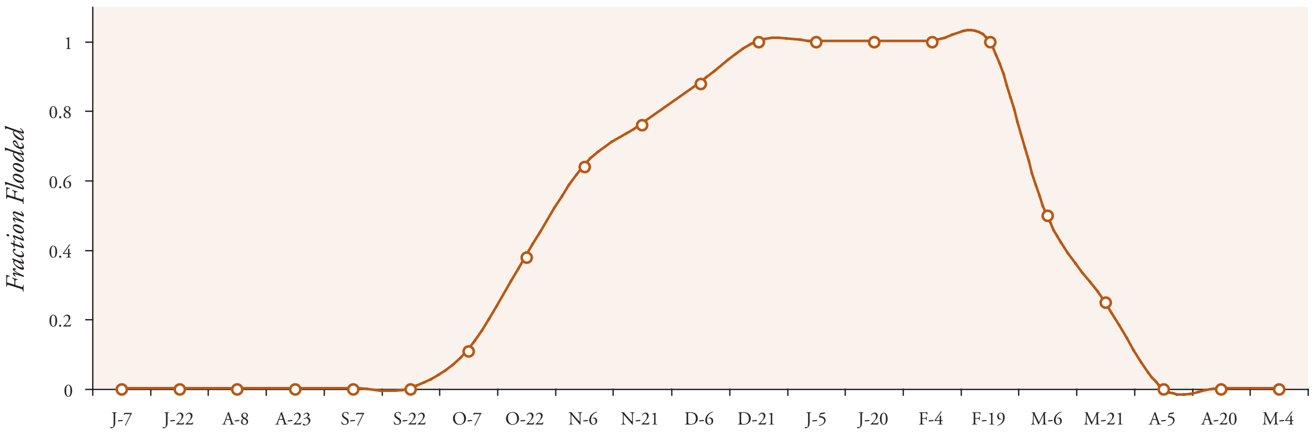


Figure 6-4. Flooding and draw down schedules for winter flooded rice in the Central Valley.

Habitat Foraging Values

The food energy approach used to estimate shorebird habitat needs in the 2006 Plan requires estimates of invertebrate biomass on a per area basis (e.g., lbs. per acre). Although numerous studies have characterized invertebrate communities in Central Valley wetlands and flooded rice fields, no estimates of invertebrate biomass exist for these habitats. Shorebird habitat in the Mississippi Alluvial Valley (MAV) is assumed to provide 20 kg/ha (~18 lbs./acre) of invertebrate biomass (Loesch et al. 2000). This estimate was adopted for planning purposes in the Central Valley, and was applied to managed wetlands and to rice fields that are winter flooded.

Using measures of invertebrate biomass from outside the Central Valley adds another level of uncertainty to the JVs estimates of shorebird habitat needs. The assumption that managed wetlands and rice habitat provide 20 kg/ha of invertebrate biomass also assumes that invertebrate food resources are non-renewable in response to shorebird foraging. In reality, invertebrate biomass is likely influenced by seasonal changes in invertebrate growth rates, reproduction, and the effects of shorebird foraging. For example, invertebrate biomass may increase through time, though this increase may be partially constrained by the effects of shorebird foraging. Assuming a static value of 20 kg/ha does not reflect the complexity of invertebrate food resources. Therefore, future efforts to understand temporal changes in invertebrate biomass would add greatly to the JV's understanding of shorebird habitat needs.

Overall Assessment of Current Habitat Conditions in the Central Valley

Habitat conditions for wintering shorebirds were first evaluated for the entire Central Valley. Flooding schedules and flooding depths strongly influence shorebird food supplies, and the JV began its assessment of habitat conditions by comparing shorebird population objectives and water management practices in key habitats.

Seasonal Wetlands

Figure 6-5 depicts the relationship between overall shorebird population objectives for the Central Valley, and the availability of managed seasonal wetlands. Although significant numbers of shorebirds are present in July and early August, flooding of seasonal wetlands does not begin until mid-August. Flooding of seasonal wetlands is complete by late November, with water maintained in these habitats generally through the end of March. Shorebird populations are highest in March and April, when most seasonal wetlands are being drawn down (Figure 6-6). Although peak populations of shorebirds correspond to drawdown of seasonal wetlands in March and April, these drawdowns may result in increased foraging habitat. Drawdowns typically increase the area of shallow water habitat available to shorebirds, at least in the short term. Drawdowns of seasonal wetlands in spring (e.g., April) in the Grasslands did not result in higher shorebird use of these habitats (Taft et al. 2002). However, drawdown of seasonal wetlands in winter (e.g., December) resulted in significant increases in shorebird use (Taft et al. 2002). The lack of shorebird response to spring drawdowns may reflect an overall abundance of shallow water habitat, as seasonal wetlands are being dewatered throughout the Central Valley. In contrast, shorebird response to experimental winter drawdowns indicates that shallow water habitat is limited during this period because most seasonal wetlands are fully flooded (Taft et al. 2002).

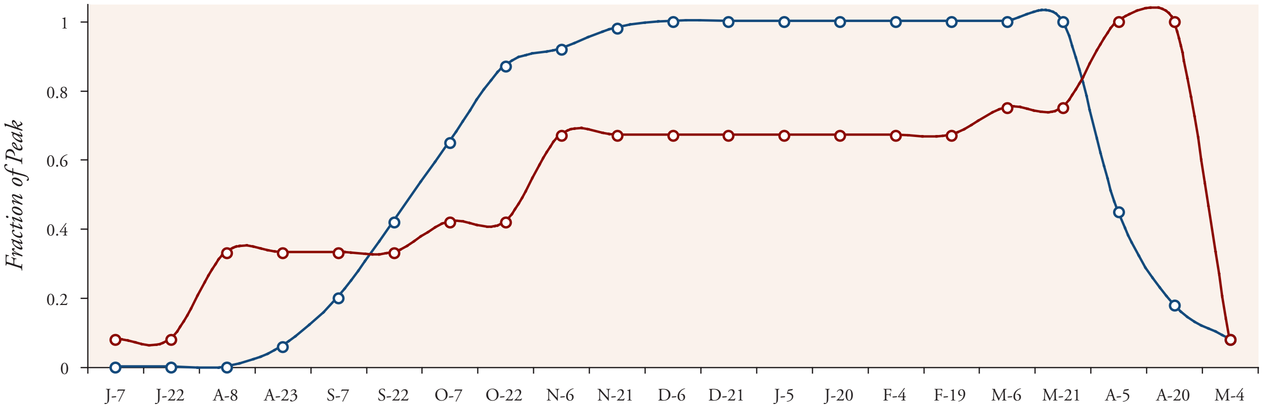


Figure 6-5. Shorebird population objectives (red) vs. flooding schedules for managed seasonal wetlands (blue) for the Central Valley. Shorebird population objectives are expressed as the fraction of peak population; wetlands are expressed as the fraction of seasonal wetlands that are flooded.

Semi-Permanent Wetlands

Although most wetlands in the Central Valley are managed on a seasonal basis, over 26,000 acres of semi-permanent wetlands also exist (Table 6-5). Semi-permanent wetlands are typically flooded in early fall, with drawdowns occurring during the first half of July. Although semi-permanent wetlands may provide little shorebird habitat for much of the year because of deep flooding, these habitats may be critical to shorebirds during July. Drawdown of semi-permanent wetlands in July could provide shallow water habitat that helps meet shorebird needs at a time when few alternative habitats exist.

Winter Flooded Rice

Figure 6-6 depicts the relationship between shorebird population objectives and the availability of winter flooded rice fields. Flooding schedules for harvest rice indicate that this habitat provides few shorebird food resources prior to mid-October. Winter flooding of rice fields peaks in mid-winter with most fields drained by late March or early April (Figure 6-7). Mean water depths in flooded rice fields range between 15-20 cm from November through January, but decline thereafter to less than 10 cm in February and March (Elphick 1998). Although winter flooded rice fields provide little shorebird habitat during peak populations in April, declining water depths from January to March may provide an abundance of foraging habitat during the late winter period (Shuford et al. 1998).

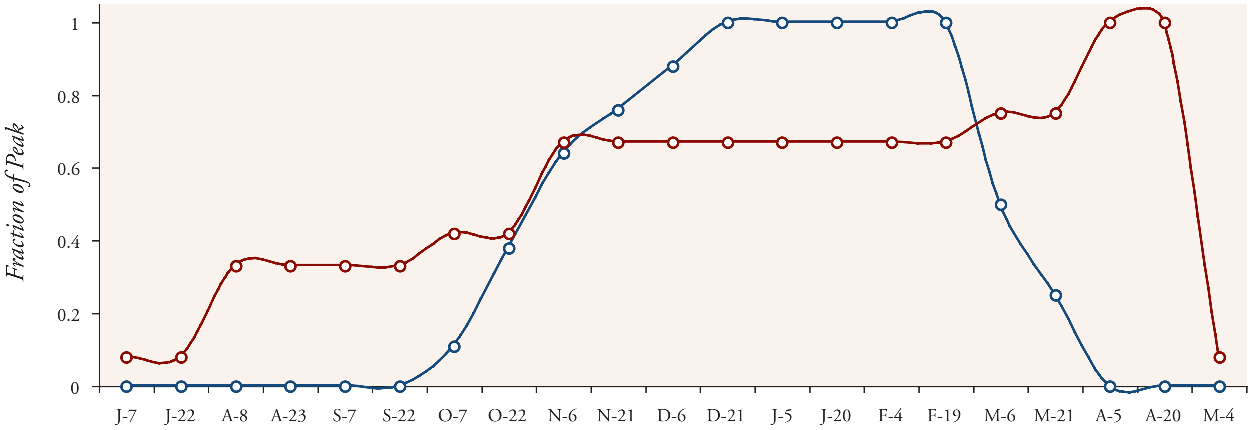


Figure 6-6. Shorebird population objectives for the Central Valley (red) vs. flooding schedules for winter flooded rice (blue).

In general, flooding schedules for managed wetlands and for winter flooded rice are more consistent with the needs of waterfowl than shorebirds in the Central Valley. Migration chronology of wintering waterfowl in the Central Valley corresponds well with flooding schedules for seasonal wetlands and with the availability of winter flooded rice (Figure 6-7). In contrast, shorebirds occur in significant numbers during July and August when important wetland and agricultural habitats have yet to be flooded.

Although shorebird planning efforts in the Central Valley benefit from reliable estimates of habitat acres and flooding schedules, no effort was made to evaluate the current relationship between food energy needs and food energy supplies using TRUEMET, as was done for wintering waterfowl. This supply-demand analysis would be meaningless without a better understanding of how habitats are stratified by foraging depth. To provide some insight into current habitat conditions, the JV determined the fraction of existing wetland and agricultural resources that must be <10 cm deep to meet shorebird needs. This measure is called the required depth ratio and is described later in Chapter 6.

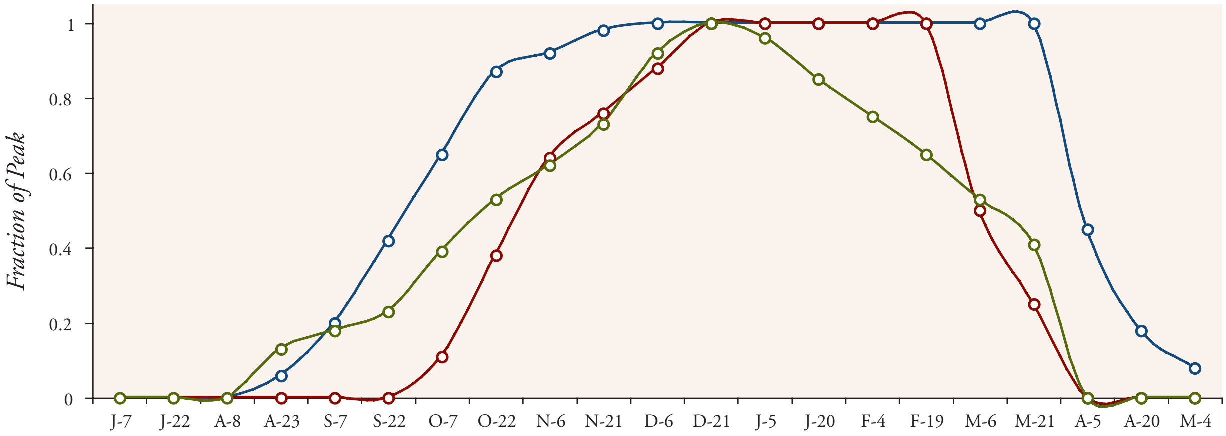


Figure 6-7. Shorebird population objectives (red) vs. flooding schedules for managed seasonal wetlands (blue) and rice (green). Shorebird population objectives are expressed as the fraction of peak population; wetlands and rice are expressed as the fraction of these habitats that are flooded.

Methods for Establishing Conservation Objectives for Wintering Shorebirds

The JV's assessment of habitat conditions in the Central Valley suggests that shorebird needs may be met by: (1) managing wetlands and agricultural habitats to provide foraging depths <10 cm; and (2) adjusting flooding and draw down schedules of wetlands to meet the needs of wintering shorebirds, especially during July and August. These conclusions are important because they provide the types of conservation objectives that should be established for shorebirds in each of the four planning regions.

Three conservation objectives were identified for wintering shorebirds: 1) Management of existing seasonal and semi-permanent wetlands to provide foraging depths < 10 cm. This includes changes in traditional flooding schedules. Existing wetlands are defined as wetlands that may be restored to meet habitat objectives for non-breeding waterfowl; 2) Securing additional water supplies that may be needed for changes in seasonal wetland flooding schedules; and 3) Management of agricultural habitats to provide foraging depths < 10 cm.

Prior to the 2006 Plan, the JV Technical Committee imposed a constraint that at least 50% of shorebird energy needs must be met from wetlands in each planning region. This decision was made because changing agricultural markets are beyond the control of the JV, and seeking a balance between agricultural and wetland habitat is warranted. However, Central Valley agriculture provides little or no shorebird benefits prior to early October (Figure 6-6). Drawdown of winter flooded rice fields in March also requires shorebirds to rely exclusively on wetland habitats during April and early May. As a result, the wetland constraint was modified so that wetlands are required to meet 100% of shorebird needs in all 15-day intervals between July 1 and October 1, and all 15-day intervals between March 30 and May 10.

The same approach was used to establish conservation objectives for shorebirds in each planning region. Shorebird population objectives between July and May were first compared to seasonal changes in habitat availability. Seasonal changes in shorebird foraging habitat are largely dependent on water management practices in wetlands and winter flooded agricultural lands. Understanding how these practices meet or do not meet shorebird needs is essential to developing effective conservation objectives for this bird group.

Next, shorebird food energy needs in each 15-day interval were estimated using the TRUEMET model. Food energy needs were a function of population objectives for that 15-day interval, and the daily energy requirement of a single bird. TRUEMET was then used to convert these food energy needs into an equivalent amount of foraging habitat for each 15-day interval. This overall foraging habitat need was then stepped down to the appropriate conservation objective(s). The methods for establishing shorebird conservation objectives are described below.

Management of Existing Seasonal and Semi-permanent Wetlands

To determine how much seasonal and semi-permanent wetland habitat must be managed at depths <10 cm in depth, the JV recognized four distinct flooding periods; summer, fall, spring, and winter. Conservation objectives for these managed wetlands were broken down by flooding period because water management practices within these flooding periods differ. These differences are likely to influence the availability of habitat <10 cm in depth. The four flooding periods are described as follows:

Description of Flooding Periods

Summer Flooding Period (July 1–August 16)

Historically, snow runoff provided huge lacustrine wetlands in the Tulare Basin, and evaporation of wetlands in the Delta Planning Region and the Butte Sink and Colusa Trough areas of the Sacramento Valley Planning Region provided shorebird habitat during July and August. Today, this period is characterized by an absence of seasonal wetlands, as flooding of these habitats does not begin until after mid-August. Semi-permanent wetlands are typically drawn down during July, with most assumed to be dry by mid-July. However, some wetlands may contain water through July if drawdowns are delayed until mid-month. Semi-permanent wetlands can provide shorebird habitat during these July drawdowns because water depths decline at this time. The JV assumes that semi-permanent wetlands provide no shorebird habitat outside of this July drawdown period, as water depths generally exceed 10 cm.

Fall Flooding Period (August 17–November 29)

Historically, this was the driest period in the Central Valley, resulting in fewer wetlands available to shorebirds. Exposure of shallow habitats would have occurred in Tulare Basin, and flooding of seasonal wetlands could have occurred in October and November. This period is characterized by flooding of seasonal wetlands. Beginning in mid-August, seasonal wetlands on public and private wetlands are flooded throughout the Central Valley. This flooding is mostly complete by late November, though there is some variation among shorebird planning regions. The availability of shorebird habitat during this period is likely characterized by large temporal and spatial variation. For example, water depths <10 cm may be abundant during the initial phases of flooding. This would be true for both individual wetlands, and for the entire shorebird-planning region. As fall progresses and many of these seasonal wetlands are fully flooded, the availability of foraging habitat <10 cm deep may decline.

Although the JV assumes that seasonal wetlands provide 20 kg/ha of invertebrates, it is unclear how invertebrate availability changes through the Fall Flooding Period. For example, there may be a significant lag between when water is applied to seasonal wetlands and when invertebrate populations reach levels that are beneficial to shorebirds. Future efforts to understand how invertebrate communities and biomass change, relative to the date of flooding, will help refine the JV's estimates of shorebird needs during the Fall Flooding Period.

Winter Flooding Period (November 30–March 29)

Historically, this period would have provided the greatest abundance of shallow habitat throughout the Central Valley. Today, this period is characterized by maximum availability of seasonal wetlands as most habitats are flooded by mid-November with water levels maintained through late March (Figure 6-3). Although water levels fluctuate during this period, the temporal and spatial variation in water levels that characterized the Fall Flooding Period may be diminished. Shorebirds during the Winter Flooding Period period may face a more stable wetland environment, as changing water levels are less likely compared to the Fall Flooding Period. However, this may ultimately result in fewer acres flooded to <10 cm in depth, especially during the early portion of this period.

Spring Flooding Period (April 1–May 12)

Historically, many floodplain wetlands would be drying during this period. Today, this period is characterized by the drawdown of seasonal wetlands (Figure 6-3). These drawdowns likely increase the area of shallow water habitat for shorebirds, especially if most seasonal wetlands were managed at depths greater than 10 cm. Many of the public and private seasonal wetlands are managed for April and early May drawdowns to maximize moist soil plant germination.

Hypothetical Shorebird Planning Region

The method for determining how much seasonal and semi-permanent wetland habitat must be managed at depths <10 cm is described using a hypothetical shorebird-planning region. Habitat resources and water management schedules for this planning region are presented in Table 6-6, while shorebird foraging habitat needs are presented for each 15-day interval in Table 6-7.

Table 6-6. Habitat resources and associated flooding schedules for a hypothetical shorebird planning region.

Interval	*Seasonal Wetlands (Acres)*	*Semi-Perm. Wetlands (Acres)*	*Winter Flooded Rice (Acres)*
J-7 (July 1-July 15)	0	2000	0
J-22 (July 16-July 31)	0	0	0
A-8 (Aug 1-Aug 16)	0	0	0
A-23 (Aug 17-Aug 23)	600	0	0
S-7 (Sept 1-Sept 15)	2,000	120	0
S-22 (Sept 16-Sept 30)	4,200	400	0
O-7 (Oct 1-Oct 15)	6,500	840	2,200
O-22 (Oct 16-Oct 30)	8,700	1,300	7,600
N-6 (Oct 31-Nov 14)	9,200	1,740	12,800
N-21 (Nov 15-Nov 29)	10,000	1,840	15,200
D-6 (Nov 30-Dec 14)	10,000	2,000	17,600
D-21 (Dec 15-Dec 29)	10,000	2,000	20,000
J-5 (Dec 30-Jan 13)	10,000	2,000	20,000
J-20 (Jan 14-Jan 28)	10,000	2,000	20,000
F-4 (Jan 29-Feb 12)	10,000	2,000	20,000
F-19 (Feb 13-Feb 27)	10,000	2,000	20,000
M-6 (Feb 28-Mar 14)	10,000	2,000	10,000
M-21 (Mar 15-Mar 29)	10,000	2,000	5,000
A-5 (Mar 30-Apr 13)	10,000	2,000	0
A-20 (Apr 14-Apr 28)	3,150	2,000	0
M-4 (Apr 29-May 10)	1,300	2,000	0

Long-billed dowitcher
Photo: Brian Gilmore

To provide some insight into whether wetlands currently satisfy shorebird energy requirements, the JV estimated a "required depth ratio" for all time intervals in all flooding periods. This ratio reflects the fraction of existing seasonal or semi-permanent wetlands that must be <10 cm in depth to meet shorebird needs. These depth ratios may provide some basis for future monitoring and evaluation. For example, water depths periodically measured in seasonal wetlands can be compared to these depth ratios to determine if adequate shallow water habitat is being provided.

Summer Flooding Period for the Hypothetical Planning Region

Shorebirds require 100 acres of wetland habitat <10 cm deep in both the July 7 and July 22 intervals, with habitat needs increasing to 150 acres during the August 8 interval (Table 6-7). All habitat requirements during the Summer Flooding Period must be met from managed wetlands, as no winter flooded rice is available.

Table 6-7. Habitat needs of non-breeding shorebirds in a hypothetical planning region.

Interval	*Habitat Needs (acres)*[a]
J-7 (July 1-July 15)	100
J-22 (July 16-July 31)	100
A-8 (Aug 1-Aug 16)	150
A-23 (Aug 17-Aug 23)	300
S-7 (Sept 1-Sept 15)	300
S-22 (Sept 16-Sept 30)	300
O-7 (Oct 1-Oct 15)	500
O-22 (Oct 16-Oct 30)	500
N-6 (Oct 31-Nov 14)	600
N-21 (Nov 15-Nov 29)	600
D-6 (Nov 30-Dec 14)	100
D-21 (Dec 15-Dec 29)	100
J-5 (Dec 30-Jan 13)	100
J-20 (Jan 14-Jan 28)	100
F-4 (Jan 29-Feb 12)	200
F-19 (Feb 13-Feb 27)	200
M-6 (Feb 28-Mar 14)	200
M-21 (Mar 15-Mar 29)	200
A-5 (Mar 30-Apr 13)	500
A-20 (Apr 14-Apr 28)	500
M-4 (Apr 29-May 10)	500
Total	**6,150**

[a] *Habitat acres that have not been subject to food depletion as a result of prior shorebird foraging.*

Providing 100 acres of shallowly flooded habitat would meet shorebird needs in the July 7 interval. However, simply maintaining the same 100 acres would not meet shorebirds needs in the July 22 interval, because food resources in these 100 acres are depleted by July 15 (the 2006 Plan assumes that invertebrate populations are not self-renewing). Meeting shorebird needs for the entire month of July requires that 100 acres of wetlands be provided on July 1, with an additional 100 acres to be provided on or before July 16. In theory, the 100 acres of wetland habitat needed in the July 22 interval can be provided at any date between July 1 and July 16. For example, 200 acres flooded on July 1 would meet shorebird needs for the entire month.

Semi-permanent wetlands may provide the best opportunity to meet shorebird needs during July. Most semi-permanent wetlands are drawn down during the first part of July, which may result in significant habitat <10 cm deep. The planning region contains 2,000 acres of semi-permanent wetlands (Table 6-6). If all wetlands are drawn down by mid-July, the required depth ratio for these semi-permanent habitats is 5% (i.e., 100 of the 2,000 acres must provide water depths <10 cm). If all 2,000 acres of semi-permanent wetlands are dry by mid-July, no opportunity exists to meet shorebird needs in the July 22 interval using these wetlands. Seasonal wetlands could be flooded to meet habitat needs during the second half of July. However, it may be better to delay the drawdown of some semi-permanent wetlands to meet shorebird needs in the July 22 interval.

Although habitat needs of shorebirds in the July 22 interval may be met through delayed drawdown of semi-permanent wetlands, it is assumed that habitat needs in the August 8 interval (150 acres) must be met by flooding seasonal wetlands. Flooding of seasonal wetlands in this hypothetical shorebird region has not occurred prior to mid-August; so providing 150 acres of seasonal wetlands in the August 8 interval represents a management effort directed solely at shorebird needs. However, this involves early flooding of only 1.5% of the existing seasonal wetland base (150/10,000).

Fall Flooding Period for the Hypothetical Planning Region

Habitat needs for shorebirds in the Fall Flooding Period (August 17-November 29) range from 300 acres in August and September, to 600 acres for the November 21 interval (Table 6-7). Although this hypothetical shorebird region contains 20,000 acres of winter flooded rice, none of this agricultural habitat is available prior to the October 7 interval (October 1-15). As a result, shorebird needs must be met entirely from seasonal wetland habitats in the August and September intervals.

Table 6-8. Seasonal wetland objectives (acres) for shorebirds in the Fall Flooding Period of a hypothetical planning region.

Interval	*SW Interval Objective*	*Cumulative[a] SW Objective*	*Flooded[b] SWs*	*Required Depth[c] Ratio (%)*
A-23 (Aug 17-Aug 23)	300	450	600	67
S-7 (Sept 1-Sept 15)	300	750	2,000	38
S-22 (Sept 16-Sept 30)	300	1,050	4,200	25
O-7 (Oct 1-Oct 15)	250	1,300	6,500	20
O-22 (Oct 16-Oct 30)	250	1,550	8,700	18
N-6 (Oct 31-Nov 14)	300	1,850	9,200	20
N-21 (Nov 15-Nov 29)	300	2,150	10,000	22
Total	2,000	2,150		

SW – Seasonal Wetland.
[a] Includes SW objectives from previous flooding periods.
[b] Flooded SWs reflect flooding schedules within a shorebird planning region.
[c] Cumulative SW Objective/Flooded SWs.

Table 6-9. Seasonal wetland objectives (acres) for shorebirds in the Winter Flooding Period of a hypothetical planning region.

Interval	*SW Interval Objective*	*Cumulative[a] SW Objective*	*Flooded[b] SWs*	*Required Depth[c] Ratio (%)*
D-6 (Nov 30-Dec 14)	50	2,200	10,000	22
D-21 (Dec 15-Dec 29)	50	2,300	10,000	23
J-5 (Dec 30-Jan 13)	50	2,350	10,000	24
J-20 (Jan 14-Jan28)	50	2,400	10,000	24
F-4 (Jan 29-Feb 12)	100	2,500	10,000	25
F-19 (Feb 13-Feb 27)	100	2,600	10,000	26
M-6 (Feb 28-Mar 14)	100	2,700	10,000	27
M-21 (Mar 15-Mar 29)	100	2,800	10,000	28
Total	600	2,800		

SW – Seasonal Wetland.
[a] Includes SW objectives from previous flooding periods.
[b] Flooded SWs reflect flooding schedules within a shorebird planning region.
[c] Cumulative SW Objective/Flooded SWs.

Seasonal wetland habitat objectives for shorebirds in the Fall Flooding Period are provided in Table 6-8. Seasonal wetland objectives prior to October are equivalent to the overall habitat needs of shorebirds, as most winter flooding of rice has yet to begin. Beginning in October, seasonal wetland objectives decline to 50% of overall habitat needs (Table 6-7), as rice becomes available and is assumed to meet half of shorebird energy requirements.

Although the summed seasonal wetland objective of 2,000 acres is staggered over seven 15-day intervals, it is possible to meet this overall habitat objective in a shorter period of time. For example, seasonal wetland objectives for shorebirds could be met in the Fall Flooding Period by providing 2,000 acres during the August 23 interval and maintaining these acres at a depth <10 cm through the end of November (Figure 6-8).

Seasonal wetlands become increasingly available from August through November, as these habitats are flooded prior to the hunting season. This increase in seasonal wetlands is reflected in the required depth ratio of shorebird habitat. Two thirds of all seasonal wetland acres that are flooded by the August 23 interval must be <10 cm deep if shorebird habitat needs are to be met in this 15-day interval. However, the depth ratio declines in later intervals as seasonal wetlands become increasingly abundant and fewer of these acres must be <10 cm to meet shorebird needs (Figure 6-9). The required depth ratio for intervals in the Fall Flooding Period is calculated as the cumulative objective for seasonal wetlands, divided by the acres of seasonal wetlands that are flooded. The cumulative seasonal wetland objective includes any objectives from previous flooding periods. In Table 6-8, 4,200 acres of seasonal wetlands are flooded by the September 22 interval. Twenty five percent of these acres must have provided water depths <10 cm through this interval. This is equivalent to about 1,050 acres of shallow water habitat. Note that this 1050-acre objective must be appropriately staggered between the August 23 and September 22 intervals if shorebirds needs are to be met for all intervals (i.e., the required depth ratios must be met for the earlier intervals as well).

Winter Flooding Period for the Hypothetical Planning Region

Overall habitat needs for shorebirds in the Winter Flooding Period (November 30-March 29) range from 100 acres in December and January, to 200 acres in February and March (Table 6-7). Seasonal wetland objectives for shorebird populations in the Winter Flooding Period are provided in Table 6-9. These wetland objectives are equivalent to 50% of the interval habitat needs, as winter flooded rice is assumed to meet half of all shorebird energy requirements. Seasonal wetland objectives are also summed from one interval to the next to provide a total seasonal wetland objective between December and March. Although the summed seasonal wetland objective is staggered over several 15-day intervals, it is possible to front-end this overall habitat objective. For example, seasonal wetland objectives for shorebirds could be met in the Winter Flooding Period by providing 600 acres during the December 6 interval and maintaining these acres at a depth <10 cm through the end of March (Figure 6-10).

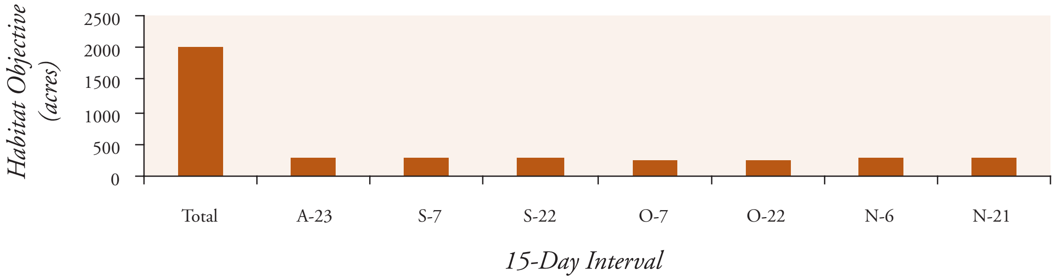


Figure 6-8. Seasonal wetland objectives for shorebirds in the Fall Flooding Period by 15-day intervals for a hypothetical planning region.

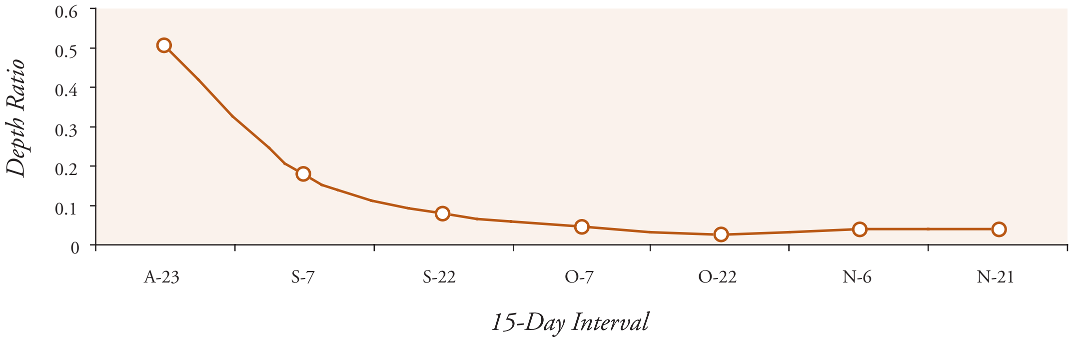


Figure 6-9. Changes in the depth ratio for shorebirds in the Fall Flooding Period. The fraction of potential shorebird habitat (seasonal wetlands) that must be <10 cm deep declines from August through November.

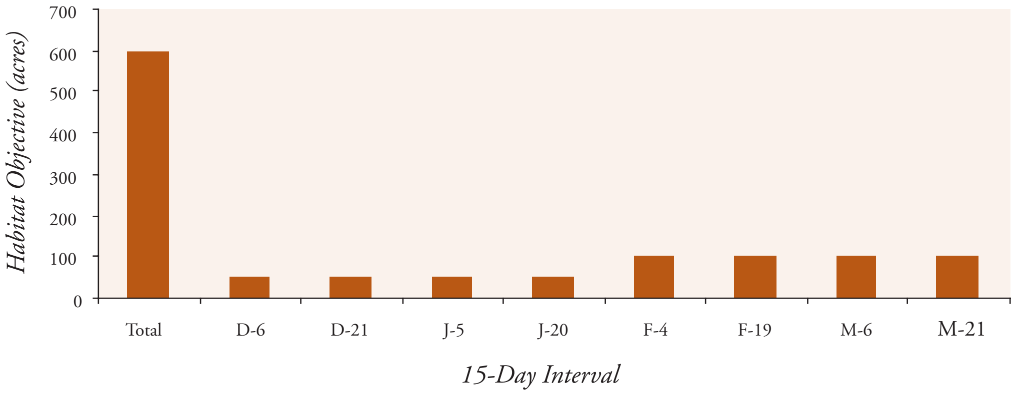


Figure 6-10. Seasonal wetland objectives for shorebirds in the Winter Flooding Period by 15-day intervals for a hypothetical planning region.

The required depth ratio increases from December through March (Table 6-9). For the Winter Flooding Period, the depth ratio is calculated as the summed seasonal wetland objective for a given interval divided by the potential seasonal wetland habitat at the beginning of the Winter Flooding Period (i.e., the December 6 interval). The required depth ratio increases through winter, as no new wetlands are being flooded and shorebirds deplete food resources on seasonal wetland acres that are managed below 10 cm in depth (Figure 6-11). Wetland managers could respond to this increase in required depth ratios by reducing water depths in some wetlands that are traditionally managed for waterfowl.

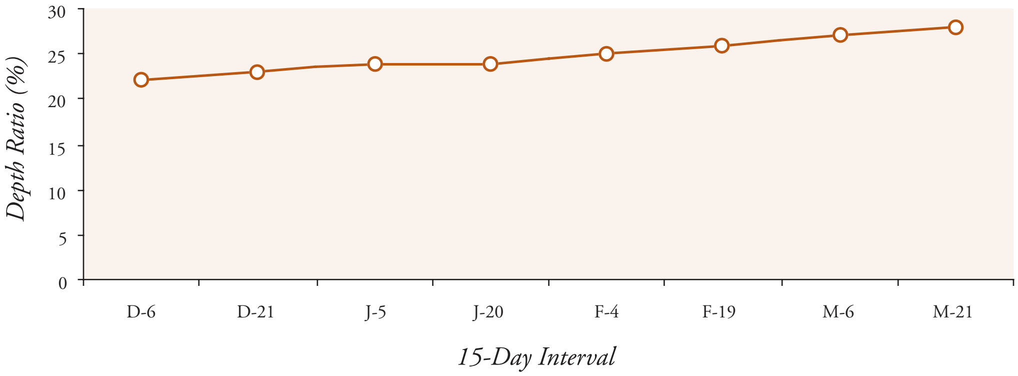


Figure 6-11. Changes in the required depth ratio for seasonal wetlands in the Winter Flooding Period for a hypothetical planning region.

Spring Flooding Period for the Hypothetical Planning Region

Overall, habitat needs for shorebirds in the Spring Flooding Period (March 30-May 12) range from 500 acres in each of the April intervals, to 300 acres in the May 4 interval (Table 6-7). Seasonal wetland objectives for shorebirds in each 15-day interval of the Spring Flooding Period are provided in Table 6-10. These wetland objectives are equivalent to the overall habitat needs of shorebirds, as winter flooded rice has been drained prior to the growing season. Seasonal wetland objectives are also summed from one interval to the next to provide a total seasonal wetland objective for April and May. Although the summed seasonal wetland objective is staggered over three 15-day intervals, it is possible to front-end this overall habitat objective. For example, seasonal wetland objectives could be met in the spring period by providing 1,300 acres at the beginning of the April 5 interval and maintaining these acres at a depth <10 cm until mid-May (Figure 6-12). Required depth ratios were not calculated for intervals in the Spring Flooding Period because of the uncertainty introduced by drawdowns of wetlands during this time. The drawdown of seasonal wetlands may result in an abundance of shorebird habitat during the Spring Flooding Period (Taft et al. 2002). Finally, the ending cumulative objective of 4,100 acres suggests that forty one percent (4,100/10,000) of all seasonal wetlands in this hypothetical planning region must be managed for shorebirds for at least some time during the wintering period. Estimating what fraction of wetlands must be managed for shorebirds may be a useful exercise (i.e., depth ratios). However, it bears repeating that such estimates are compromised by a lack of knowledge on invertebrate communities within these habitats, and how these communities respond to shorebird foraging.

Table 6-10. Seasonal wetland objectives (acres) for shorebirds in the Spring Flooding Period of a hypothetical planning region.

Interval	*SW Interval Objective*	*Cumulative SW[a] Objective*	*Flooded SWs[b]*
A-5 (Mar 30-Apr 13)	500	3,300	10,000
A-20 (Apr 14-Apr 28)	500	3,800	3,150
M-4 (Apr 29-May 10)	300	4,100	1,300
Total	**1,300**	**4,100**	

SW – Seasonal Wetland.

[a] Includes SW objectives from previous flooding periods.

[b] Flooded SWs reflect flooding schedules within a shorebird planning region.

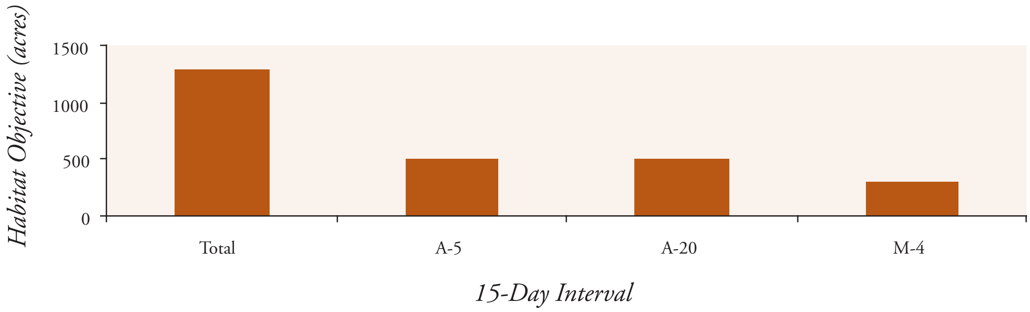


Figure 6-12. Seasonal wetland objectives for shorebirds in the Spring Flooding Period by 15-day intervals for a hypothetical planning region.

Water Supplies for Wetland Management for the Hypothetical Planning Region

Water supplies needed to manage seasonal wetlands for wintering waterfowl were estimated in Chapter 4. The assumption here is that shorebird needs can be met in the context of meeting waterfowl needs provided that adequate amounts of wetland habitat are managed at depths <10 cm. As a result, water supply estimates that are specific to shorebirds are not needed for the period when seasonal wetlands are traditionally flooded in the Central Valley (i.e., beginning in mid-August). However, shorebirds rely on the Central Valley prior to when seasonal wetlands are traditionally flooded (i.e., July and early August), and flooding of wetlands in this period may be needed to meet shorebird needs. As a result, the water needs (acre-feet) associated with providing seasonal wetlands prior to conventional flooding dates was estimated. These estimates were based on wetland acre needs of shorebirds outside of conventional flooding dates (e.g., July and early August). The acre-feet estimate of water needed to flood these wetlands was based on annual wetland water requirements from the 2000 *Central Valley Wetland Water Supply Investigations, CVPIA 3406 (d)(6)(A,B), A Report to Congress* (U.S. Fish & Wildlife Service 2000).

Meeting shorebird needs in the hypothetical planning region required flooding 150 acres of seasonal wetlands in the August 8 interval. Conventional flooding schedules indicate that seasonal wetlands receive about 1 acre-foot of water during the second half of August and 2-acre feet of water in September (Figure 6-13). However, these water requirements are geared towards waterfowl and may provide water depths that are less than optimal for shorebirds. The JV tentatively assumes that providing shorebird habitat outside of the conventional flooding schedules requires 2 acre-feet per acre. For example, providing 150 acres of seasonal wetlands in the August 8 interval would require 300 acre-feet of water. This water requirement is above and beyond the water needed to manage seasonal wetlands in a conventional manner (i.e., where flooding does not begin before mid to late August).

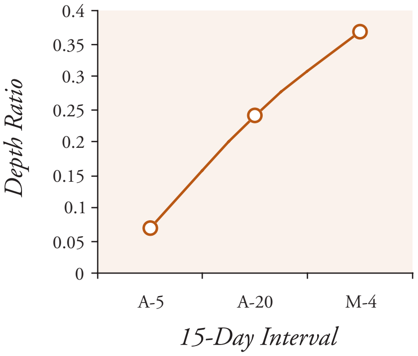


Figure 6-13. Changes in the seasonal wetland depth ratio for shorebirds during the Spring Flooding Period.

Agricultural Enhancement

Harvested rice fields that are winter flooded in the Central Valley can provide important shorebird habitat during the wintering period. Similar to wintering waterfowl, winter flooded rice may provide up to 50% of the food energy needs of shorebirds. However, winter flooded rice is only available from early October through late March (Figure 6-4). As a result, wetlands must meet 100% of shorebird needs in all 15-day intervals between July 1 and October 1, and March 30 and May 10.

The methods for determining how much winter flooded rice must be managed at depths <10 cm is described using the hypothetical shorebird region in Table 6-6. The planning region contains 20,000 acres of winter flooded rice. Flooding of this rice begins in early October, with drawdown complete by the end of March (Figure 6-4).

Overall, habitat needs for shorebirds between October 1 and March 29 range from a high of 600 acres in November, to a low of 100 acres in the December and January intervals (Table 6-7). Agricultural enhancement objectives (i.e., flooded rice) for shorebirds between October and March are presented in Table 6-11. The agricultural objectives are equivalent to 50% of the interval habitat needs, as seasonal wetlands are assumed to meet half of all shorebird energy requirements. Agricultural enhancement objectives are also summed from one interval to the next to provide a total rice objective between early October and the end of March. Although the summed agricultural objective of 1,700 acres is staggered over several 15-day intervals, it is possible to front-end this overall habitat objective. For example, the agricultural enhancement objective could be met by providing 1,700 acres of winter flooded rice in early October and maintaining these acres at a depth <10 cm through the end of March (Figure 6-14). The required depth ratio remains relatively steady for winter flooded rice between October and March (Figure 6-15). This is largely the result of interval rice objectives being small relative to the amount of flooded rice that is available.

Table 6-11. Rice habitat objectives (acres) for shorebirds between early October and the end of March in a hypothetical planning region.

Interval	*Rice Interval Objective*	*Cumulative Rice Objective*	*Flooded[a] Rice*	*Required[b] Depth Ratio (%)*
O-7 (Oct 1-Oct 15)	250	250	2,200	11
O-22 (Oct 16-Oct 30)	250	500	7,600	7
N-6 (Oct 31-Nov 14)	300	800	12,800	6
N-21 (Nov 15-Nov 29)	300	1,100	15,200	7
D-6 (Nov 30-Dec 14)	50	1,150	1,7600	7
D-21 (Dec 15-Dec 29)	50	1,200	20,000	6
J-5 (Dec 30-Jan 13)	50	1,250	20,000	6
J-20 (Jan 14-Jan 28)	50	1,300	20,000	7
F-4 (Jan 29-Feb 12)	100	1,400	20,000	7
F-19 (Feb 13-Feb 27)	100	1,500	20,000	8
M-6 (Feb 28-Mar 14)	100	1,600	10,000	
M-21 (Mar 15-Mar 29)	100	1,700	5,000	
Total	**1,700**	**1,700**		

[a] *Flooded Rice reflects post-harvest flooding schedules for rice.*
[b] *Cumulative Rice Objective/Flooded Rice.*

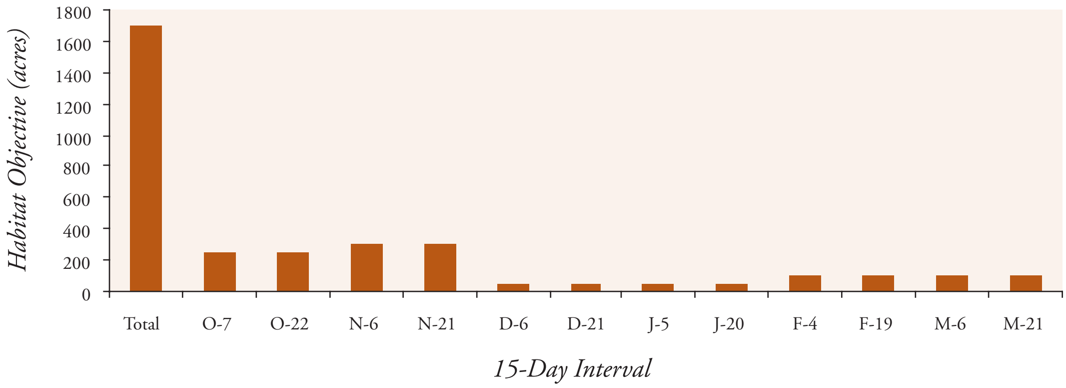


Figure 6-14. Rice habitat objectives for shorebirds by 15-day intervals for a hypothetical planning region.

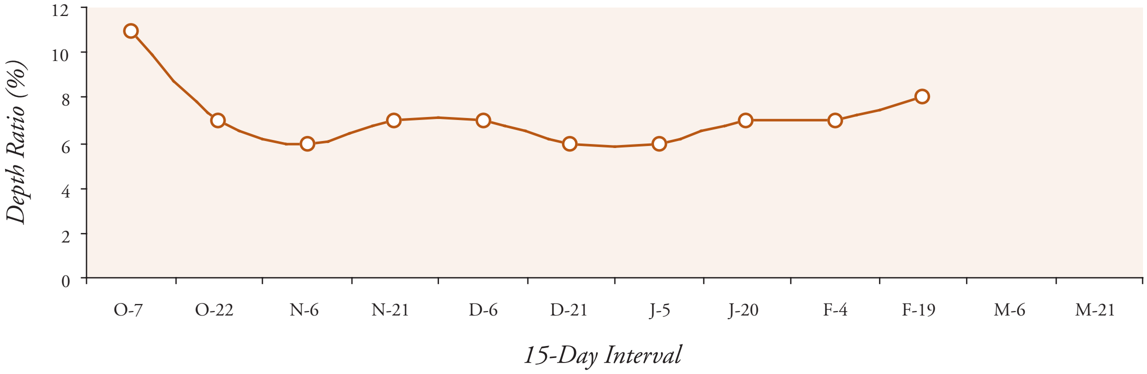


Figure 6-15. Changes in the required depth ratio for rice habitat between October and March.

Summary

Conservation objectives for managed seasonal and semi-permanent wetlands, water supplies, and agricultural enhancement are summarized for the hypothetical shorebird-planning region in Table 6-12.

Table 6-12. Conservation objectives for non-breeding shorebirds in a hypothetical planning region.

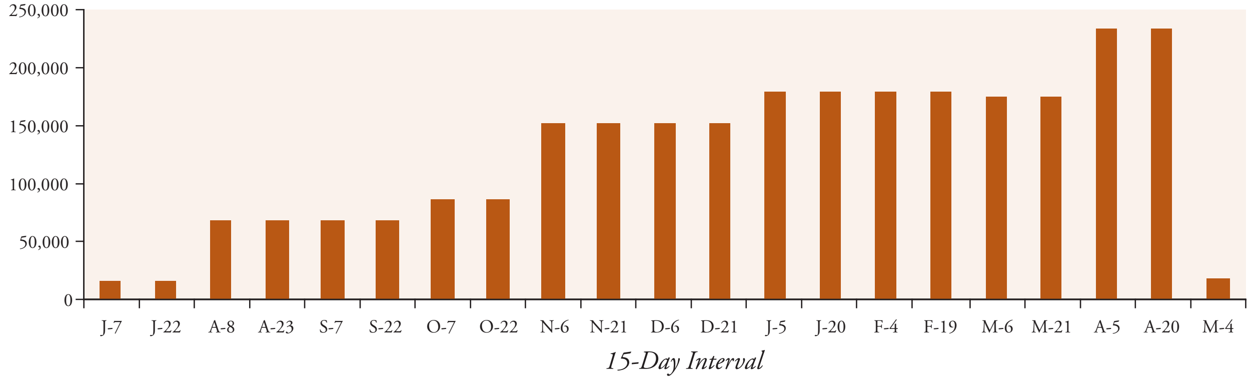
Interval	*Seasonal Wetlands (Acres)*	*Semi-Perm. Wetlands (Acres)*	*Water (Acre-Feet)*	*Winter Flooded Rice (Acres)*
J-7 (July 1-July 15)	0	100	0	0
J-22 (July 16-July 31)	0	100	0	0
A-8 (Aug 1-Aug 16)	150	0	300	0
A-23 (Aug 17-Aug 23)	300	0	0	0
S-7 (Sept 1-Sept 15)	300	0	0	0
S-22 (Sept 16-Sept 30)	300	0	0	0
O-7 (Oct 1-Oct 15)	250	0	0	250
O-22 (Oct 16-Oct 30)	250	0	0	250
N-6 (Oct 31-Nov 14)	300	0	0	300
N-21 (Nov 15-Nov 29)	300	0	0	300
D-6 (Nov 30-Dec 14)	50	0	0	50
D-21 (Dec 15-Dec 29)	50	0	0	50
J-5 (Dec 30-Jan 13)	50	0	0	50
J-20 (Jan 14-Jan 28)	50	0	0	50
F-4 (Jan 29-Feb 12)	100	0	0	100
F-19 (Feb 13-Feb 27)	100	0	0	100
M-6 (Feb 28-Mar 14)	100	0	0	100
M-21 (Mar 15-Mar 29)	100	0	0	100
A-5 (Mar 30-Apr 13)	500	0	0	0
A-20 (Apr 14-Apr 28)	500	0	0	0
M-4 (Apr 29-May 10)	300	0	0	0
Total	**4,050**	**200**	**300**	**1,700**

Conservation Objectives for Wintering Shorebirds Within Planning Regions

Sacramento Valley Planning Region

Current Conditions

Population objectives for migrating and wintering shorebirds in the Sacramento Valley Planning Region (Colusa, Butte, American, and Sutter Basins) are presented in Figure 6-16. Population objectives are the highest for April, with shorebird numbers reaching a minimum in July. Winter flooded rice provides the majority of foraging habitat potentially available to shorebirds, though seasonal wetlands exceed 50,000 acres (Table 6-13).



July 7	July 22	Aug. 8	Aug. 23	Sept.-7	Sept. 22	Oct. 7	Oct. 22	Nov. 6	Nov. 21	Dec. 6	Dec. 21	Jan. 5	Jan. 20	Feb. 4	Feb. 19	Mar. 6	Mar. 21	Apr. 5	Apr. 20	May 4
17,500	17,500	70,000	70,000	70,000	70,000	87,500	87,500	152,000	152,000	152,000	152,000	180,000	180,000	180,000	180,000	175,500	175,500	234,000	234,000	19,500

Figure 6-16. Shorebird population objectives (acres) for the Sacramento Valley Planning Region.

Figure 6-17 depicts the relationship between shorebird population objectives and the availability of seasonally flooded wetlands and winter flooded rice. Semi-permanent wetlands are assumed to provide shorebird habitat from July 1 to July 15 when they are typically drawn down and more likely to provide foraging habitat <10 cm in depth.

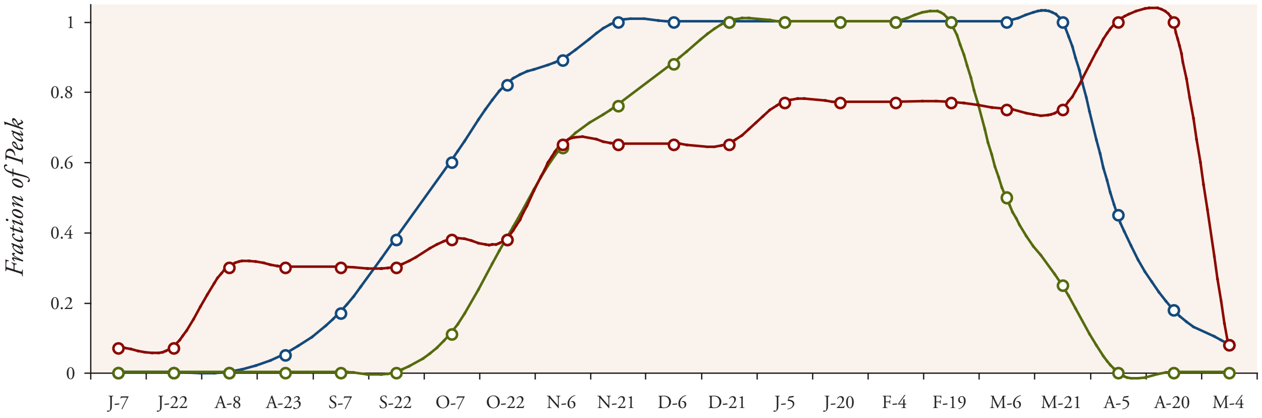


Figure 6-17. Shorebird population objectives (red) vs. flooding schedules for managed seasonal wetlands (blue) and rice (green) for the Sacramento Valley Planning Region. Shorebird population objectives are expressed as the fraction of peak population; wetlands and rice are expressed as the fraction of these habitats that are flooded.

Seasonal wetlands provide no habitat prior to the August 23 interval when flooding of these wetlands in the SV Planning Region typically begins. However, drawdown of semi-permanent wetlands in early July provides some foraging habitat between July 1 and July 15. Increases in the amount of seasonal wetlands track increases in shorebird numbers from late August to early December. Shorebird numbers increase during April when seasonal wetlands are being drawn down and the amount of foraging habitat <10 cm deep is likely increasing.

Winter flooded rice provides no foraging habitat prior to the October 7 interval. Although rice provides large amounts of potential habitat from late October through late March, these habitats are largely dry by the time shorebird numbers peak in April.

Management of Existing Seasonal and Semi-Permanent Wetlands

Summer Flooding Period (July 1–August 16)

Shorebirds require 396 acres of foraging habitat <10 cm deep in the July 7 interval, with habitat needs increasing to 423 acres and 1,584 acres in the July 22 and August 8 intervals respectively (Table 6-14). All habitat requirements during the Summer Flooding Period must be met from managed wetlands, as no winter flooded rice is available.

Semi-permanent wetlands may provide the best opportunity to meet shorebird needs in July. The SV Planning Region contains nearly 9,000 acres of semi-permanent wetlands (Table 6-13). If all these wetlands are drawn down between July 1 and July 15, the required depth ratio for these semi-permanent habitats is 4% (i.e., 396 of the 8,968 acres must provide water depths <10 cm to meet shorebird needs in the July 7 interval). Semi-permanent public wetlands alone (3,562 acres) can meet shorebird needs in the July 7 interval if only 11% of these habitats provide suitable water depths during drawdown. If all 8,968 acres of semi-permanent wetlands are drawn down by mid-July, no opportunity exists to meet shorebird needs in the July 22 interval using these habitats. Delaying the drawn down of some semi-permanent wetlands until late July could help provide the 423 acres of habitat needed by shorebirds in the July 22 interval.

Table 6-13. Acres of managed wetlands and intentionally flooded rice in the Sacramento Valley Planning Region.

Seasonal Wetland	*Semi-Perm. Wetland*	*Winter Flooded Rice*
50,868	8,968	346,606

Table 6-14. Habitat objectives for shorebirds in the Sacramento Valley Planning Region during the Summer Flooding Period.

Interval	*Habitat Objective (Acres)*
J-7 (July 1-July 15)	396
J-22 (July 16-July 31)	423
A-8 (Aug 1-Aug 16)	1,584

Table 6-15. Overall habitat needs for shorebirds in the Sacramento Planning Region during the Fall Flooding Period.

Interval	*Habitat Objective (Acres)*
A-23 (Aug 17-Aug 31)	1,584
S-7 (Sept 1-Sept 15)	1,584
S-22 (Sept 16-Sept 30)	1,584
O-7 (Oct 1-Oct 15)	1,980
O-22 (Oct 16-Oct 30)	1,980
N-6 (Oct 31-Nov 14)	2,965
N-21 (Nov 15-Nov 29)	2,965
Total	**14,642**

Population energy demand estimates for shorebirds indicate that 1,584 acres of wetland habitat are required during the August 8 interval. There are currently no seasonal wetlands flooded in the SV Planning Region during the first two weeks of August, and all semi-permanent wetlands are assumed to be dry by this time. The 1,584 acres of wetlands needed by shorebirds during this interval could be met through early flooding of seasonal wetlands. These 1,584 acres represent 3% of existing seasonal wetlands in the SV Planning Region, and 13% of all public seasonal wetlands.

Fall Flooding Period (August 17–November 29)

Habitat needs for shorebirds in the Fall Flooding Period range from 1,584 acres in each of the August and September intervals, to nearly 3,000 acres in each of the November intervals (Table 6-15). Although the SV Planning Region has over 350,000 acres of winter flooded rice, none of this agricultural habitat is available prior to the October 7 interval. As a result, shorebird needs must be met entirely from seasonal wetland habitats in the August and September intervals. Beginning in October, seasonal wetland objectives decline to 50% of interval habitat needs as rice is assumed to meet half of all shorebird needs (Table 6-16).

Table 6-16. Seasonal wetland objectives (acres) for shorebirds in the Sacramento Valley Planning Region during the Fall Flooding Period.

Interval	*SW Interval Objective*	*Cumulative SW[a] Objective*	*Flooded SWs[b]*	*Required Depth[c] Ratio (%)*
A-23 (Aug 17-Aug 31)	1,584	3,168	2,543	>100
S-7 (Sept 1-Sept 15)	1,584	4,752	8,648	55
S-22 (Sept 16-Sept 30)	1,584	6,336	19,330	33
O-7 (Oct 1-Oct 15)	990	7,326	30,521	24
O-22 (Oct 16-Oct 30)	990	8,316	41,712	20
N-6 (Oct 31-Nov 14)	1,483	9,799	45,273	22
N-21 (Nov 15-Nov 29)	1,483	11,282	50,868	22
Total	9,698			

SW – Seasonal Wetland.

[a] *Includes SW objectives from previous flooding periods.*

[b] *Flooded SWs reflect flooding schedules within a shorebird planning region.*

[c] *Cumulative SW Objective/Flooded SWs.*

Although the total seasonal wetland objective of 9,698 acres is staggered over seven 15-day intervals, it is possible to meet this overall habitat objective in a shorter period of time. For example, seasonal wetland objectives for shorebirds could be met in the Fall Flooding Period by providing 9,698 acres during the August 23 interval and maintaining these acres at a depth <10 cm through the end of November (Figure 6-18).

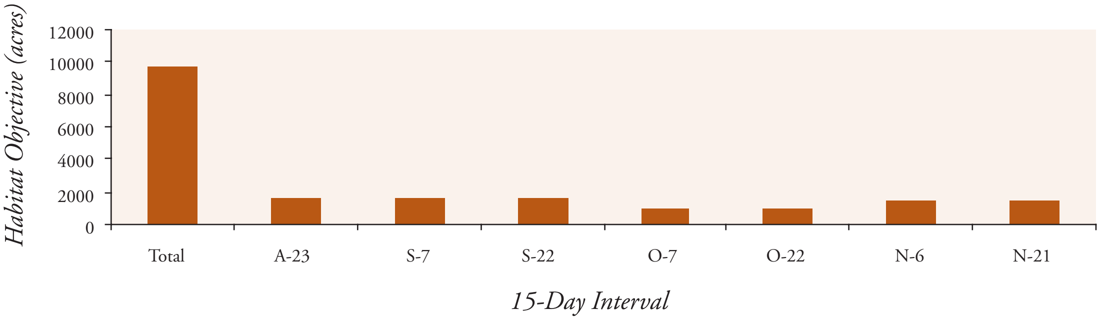


Figure 6-18. Seasonal wetland objectives for shorebirds in the Fall Flooding Period by 15-day intervals for the Sacramento Valley Planning Region.

Seasonal wetlands become increasingly available from August through November as these habitats are flooded prior to the hunting season. This increase in seasonal wetlands is reflected in the required depth ratio, which declines from August through October (Figure 6-19).

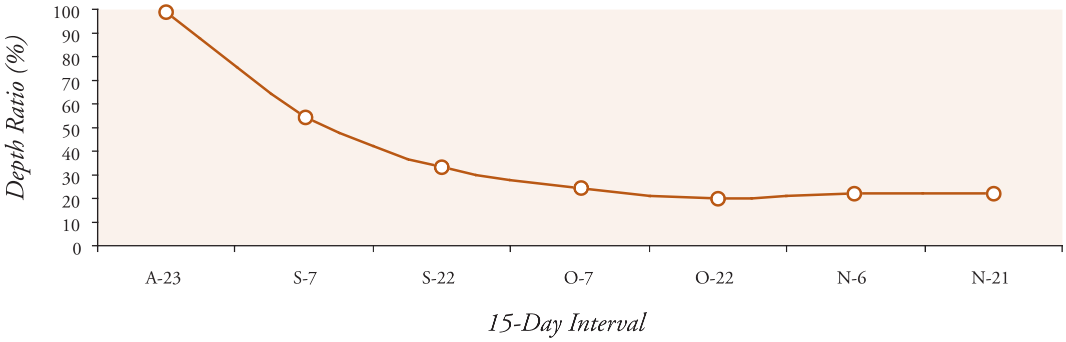


Figure 6-19. Changes in the required depth ratio for seasonal wetlands in the Fall Flooding Period for the Sacramento Valley Planning Region.


Common snipe
Photo: Dave Feliz, CDFG

Table 6-17. Overall habitat needs for shorebirds during the Winter Flooding Period.

Interval	*Habitat Objective (Acres)*
D-6 (Nov 30-Dec 14)	2,965
D-21 (Dec 15-Dec 29)	2,965
J-5 (Dec 30-Jan 13)	3,367
J-20 (Jan 14-Jan 28)	3,367
F-4 (Jan 29-Feb 12)	3,367
F-19 (Feb 13-Feb 27)	3,367
M-6 (Feb 28-Mar 14)	3,918
M-21 (Mar 15-Mar 29)	3,918
TOTAL	27,234

Winter Flooding Period (November 30–March 29)

Habitat needs for shorebirds in the Winter Flooding Period range from nearly 3,000 acres in the December intervals, to over 3,900 acres in March intervals (Table 6-17). Fifty percent of these habitat needs must be met from seasonal wetlands, with the balance being provided by winter flooded rice (Table 6-18). The overall seasonal wetland objective for the Winter Flooding Period is 13,260 acres. Although this wetland objective is staggered over several 15-day intervals, it is possible to meet this conservation objective in ashorter period of time. For example, seasonal wetland objectives for shorebirds could be met in the Winter Flooding Period by providing 13,620 acres during the December 6 interval and maintaining these acres at a depth <10 cm through the end of March (Figure 6-20). As expected, the required depth ratio increases through the Winter Flooding Period, as no new wetlands are being flooded and shorebirds deplete food resources on seasonal wetland acres that are managed <10 cm in depth (Figure 6-21).

Table 6-18. Seasonal wetland objectives (acres) for shorebirds in the Sacramento Valley Planning Region during the Winter Flooding Period.

Interval	*SW Interval Objective*	*Cumulative SW[a] Objective*	*Flooded[b] SWs*	*Required Depth[c] Ratio (%)*
D-6 (Nov 30-Dec 14)	1,483	12,765	50,868	25
D-21 (Dec 15-Dec 29)	1,483	14,248	50,868	28
J-5 (Dec 30-Jan 13)	1,684	15,932	50,868	31
J-20 (Jan 14-Jan 28)	1,684	17,616	50,868	35
F-4 (Jan 29-Feb 12)	1,684	19,300	50,868	38
F-19 (Feb 13-Feb 27)	1,684	20,984	50,868	41
M-6 (Feb 28-Mar 14)	1,959	22,943	50,868	45
M-21 (Mar 15-Mar 29)	1,959	24,902	50,868	49
TOTAL	13,620	24,902		

SW – Seasonal Wetland.
[a] Includes SW objectives from previous flooding periods.
[b] Flooded SWs reflect flooding schedules within a shorebird planning region.
[c] Cumulative SW Objective/Flooded SWs.

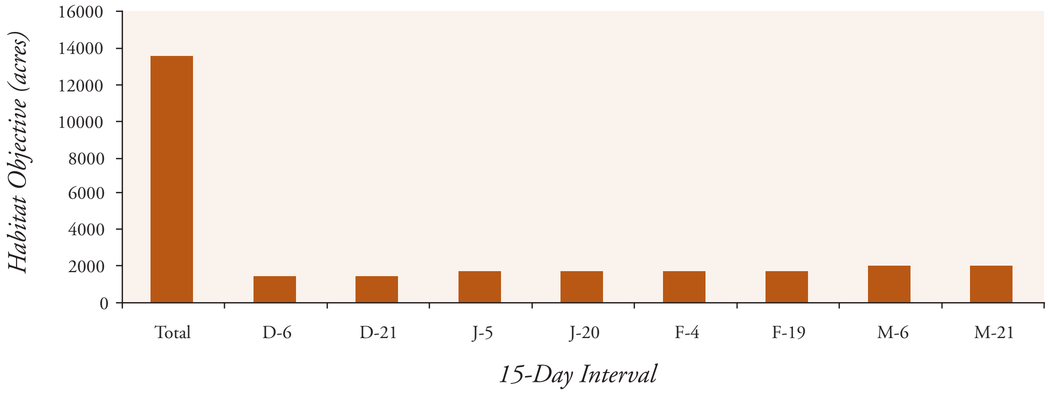


Figure 6-20. Seasonal wetland objectives for shorebirds in the Winter Flooding Period by 15-day intervals for the Sacramento Valley Planning Region.

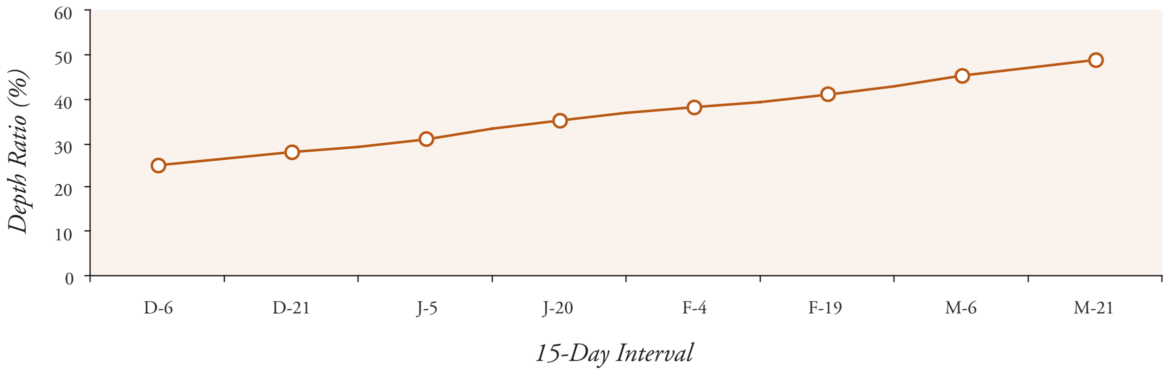


Figure 6-21. Changes in the required depth ratio for seasonal wetlands in the Winter Flooding Period for the Sacramento Valley Planning Region.

Spring Flooding Period (March 30–May 12)

Habitat needs for shorebirds in the Spring Flooding Period range from over 5,000 acres in each of the April intervals to less than 400 acres in May. Shorebird needs must be met exclusively by seasonal wetlands as rice fields are assumed to be dry by this time (Table 6-19). The summed seasonal wetland objective for the Spring Flooding Period is nearly 11,000 acres, with most of these acres needed in the April intervals (Figure 6-22).

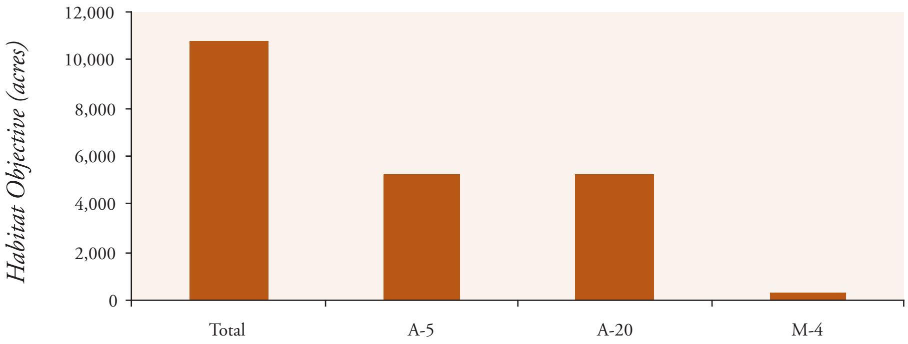


Figure 6-22. Seasonal wetland objectives for shorebirds in the Spring Flooding Period by 15-day intervals for the Sacramento Valley Planning Region.

Table 6-19. Seasonal wetland objectives (acres) for shorebirds in the Sacramento Valley Planning Region during the Spring Flooding Period.

Interval	*SW Interval Objective*	*Cumulative SW[a] Objective*	*Flooded SW[b] Habitat*
A-5 (Mar 30-Apr 13)	5,223	30,125	50,868
A-20 (Apr 14-Apr 28)	5,223	35,348	16,023
M-4 (Apr 29-May 10)	348	35,696	6,612
Total	**10,794**	**35,696**	

SW – Seasonal Wetland.

[a] *Includes SW objectives from previous flooding periods.*

[b] *Flooded SWs reflect flooding schedules within a shorebird planning region.*

Water Supplies for Wetland Management

Additional water supplies that are needed for shorebirds are based on seasonal wetland needs in the August 8 interval (see earlier description for establishing water supply objectives). Seasonal wetland objectives for shorebirds in the SV Planning Region during the August 8 interval are estimated at 1,584 acres. This equates to a water supply need of 3,168 acre-feet.

Agricultural Enhancement

Habitat objectives for flooded rice in the SV Planning Region range from just under 1,000 acres in the October intervals, to nearly 2,000 acres throughout March (Table 6-20). Although the summed agricultural enhancement objective is staggered over several 15-day intervals, it is possible to front-end this objective. For example, rice habitat objectives could be met by providing 18,566 acres during the October 7 interval and maintaining these acres at a depth <10 cm through the end of March (Figure 6-23). The required depth ratio for rice habitat is low for all time intervals, which reflects the large amount of rice acreage that is available relative to shorebird needs in the SV Planning Region (Figure 6-24).

Table 6-20. Rice habitat objectives (acres) for shorebirds between early October and the end of March in the Sacramento Valley Planning Region.

Interval	*Rice Interval Objective*	*Cumulative Rice Objective*	*Flooded Rice[a]*	*Required Depth[b] Ratio (%)*
O-7 (Oct 1-Oct 15)	990	990	38,123	3
O-22 (Oct 16-Oct 30)	990	1,980	131,171	2
N-6 (Oct 31-Nov 14)	1,483	3,463	221,828	2
N-21 (Nov 15-Nov 29)	1,483	4,946	263,421	2
D-6 (Nov 30-Dec 14)	1,483	6,429	305,013	2
D-21 (Dec 15-Dec 29)	1,483	7,912	346,606	2
J-5 (Dec 30-Jan 13)	1,684	9,596	346,606	3
J-20 (Jan 14-Jan 28)	1,684	11,280	346,606	3
F-4 (Jan 29-Feb 12)	1,684	12,964	346,606	4
F-19 (Feb 13-Feb 27)	1,684	14,648	346,606	4
M-6 (Feb 28-Mar 14)	1,959	16,607	346,606	5
M-21 (Mar 15-Mar 29)	1,959	18,566	346,606	5
Total	**18,566**	**18,566**	**346,606**	

[a] *Flooded Rice reflects post-harvest flooding schedules of rice.*

[b] *Cumulative Rice Objective/Flooded Rice.*

Greater yellowlegs
Photo: Dave Feliz, CDFG

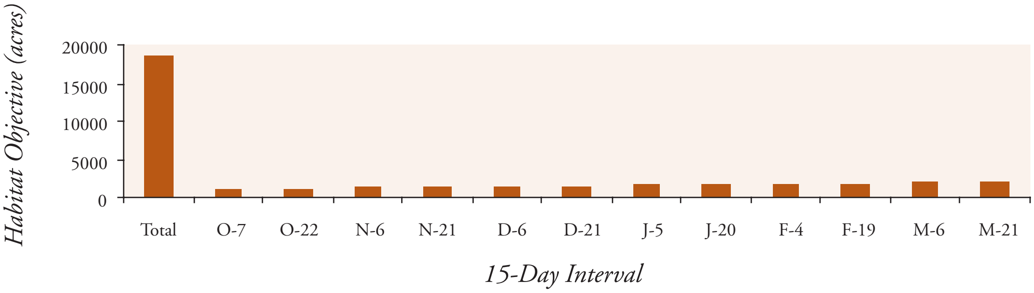


Figure 6-23. Rice habitat objectives for shorebirds by 15-day intervals for the Sacramento Valley Planning Region.

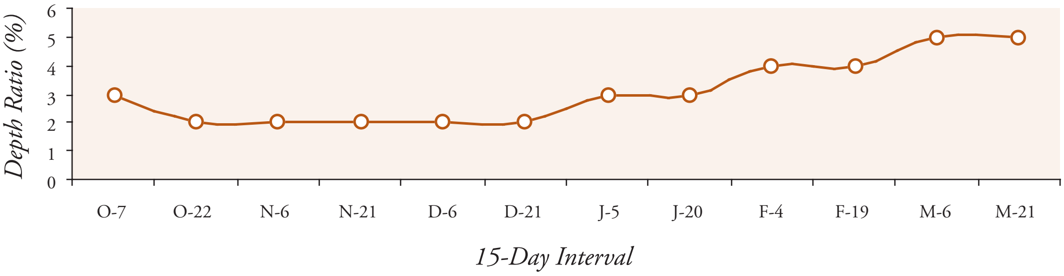


Figure 6-24. Changes in the required depth ratio for rice habitat in the Sacramento Valley Planning Region.

Summary

Conservation objectives for managed seasonal and semi-permanent wetlands, water supplies, and agricultural enhancement are summarized for the SV Planning Region in Table 6-21. Seventy percent of the seasonal wetlands present in the SV Planning Region (35,696/50,868) must provide foraging depths <10 cm during some portion of the wintering period if seasonal wetland objectives for shorebirds are to be met. This seems unlikely given the current emphasis on waterfowl habitat management. In contrast, only 5% of existing rice habitat (18,566/346,606) must provide suitable foraging depths during some portion of the wintering period to meet agricultural enhancement objectives for the SV Planning Region. In all likelihood, this objective is already being exceeded. Shorebirds in the SV Planning Region may be getting the majority of their food resources from these rice habitats, given that they total almost 350,000 acres.

Least sandpiper
Photo: Dave Feliz, CDFG

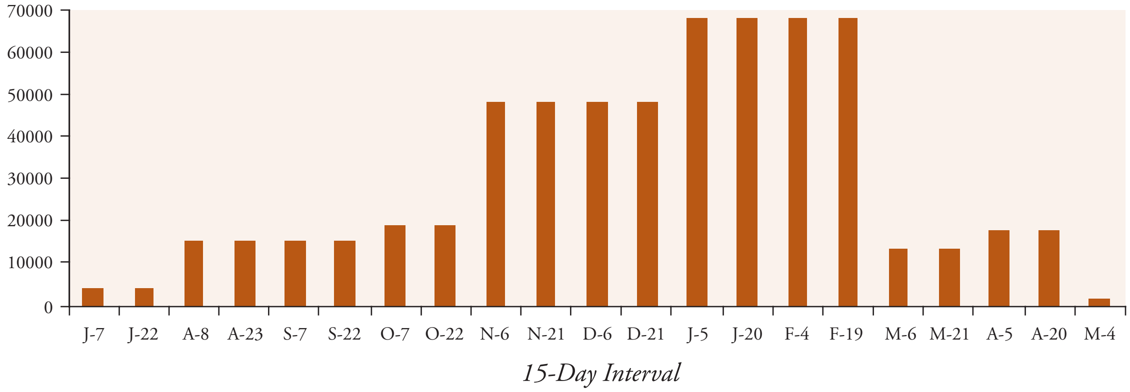
Table 6-21. Conservation Objectives for non-breeding shorebirds in the Sacramento Valley Planning Region.

Interval	*Seasonal Wetlands (Acres)*	*Semi-Perm. Wetlands (Acres)*	*Water (Acre-Feet)*	*Winter Flooded Rice (Acres)*
J-7 (July 1-July 15)	0	396	0	0
J-22 (July 16-July 31)	0	423	0	0
A-8 (Aug 1-Aug 16)	1,584	0	1,584	0
A-23 (Aug 17-Aug 31)	1,584	0	0	0
S-7 (Sept 1-Sept 15)	1,584	0	0	0
S-22 (Sept 16-Sept 30)	1,584	0	0	0
O-7 (Oct 1-Oct 15)	990	0	0	990
O-22 (Oct 16-Oct 30)	990	0	0	990
N-6 (Oct 31-Nov 14)	1,483	0	0	1,483
N-21 (Nov 15-Nov 29)	1,483	0	0	1,483
D-6 (Nov 30-Dec 14)	1,483	0	0	1,483
D-21 (Dec 15-Dec 29)	1,483	0	0	1,483
J-5 (Dec 30-Jan 13)	1,684	0	0	1,684
J-20 (Jan 14-Jan 28)	1,684	0	0	1,684
F-4 (Jan 29-Feb 12)	1,684	0	0	1,684
F-19 (Feb 13-Feb 27)	1,684	0	0	1,684
M-6 (Feb 28-Mar 14)	1,959	0	0	1,959
M-21 (Mar 15-Mar 29)	1,959	0	0	1,959
A-5 (Mar 30-Apr 13)	5,223	0	0	0
A-20 (Apr 14-Apr 28)	5,223	0	0	0
M-4 (Apr 29-May 10)	348	0	0	0
Total	35,696	819	1584	18,566

Delta Planning Region

Current Conditions

Population objectives for migrating and wintering shorebirds in the Delta Planning Region are presented in Figure 6-25. Population objectives are highest for January and February, with shorebird numbers reaching a minimum in July. Seasonal wetlands provide the majority of foraging habitat available to shorebirds (Table 6-22).



July 7	July 22	Aug. 8	Aug. 23	Sept. 7	Sept. 22	Oct. 7	Oct. 22	Nov. 6	Nov. 21	Dec. 6	Dec. 21	Jan. 5	Jan. 20	Feb. 4	Feb. 19	Mar. 6	Mar. 21	Apr. 5	Apr. 20	May 4
3,750	3,750	15,000	15,000	15,000	15,000	18,750	18,750	48,000	48,000	48,000	48,000	68,000	68,000	68,000	68,000	13,500	13,500	18,000	18,000	1,500

Figure 6-25. Shorebird population objectives (acres) for the Delta Planning Region.

Table 6-22. Foraging habitats (acres) available to wintering shorebirds in the Delta Planning Region.

Seasonal Wetland	*Semi-Permanent Wetland*	*Winter Flooded Rice*
14,907	2,633	8,027

Figure 6-26 depicts the relationship between shorebird population objectives and the availability of seasonally flooded wetlands and winter flooded rice. Semi-permanent wetlands are assumed to provide shorebird habitat from July 1 to July 15 when they are typically drawn down and likely to provide foraging habitat <10 cm in depth. Seasonal wetlands provide no habitat prior to the August 23 interval when flooding of these wetlands in the Delta Planning Region typically begins. However, drawdown of semi-permanent wetlands in early July likely provides some foraging habitat between July 1 and July 15. Increases in the amount of seasonal wetlands generally track increases in shorebird numbers in this region from late August through February. Although declines in shorebird numbers correspond to a decline in seasonal wetland acres between late March and May, the amount of foraging habitat is likely increasing during this period as drawdowns increase the numbers of acres <10 cm in depth. (Figure 6-26). Winter flooded rice provides no foraging habitat prior to the October 7 interval. However, rice provides large amounts of potential habitat from November through March when shorebird populations in this region reach their peak.

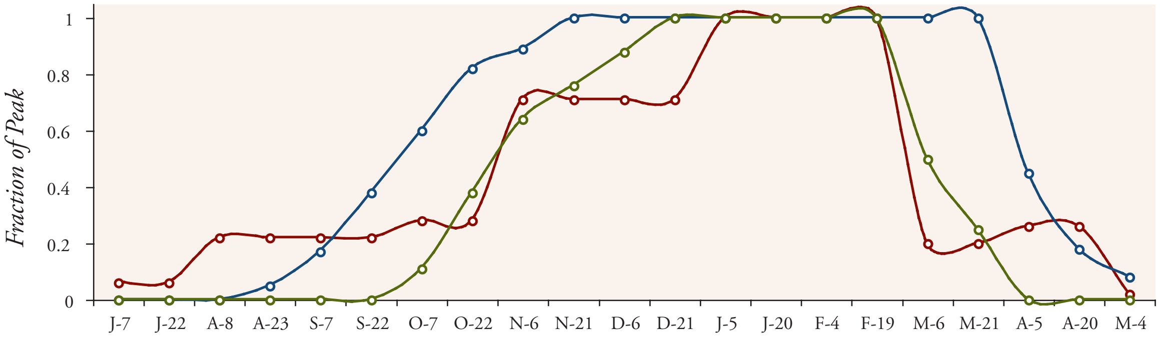


Figure 6-26. Shorebird population objectives (red) vs. flooding schedules for managed seasonal wetlands (blue) and rice (green) for the Delta Planning Region. Shorebird population objectives are expressed as the fraction of peak population; wetlands and rice are expressed as the fraction of these habitats that are flooded.

Management of Existing Seasonal and Semi-Permanent Wetlands

Summer Flooding Period (July 1–August 15)

Shorebirds require 85 acres of foraging habitat in both the July 7 and July 22 intervals, with habitat needs increasing to 340 acres in the August 8 interval (Table 6-23). All habitat requirements during the Summer Flooding Period must be met from managed wetlands, as no winter flooded rice is available.

Table 6-23. Habitat objectives for shorebirds in the Delta Planning Region during the Summer Flooding Period.

Interval	*Habitat Objective (Acres)*
J-7 (July 1-July 15)	85
J-22 (July 16-July 31)	85
A-8 (Aug 1-Aug 16)	340
Total	510

Semi-permanent wetlands may provide the best opportunity to meet shorebird needs in July. The Delta Planning Region contains over 2,600 acres of semi-permanent wetlands. If all these wetlands are drawn down between July 1 and July 15, the required depth ratio for these semi-permanent habitats is 3% (i.e., 85 of the 2,633 acres must provide water depths <10 cm to meet shorebird needs in the July 7 interval). Semi-permanent public wetlands alone (945 acres) can meet shorebird needs in the July 7 interval if 9% of these habitats provide suitable water depths during drawdown. If all 8,968 acres of semi-permanent wetlands are drawn down by mid-July, no opportunity exists to meet shorebird needs in the July 22 interval using these habitats. Delaying the drawn down of some semi-permanent wetlands until late July could help meet the 85 acres of habitat needed by shorebirds in the July 22 interval.

Population energy demand estimates for shorebirds indicate that 340 acres of wetland habitat are required during the August 8 interval. There are currently no seasonal wetlands flooded in the region during the first two weeks of August, and all semi-permanent wetlands are assumed to be dry by this time. The 340 acres of wetlands needed by shorebirds during this interval could be met through early flooding of seasonal wetlands. These 340 acres represent 2% of existing seasonal wetlands in the region, and 6% of all public seasonal wetlands.

Fall Flooding Period (August 17–November 29)

Habitat needs of shorebirds in the Fall Flooding Period range from 340 acres in the August and September intervals, to nearly 1,300 acres in the January and February intervals (Table 6-24).

Table 6-24. Overall habitat needs for shorebirds in the Delta Planning Region during the Fall Flooding Period.

Interval	*Habitat Objective (Acres)*
A-23 (Aug 17-Aug 31)	340
S-7 (Sept 1-Sept 15)	340
S-22 (Sept 16-Sept 30)	340
O-7 (Oct 1-Oct 15)	424
O-22 (Oct 16-Oct 30)	424
N-6 (Oct 31-Nov 14)	936
N-21 (Nov 15-Nov 29)	936
Total	**3,740**

Because winter flooded rice is unavailable prior to October, shorebird needs must be met entirely from seasonal wetland habitats in the August and September intervals. Beginning in October, seasonal wetland objectives decline to 50% of interval habitat needs, as rice is assumed to meet half of all shorebird needs (Table 6-25).

Table 6-25. Seasonal wetland objectives (acres) for shorebirds in the Delta Planning Region during the Fall Flooding Period.

Interval	*SW Interval Objective*	*Cumulative SW[a] Objective*	*Flooded SWs[b]*	*Required Depth[c] Ratio*
A-23 (Aug 17-Aug 31)	340	680	745	91
S-7 (Sept 1-Sept 15)	340	1,020	2,534	40
S-22 (Sept 16-Sept 30)	340	1,360	5,665	24
O-7 (Oct 1-Oct 15)	212	1,572	8,944	18
O-22 (Oct 16-Oct 30)	212	1,784	12,224	15
N-6 (Oct 31-Nov 14)	468	2,252	13,268	17
N-21 (Nov 15-Nov 29)	468	2,720	14,907	18
Total	**2,380**			

SW – Seasonal Wetland.

[a] Includes SW objectives from previous flooding periods.

[b] Flooded SWs reflect flooding schedules within a shorebird planning region.

[c] Cumulative SW Objective/Flooded SWs.

Although the total seasonal wetland objective of 2,380 acres is staggered over seven 15-day intervals, it is possible to front-end this overall habitat objective. For example, seasonal wetland objectives for shorebirds could be met in the Fall Flooding Period by providing 2,380 acres during the August 23 interval and maintaining these acres at a depth <10 cm through the end of November (Figure 6-27).

Seasonal wetlands become increasingly available from August through November, as these habitats are flooded prior to the hunting season. This increase in seasonal wetlands is reflected in the required depth ratio, which declines from August through October (Figure 6-28).

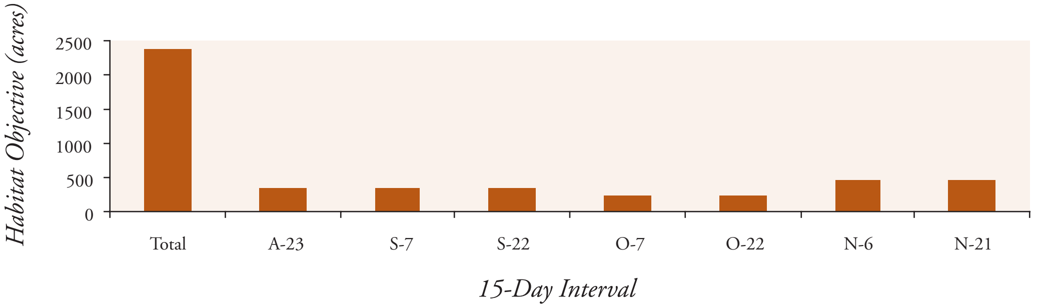


Figure 6-27. Seasonal wetland objectives for shorebirds in the Fall Flooding Period by 15-day intervals for the Delta Planning Region.

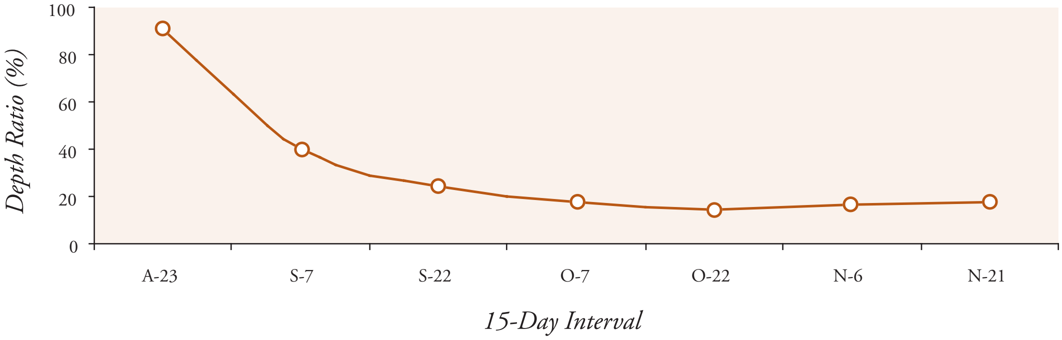


Figure 6-28. Changes in the required depth ratio for seasonal wetlands in the Fall Flooding Period for the Delta Planning Region.

Winter Flooding Period (November 30–March 29)

Habitat needs for shorebirds in the Winter Flooding Period range from nearly 1,300 acres in the December intervals, to 300 acres in March intervals (Table 6-26). Fifty percent of these habitat needs must be met from seasonal wetlands, with the balance being provided by winter flooded rice (Table 6-27). The overall seasonal wetland objective for the Winter Flooding Period is 3,782 acres. Although this wetland objective is staggered over several 15-day intervals, it is possible to front-end this conservation objective. For example, seasonal wetland objectives for shorebirds could be met in the Winter Flooding Period by providing 3,782 acres during the December 6 interval and maintaining these acres at a depth <10 cm through the end of March (Figure 6-29).

As expected, the required depth ratio increases through the Winter Flooding Period as no new wetlands are being flooded and shorebirds deplete food resources on seasonal wetland acres that are managed <10 cm in depth (Figure 6-30).

Table 6-26. Overall habitat needs for shorebirds in the Delta Planning Region during the Winter Flooding Period.

Interval	*Habitat Objective (Acres)*
D-6 (Nov 30-Dec 14)	936
D-21 (Dec 15-Dec 29)	936
J-5 (Dec 30-Jan 13)	1,272
J-20 (Jan 14-Jan 28)	1,272
F-4 (Jan 29-Feb 12)	1,272
F-19 (Feb 13-Feb 27)	1,272
M-6 (Feb 28-Mar 14)	301
M-21 (Mar 15-Mar 29)	301
Total	**7,562**

Table 6-27. Seasonal wetland objectives (acres) for shorebirds in the Delta Planning Region during the Winter Flooding Period.

Interval	*SW Interval Objective*	*Cumulative SW[a] Objective*	*Flooded[b] SWs*	*Required Depth[c] Ratio*
D-6 (Nov 30-Dec 14)	468	3,188	14,907	21
D-21 (Dec 15-Dec 29)	468	3,656	14,907	25
J-5 (Dec 30-Jan 13)	636	4,292	14,907	29
J-20 (Jan 14-Jan 28)	636	4,928	14,907	33
F-4 (Jan 29-Feb 12)	636	5,564	14,907	37
F-19 (Feb 13-Feb 27)	636	6,200	14,907	42
M-6 (Feb 28-Mar 14)	151	6,351	14,907	43
M-21 (Mar 15-Mar 29)	151	6,502	14,907	44
Total	**3,782**	**6,502**	**14,907**	

SW – Seasonal Wetland.

[a] *Includes SW objectives from previous flooding periods.*

[b] *Flooded SWs reflect flooding schedules within a shorebird planning region.*

[c] *Cumulative SW Objective/Flooded SWs.*

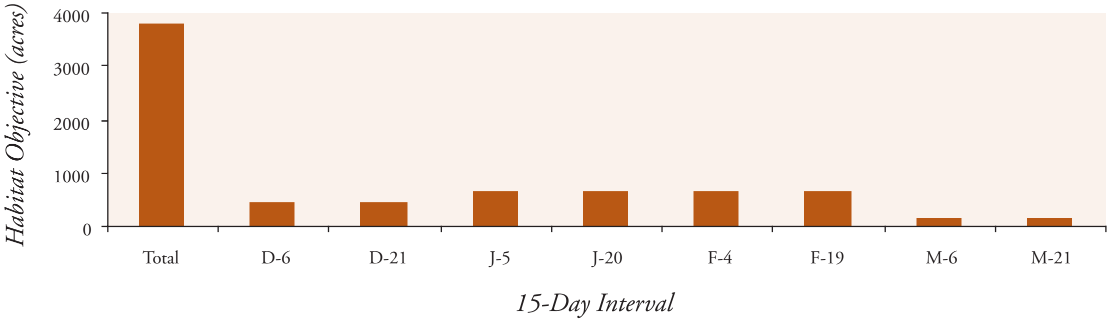


Figure 6-29. Seasonal wetland objectives for shorebirds in the Winter Flooding Period by 15-day intervals for the Delta Planning Region.

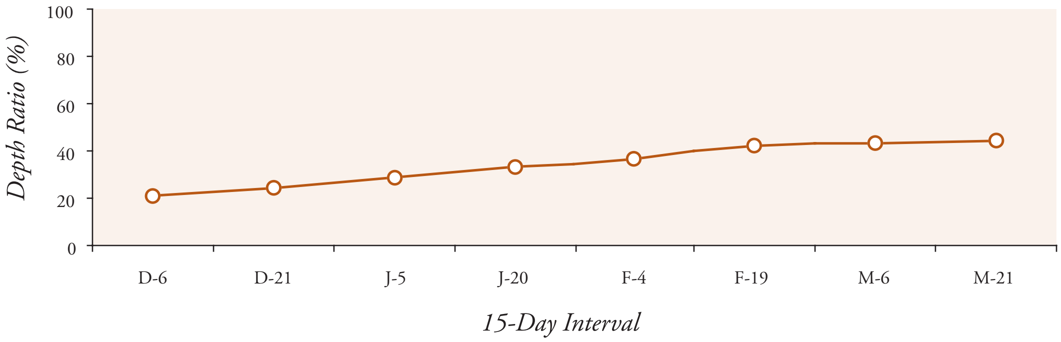


Figure 6-30. Changes in the required depth ratio for seasonal wetlands in the Winter Flooding Period for the Delta Planning Region.

Spring Flooding Period (March 30–May 12)

Habitat needs for shorebirds in the Spring Flooding Period range from 402 acres in each of the April intervals, to 28 acres in May. Shorebird needs must be met exclusively by seasonal wetlands as rice fields are assumed to be dry by this time (Table 6-28). The summed seasonal wetland objective for the Spring Flooding Period is nearly 832 acres, with most of these acres needed in the April intervals (Figure 6-31).

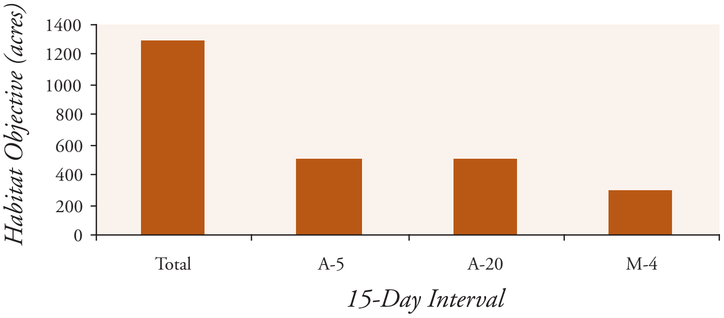


Figure 6-31. Seasonal wetland objectives for shorebirds in the Delta Planning Region during the Spring Flooding Period by 15-day intervals.

Water Supplies for Wetland Management

Additional water supplies that are needed for shorebirds are based on seasonal wetland needs in the August 8 interval (see earlier description for establishing water supply objectives). Seasonal wetland objectives for shorebirds in the Delta Planning Region during the August 8 interval are estimated at 340 acres. This equates to a water supply need of 680 acre-feet.

Table 6-28. Seasonal wetland objectives (acres) for shorebirds in the Delta Planning Region during the Spring Flooding Period.

Interval	*SW Interval Objective*	*Cumulative SW Objective*	*Flooded SWs*
A-5 (Mar 30-Apr 13)	402	6,904	14,907
A-20 (Apr 14-Apr 28)	402	7,306	4,696
M-4 (Apr 29-May 10)	28	7,334	1,938
Total	832	7,334	

Agricultural Enhancement

Habitat objectives for flooded rice in the Delta Planning Region range from just under 1,000 acres in the October intervals, to nearly 2,000 acres throughout March (Table 6-29). Although the total agricultural enhancement objective is staggered over several 15-day intervals, it is possible to front-end this objective. For example, rice habitat objectives could be met by providing 5,142 acres during the October 7 interval and maintaining these acres at a depth <10 cm through the end of March (Figure 6-32). The required depth ratio for rice habitat increases from October through March, and reflects the relatively small amount of rice grown in the region (Figure 6-33).

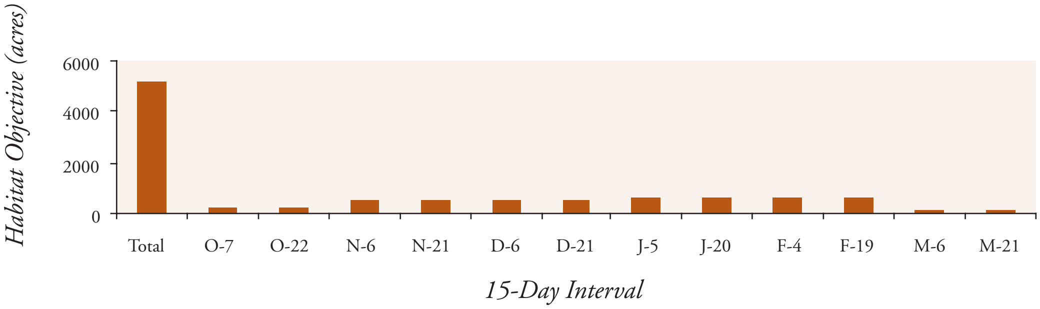


Figure 6-32. Rice habitat objectives for shorebirds by 15-day intervals in the Delta Planning Region.

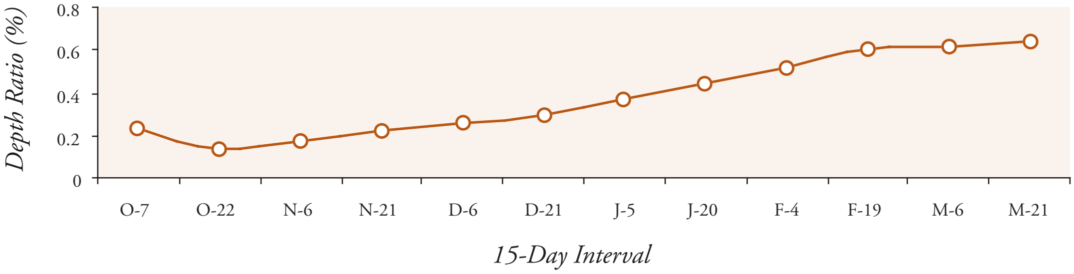


Figure 6-33. Changes in the required depth ratio for rice habitat in the Delta Planning Region.


Black-necked stilts in rice
Photo: Dave Feliz, CDFG

Table 6-29. Rice habitat objectives (acres) for shorebirds between early October and the end of March in the Delta Planning Region.

Interval	*Rice Interval Objective*	*Cumulative Rice Objective*	*Flooded[a] Rice*	*Required Depth[b] Ratio*
O-7 (Oct 1-Oct 15)	212	212	883	24
O-22 (Oct 16-Oct 30)	212	424	3,050	14
N-6 (Oct 31-Nov 14)	468	892	5,137	17
N-21 (Nov 15-Nov 29)	468	1,360	6,100	22
D-6 (Nov 30-Dec 14)	468	1,828	7,064	26
D-21 (Dec 15-Dec 29)	468	2,296	8,027	29
J-5 (Dec 30-Jan 13)	636	2,932	8,027	37
J-20 (Jan 14-Jan 28)	636	3,568	8,027	44
F-4 (Jan 29-Feb 12)	636	4,204	8,027	52
F-19 (Feb 13-Feb 27)	636	4,840	8,027	60
M-6 (Feb 28-Mar 14)	151	4,991	8,027	62
M-21 (Mar 15-Mar 29)	151	5,142	8,027	64
Total	**5,142**	**5,142**	**8,027**	

[a] *Flooded Rice reflects post-harvest flooding schedules of rice.*
[b] *Cumulative Rice Objective/Flooded Rice.*

Summary

Conservation objectives for managed seasonal and semi-permanent wetlands, water supplies, and agricultural enhancement are summarized for the Delta Planning Region in Table 6-30. Nearly 50% of the seasonal wetlands present in this region (7,334/14,907 acres) must provide foraging depths <10 cm during some portion of the wintering period if seasonal wetland objectives for shorebirds are to be met. This figure is even higher for rice, where 64% of all winter flooded rice (5,142/8,027 acres) must provide suitable foraging depths during some portion of the wintering period to meet agricultural enhancement objectives for this region.

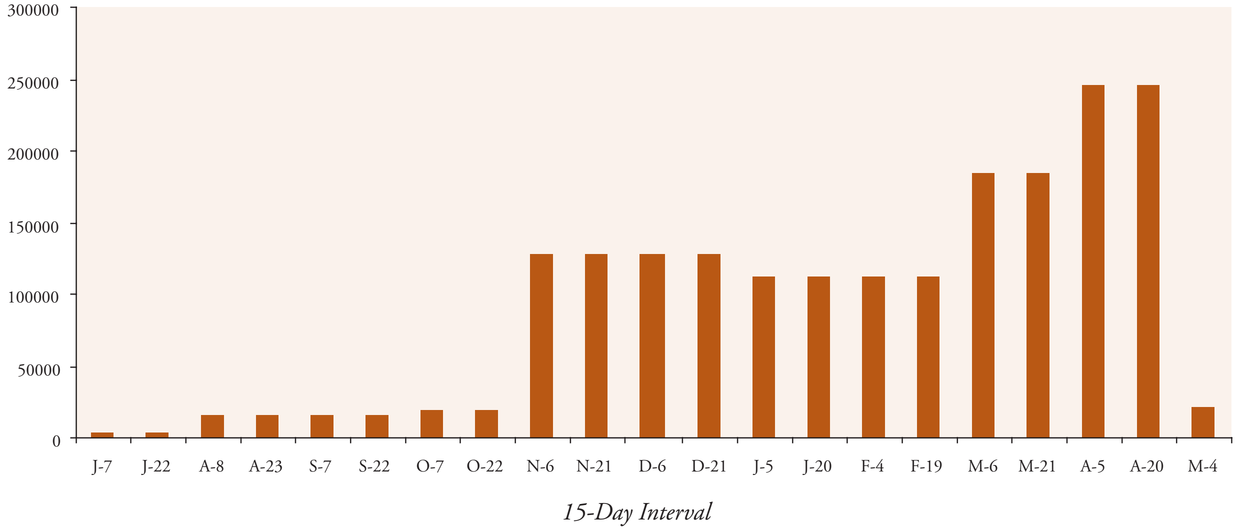
Table 6-30. Conservation Objectives for non-breeding shorebirds in the Delta Planning Region.

Interval	*Seasonal Wetlands (Acres)*	*Semi-Perm. Wetlands (Acres)*	*Water (Acre-Feet)*	*Winter Flooded Rice (Acres)*
J-7 (July 1-July 15)	0	85	0	0
J-22 (July 16-July 31)	0	85	0	0
A-8 (Aug 1-Aug 16)	340	0	680	0
A-23 (Aug 17-Aug 31)	340	0	0	0
S-7 (Sept 1-Sept 15)	340	0	0	0
S-22 (Sept 16-Sept 30)	340	0	0	0
O-7 (Oct 1-Oct 15)	212	0	0	212
O-22 (Oct 16-Oct 30)	212	0	0	212
N-6 (Oct 31-Nov 14)	468	0	0	468
N-21 (Nov 15-Nov 29)	468	0	0	468
D-6 (Nov 30-Dec 14)	468	0	0	468
D-21 (Dec 15-Dec 29)	468	0	0	468
J-5 (Dec 30-Jan 13)	636	0	0	636
J-20 (Jan 14-Jan 28)	636	0	0	636
F-4 (Jan 29-Feb 12)	636	0	0	636
F-19 (Feb 13-Feb 27)	636	0	0	636
M-6 (Feb 28-Mar 14)	151	0	0	151
M-21 (Mar 15-Mar 29)	151	0	0	151
A-5 (Mar 30-Apr 13)	402	0	0	0
A-20 (Apr 14-Apr 28)	402		0	0
M-4 (Apr 29-May 10)	28		0	0
Total	7,334	170	680	5,142

San Joaquin Basin

Current Conditions

Population objectives for migrating and wintering shorebirds in the San Joaquin Basin are presented in Figure 6-34. Population objectives are highest in April, with shorebird numbers reaching a minimum in July. Seasonal wetlands provide the majority of foraging habitat, as no winter flooded rice is available in the basin (Table 6-31).



July 7	July 22	Aug. 8	Aug. 23	Sept. 7	Sept. 22	Oct. 7	Oct. 22	Nov. 6	Nov. 21	Dec. 6	Dec. 21	Jan. 5	Jan. 20	Feb. 4	Feb. 19	Mar. 6	Mar. 21	Apr. 5	Apr. 20	May 4
3,750	3,750	15,000	15,000	15,000	15,000	18,750	18,750	128,000	128,000	128,000	128,000	112,000	112,000	112,000	112,000	184,500	184,500	246,000	246,000	20,500

Figure 6-34. Shorebird population objectives for the San Joaquin Basin.

Table 6-31. Foraging habitats (acres) available to wintering shorebirds in San Joaquin Basin.

Seasonal Wetland	*Semi-Permanent Wetland*	*Winter Flooded Rice*
61,013	6,779	0

Figure 6-35 depicts the relationship between shorebird population objectives and the availability of seasonally flooded wetlands. Semi-permanent wetlands are assumed to provide shorebird habitat from July 1 to July 15 when they are typically drawn down and likely to provide foraging habitat <10 cm in depth. Seasonal wetlands provide no habitat prior to the August 23 interval when flooding of these wetlands in the San Joaquin Basin typically begins. However, drawdown of semi-permanent wetlands in early July likely provides some foraging habitat between July 1 and July 15. Increases in the amount of seasonal wetlands track increases in shorebird numbers from late August to early November. Shorebird numbers increase during April, when seasonal wetlands are being drawn down and the amount of foraging habitat <10 cm deep is likely increasing.

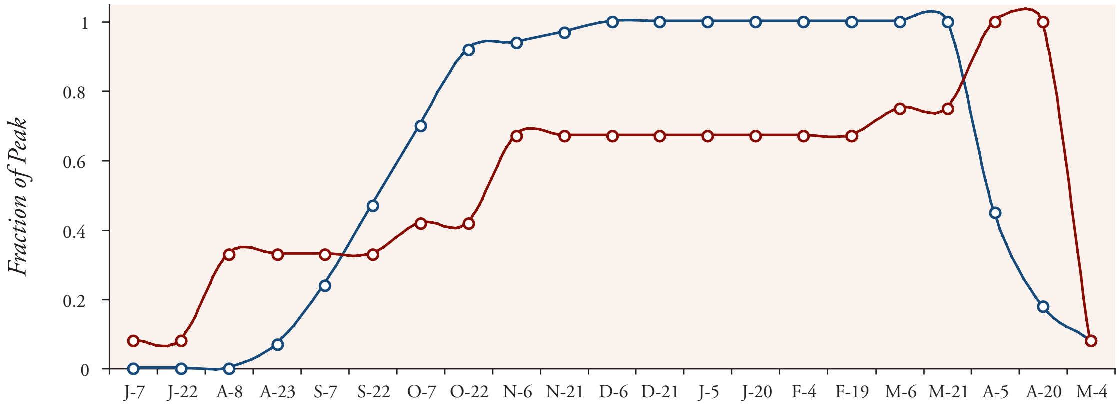


Figure 6-35. Shorebird population objectives (red) vs. flooding schedules for managed seasonal wetlands (blue) for the San Joaquin Basin. Shorebird population objectives are expressed as the fraction of peak population; wetlands are expressed as the fraction of seasonal wetlands that are flooded.

Management of Existing Seasonal and Semi-Permanent Wetlands

Table 6-32. Habitat objectives for shorebirds in San Joaquin Basin during the Summer Flooding Period.

Interval	*Habitat Objective (Acres)*
J-7 (July 1-July 15)	85
J-22 (July 16-July 31)	90
A-8 (Aug 1-Aug 16)	340
Total	**505**

Summer Flooding Period (July 1–August 15)

Shorebirds require less than 100 acres of foraging habitat in both the July intervals, with habitat needs increasing to 340 acres in the August 8 interval (Table 6-32). Semi-permanent wetlands provide the best opportunity to meet shorebird needs in July. The San Joaquin Basin contains nearly 6,800 acres of semi-permanent wetlands, of which 1,573 acres are publicly owned (Table 6-31). If all semi-permanent wetlands are drawn down between July 1 and July 15, only 1% of these acres must provide water depths <10 cm deep to meet shorebird needs in the July 7 interval. Semi-permanent public wetlands alone can meet shorebird needs in the July 7 interval even if only 5% of these habitats provide suitable water depths during drawdown. If all semi-permanent wetlands are drawn down by mid-July, there is no opportunity for these habitats to meet shorebird needs in the July 22 interval. Delaying the drawdown of some of these habitats until late July could help meet shorebird needs in the July 22 interval.

Shorebirds require 340 acres of foraging habitat in the August 8 interval. There are currently no seasonal wetlands flooded in the San Joaquin Basin during the first two weeks of August, and all semi-permanent wetlands are assumed to be dry. The 340 acres needed by shorebirds could be met through early flooding of seasonal wetlands. These 340 acres represent less than 0.1% of existing seasonal wetlands in the basin.

Fall Flooding Period (August 17–November 29)

Habitat needs for shorebirds in the Fall Flooding Period range from 340 acres in the September intervals, to nearly 2,500 acres in November (Table 6-33). Shorebird needs in the Fall Flooding Period must be met exclusively from seasonal wetlands, as no winter flooded rice is available.

Table 6-33. Seasonal wetland objectives (acres) for shorebirds in San Joaquin Basin during the Fall Flooding Period.

Interval	*SW Interval Objective*	*Cumulative SW[a] Objective*	*Flooded SWs[b]*	*Required[c] Depth Ratio*
A-23 (Aug 17-Aug 31)	340	680	4,271	16
S-7 (Sept 1-Sept 15)	340	1,020	14,643	7
S-22 (Sept 16-Sept 30)	340	1,360	28,676	5
O-7 (Oct 1-Oct 15)	424	1,784	42,709	4
O-22 (Oct 16-Oct 30)	424	2,208	56,132	4
N-6 (Oct 31-Nov 14)	2,497	4,705	56,132	8
N-21 (Nov 15-Nov 29)	2,497	7,202	59,183	12
Total	**6,862**	**7,202**		

SW – Seasonal Wetland.

[a] Includes SW objectives from previous flooding periods.

[b] Flooded SWs reflect flooding schedules within a shorebird planning region.

[c] Cumulative SW Objective/Flooded SWs.

Although the summed seasonal wetland objective of 6,862 acres is staggered over seven 15-day intervals, it is possible to front-end this overall habitat objective. For example, seasonal wetland objectives for shorebirds could be met in the Fall Flooding Period by providing 6,862 acres during the August 23 interval and maintaining these acres at a depth <10 cm through the end of November (Figure 6-36).

Seasonal wetlands become increasingly available from August through November as these habitats are flooded prior to the hunting season. This increase in seasonal wetlands is reflected in the required depth ratio, which declines from August through October (Figure 6-37).

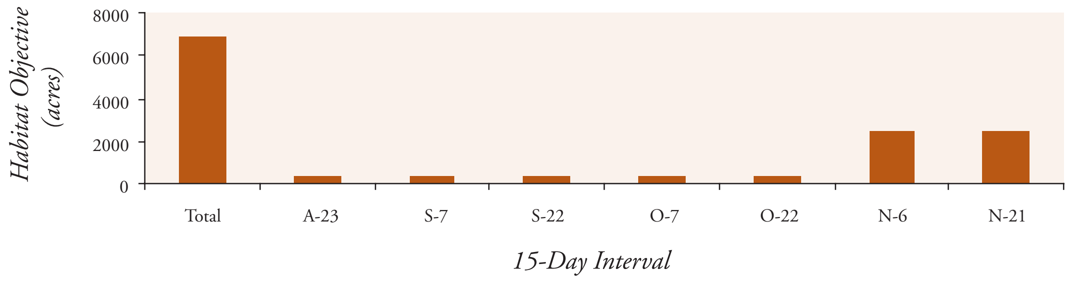


Figure 6-36. Seasonal wetland objectives for shorebirds in the Fall Flooding Period by 15-day intervals for the San Joaquin Basin.

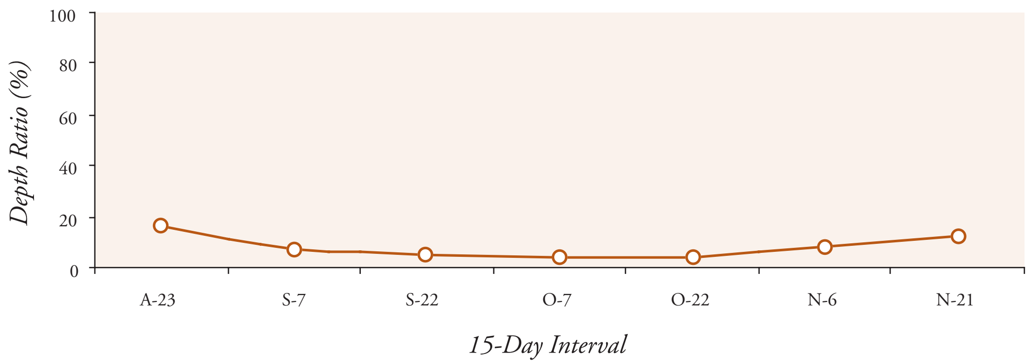


Figure 6-37. Changes in the required depth ratio for seasonal wetlands in the Fall Flooding Period for the San Joaquin Basin.

Winter Flooding Period (November 30–March 29)

Habitat needs for shorebirds in the Winter Flooding Period range from nearly 2,100 acres in the January and February intervals, to over 4,100 acres in both March intervals. All of these habitat needs must be met from seasonal wetlands, as no winter flooded rice is available (Table 6-34).

Table 6-34. Seasonal wetland objectives (acres) for shorebirds in San Joaquin Basin during the Winter Flooding Period.

Interval	*SW Interval Objective*	*Cumulative SW[a] Objective*	*Flooded SWs[b]*	*Required Depth[c] Ratio (%)*
D-6 (Nov 30-Dec 14)	2,497	9,669	61,013	16
D-21 (Dec 15-Dec 29)	2,497	12,166	61,013	20
J-5 (Dec 30-Jan 13)	2,095	14,261	61,013	23
J-20 (Jan 14-Jan 28)	2,095	16,356	61,013	27
F-4 (Jan 29-Feb 12)	2,095	18,451	61,013	30
F-19 (Feb 13-Feb 27)	2,095	20,546	61,013	33
M-6 (Feb 28-Mar 14)	4,118	24,664	61,013	40
M-21 (Mar 15-Mar 29)	4,118	28,782	61,013	47
Total	**21,610**	**28,782**	**61,013**	

SW – Seasonal Wetland.
[a] *Includes SW objectives from previous flooding periods.*
[b] *Flooded SWs reflect flooding schedules within a shorebird planning region.*
[c] *Cumulative SW Objective/Flooded SWs.*

The overall seasonal wetland objective for the Winter Flooding Period is 21,610 acres. Although this wetland objective is staggered over several 15-day intervals, it is possible to front-end this conservation objective. For example, seasonal wetland objectives for shorebirds could be met in the Winter Flooding Period by providing 21,610 acres during the December 6 interval and maintaining these acres at a depth <10 cm through the end of March (Figure 6-38).

As expected, the required depth ratio increases through the Winter Flooding Period as no new wetlands are being flooded and shorebirds deplete food resources on seasonal wetland acres that are managed <10 cm in depth (Figure 6-39).

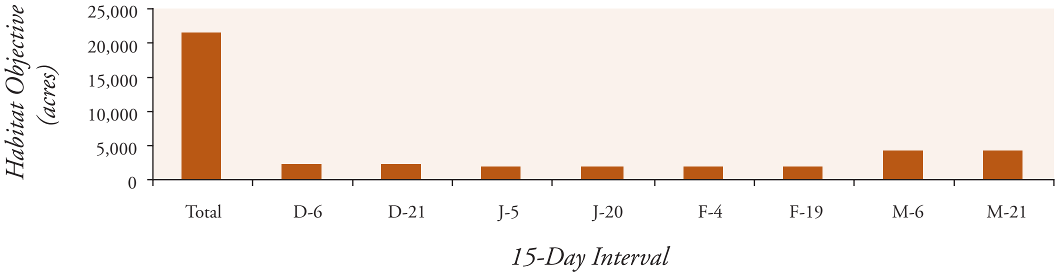


Figure 6-38. Seasonal wetland objectives for shorebirds in the Winter Flooding Period by 15-day intervals for the San Joaquin Basin.

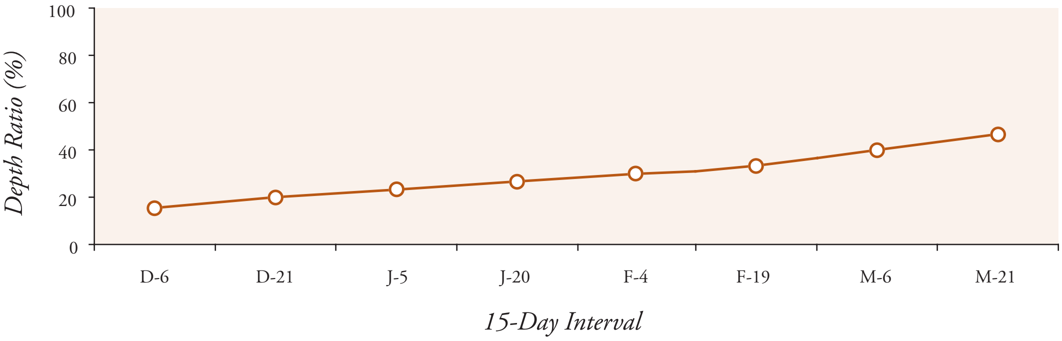


Figure 6-39. Changes in the required depth ratio for seasonal wetlands in the Winter Flooding Period for the San Joaquin Basin.

Spring Flooding Period (March 30–May 12)

Habitat needs for shorebirds in the Spring Flooding Period range from nearly 5,500 acres in each of the April intervals, to 366 acres in May (Table 6-35). The summed seasonal wetland objective for this period is 11,348 acres, with over 95% of these acres needed in the April intervals (Figure 6-40).

Table 6-35. Seasonal wetland objectives (acres) for shorebirds in San Joaquin Basin during the Spring Flooding Period.

Interval	*SW Interval Objective*	*Cumulative SW[a] Objective*	*Flooded SW[b] Habitat*
A-5 (MAR 30-APR 13)	5,491	34,273	61,013
A-20 (APR 14-APR 28)	5,491	39,764	19,219
M-4 (APR 29-MAY 10)	366	40,130	7,932
TOTAL	11,348	40,130	

SW – Seasonal Wetland.

[a] Includes SW objectives from previous flooding periods.

[b] Flooded SWs reflect flooding schedules within a shorebird planning region.

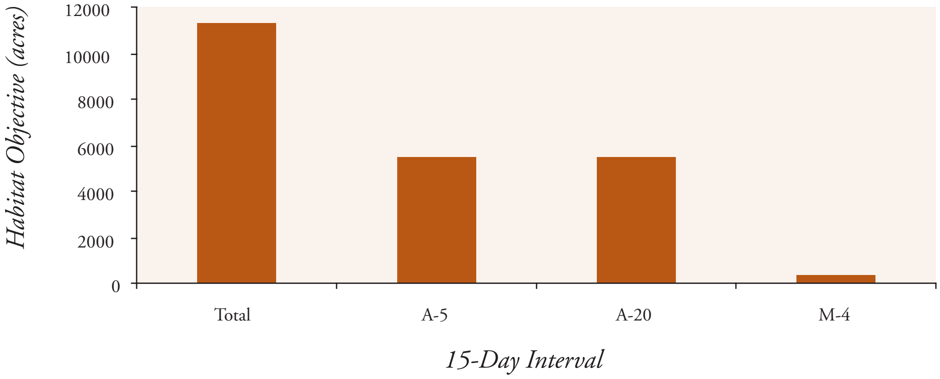


Figure 6-40. Seasonal wetland objectives for shorebirds in San Joaquin Basin during the Spring Flooding Period by 15-day intervals.

Water Supplies for Wetland Management

Additional water supplies that are needed for shorebirds are based on seasonal wetland needs in the August 8 interval (see earlier description for establishing water supply objectives). Seasonal wetland objectives for shorebirds in the San Joaquin Basin during the August 8 interval are estimated at 340 acres. This equates to a water supply need of 680 acre-feet.

Summary

Conservation objectives for managed seasonal and semi-permanent wetlands are summarized for the San Joaquin Basin in Table 6-36. Nearly 66% of the seasonal wetlands present in this planning region (40,130/61,013 acres) must provide foraging depths <10 cm during some portion of the wintering period if seasonal wetland objectives for shorebirds are to be met.

Table 6-36. Conservation Objectives for non-breeding shorebirds in San Joaquin Basin.

Interval	*Seasonal Wetlands (Acres)*	*Semi-Perm. Wetlands (Acres)*	*Water (Acre-Feet)*
J-7 (July 1-July 15)	0	85	0
J-22 (July 16-July 31)	0	90	0
A-8 (Aug 1-Aug 16)	340	0	680
A-23 (Aug 17-Aug 31)	340	0	0
S-7 (Sept 1-Sept 15)	340	0	0
S-22 (Sept 16-Sept 30)	340	0	0
O-7 (Oct 1-Oct 15)	424	0	0
O-22 (Oct 16-Oct 30)	424	0	0
N-6 (Oct 31-Nov 14)	2,497	0	0
N-21 (Nov 15-Nov 29)	2,497	0	0
D-6 (Nov 30-Dec 14)	2,497	0	0
D-21 (Dec 15-Dec 29)	2,497	0	0
J-5 (Dec 30-Jan 13)	2,095	0	0
J-20 (Jan 14-Jan 28)	2,095	0	0
F-4 (Jan 29-Feb 12)	2,095	0	0
F-19 (Feb 13-Feb 27)	2,095	0	0
M-6 (Feb 28-Mar 14)	4,118	0	0
M-21 (Mar 15-Mar 29)	4,118	0	0
A-5 (Mar 30-Apr 13)	5,491	0	0
A-20 (Apr 14-Apr 28)	5,491	0	0
M-4 (Apr 29-May 10)	366		0
Total	**40,130**	**175**	**680**

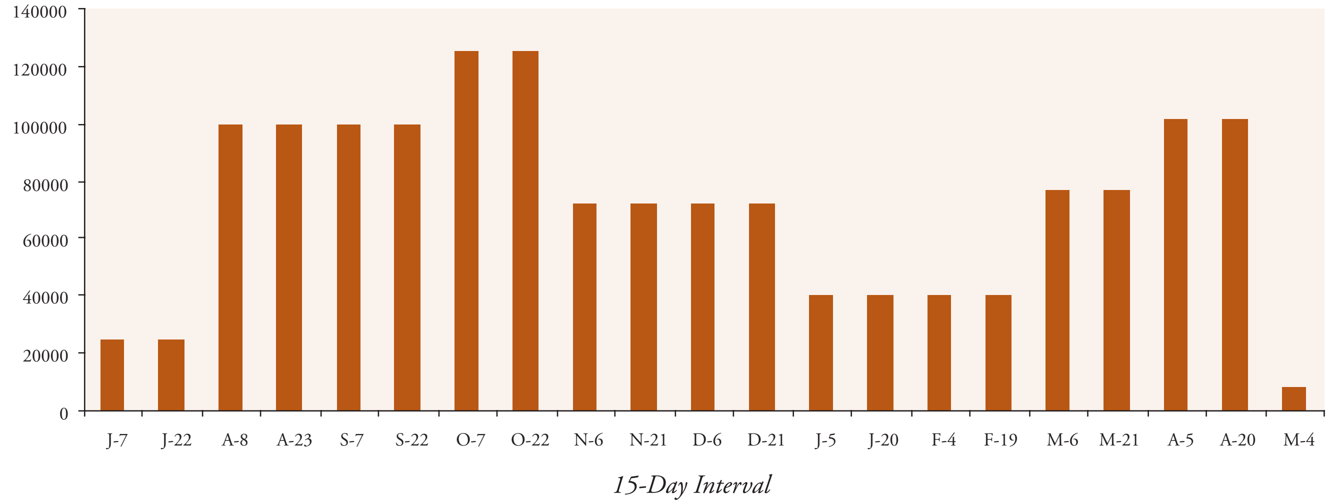
Tulare Basin

Current Conditions

Population objectives for migrating and wintering shorebirds in the Tulare Basin are presented in Figure 6-41. Population objectives are highest in April, with shorebird numbers reaching a minimum in July. Seasonal wetlands provide the majority of foraging habitat, as no winter flooded rice is available in this planning region (Table 6-37).

Table 6-37. Foraging habitats (acres) available to wintering shorebirds in the Tulare Basin.

Seasonal Wetland	*Semi-Permanent Wetland*	*Winter Flooded Rice*
20,212	2,245	0



July 7	July 22	Aug. 8	Aug. 23	Sept.7	Sept. 22	Oct.7	Oct. 22	Nov. 6	Nov. 21	Dec. 6	Dec. 21	Jan. 5	Jan. 20	Feb. 4	Feb. 19	Mar. 6	Mar. 21	Apr. 5	Apr. 20	May 4
25,000	25,000	100,000	100,000	100,000	100,000	125,000	125,000	72,000	72,000	72,000	72,000	40,000	40,000	40,000	40,000	76,500	76,500	102,000	102,000	8,500

Figure 6-41. Shorebird population objectives (acres) for the Tulare Basin.

Figure 6-42 depicts the relationship between shorebird population objectives and the availability of seasonally flooded wetlands. Semi-permanent wetlands are assumed to provide shorebird habitat from July 1 to July 15, when they are typically drawn down and likely to provide foraging habitat <10 cm in depth. Seasonal wetlands provide no habitat prior to the August 23 interval, when flooding of these wetlands in the Tulare Basin typically begins. However, drawdown of semi-permanent wetlands in early July likely provides some foraging habitat between July 1 and July 15. Increases in the amount of seasonal wetlands track increases in shorebird numbers from late August through October. However, shorebird populations are high in early and mid-August when no seasonal wetlands are available. Shorebirds in the basin currently rely on sub-optimal habitats like evaporation ponds in August (Shuford et al. 1998), which probably reflects the lack of flooded seasonal wetlands. Shorebird numbers in the basin increase again during April when seasonal wetlands are being drawn down and the amount of foraging habitat <10 cm deep is likely increasing.

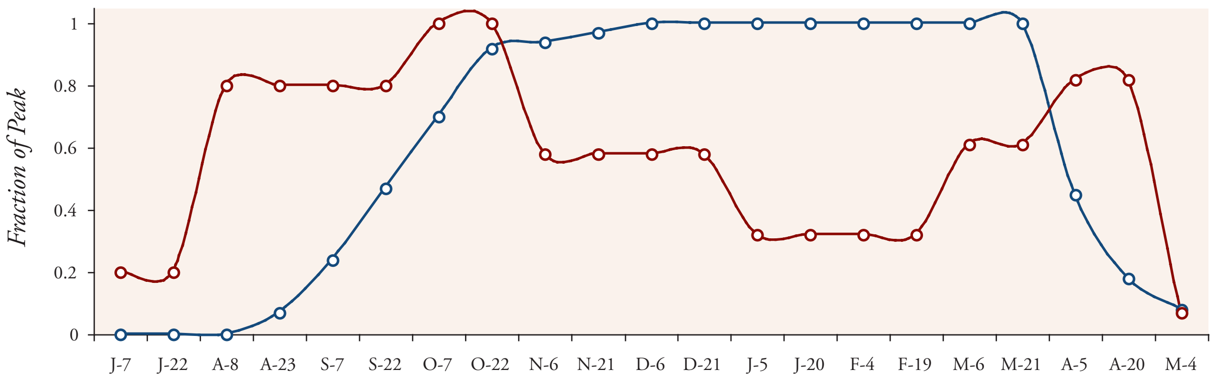


Figure 6-42. Shorebird population objectives (red) vs. flooding schedules for managed seasonal wetlands (blue) for the Tulare Basin. Shorebird population objectives are expressed as the fraction of peak population; wetlands are expressed as the fraction of seasonal wetlands that are flooded.

Management of Existing Seasonal and Semi-Permanent Wetlands

Summer Flooding Period (July 1–August 16)

Shorebirds require approximately 600 acres of foraging habitat in both the July intervals, with habitat needs increasing to nearly 2,300 acres in the August 8 interval (Table 6-38). Semi-permanent wetlands provide some opportunity to meet shorebird needs in July. The Tulare Basin contains nearly 2,250 acres of semi-permanent wetlands, of which 746 acres are publicly owned (Table 6-37). If all semi-permanent wetlands are drawn down between July 1 and July 15, twenty-five percent of these acres must maintain water depths <10 cm deep to meet shorebird needs in the July 7 interval. Semi-permanent public wetlands alone can meet shorebird needs in the July 7 interval if 76% of these habitats provide suitable water depths during drawdown. If all semi-permanent wetlands are drawn down by mid-July, there is no opportunity for these habitats to meet shorebird needs in the July 22 interval. Delaying the drawdown of some of these habitats until late July could help meet shorebird needs in the July 22 interval.

Table 6-38. Habitat objectives for shorebirds in Tulare Basin during the Summer Flooding Period.

Interval	*Habitat Objective (Acres)*
J-7 (July 1-July 15)	566
J-22 (July 16-July 31)	604
A-8 (Aug 1-Aug 16)	2,263
Total	3,433

Shorebirds require 2,263 acres of foraging habitat in the August 8 interval. There are currently no seasonal wetlands flooded in the Tulare Basin during the first two weeks of August, and all semi-permanent wetlands are assumed to be dry. The 2,263 acres needed by shorebirds could be met through early flooding of seasonal wetlands. However these 2,263 acres represent over 10% of existing seasonal wetlands in the basin, and finding water supplies for this early flooding may be difficult.

Fall Flooding Period (August 17–November 29)

Habitat needs for shorebirds in the Fall Flooding Period range from over 2,800 acres in the October intervals, to 1,400 acres in November (Table 6-39). Shorebird needs in this period must be met exclusively from seasonal wetlands, as no winter flooded rice is available in basin.

Table 6-39. Seasonal wetland objectives (acres) for shorebirds in Tulare Basin during the Fall Flooding Period.

Interval	*SW Interval Objective*	*Cumulative[a] SW Objective*	*Flooded SWs[b]*	*Required[c] Depth Ratio*
A-23 (Aug 17-Aug 31)	2,263	4,526	1,415	>100
S-7 (Sept 1-Sept 15)	2,263	6,789	4,851	>100
S-22 (Sept 16-Sept 30)	2,263	9,052	9,500	95
O-7 (Oct 1-Oct 15)	2,829	11,881	14,148	84
O-22 (Oct 16-Oct 30)	2,829	14,710	18,595	79
N-6 (Oct 31-Nov 14)	1,404	16,114	18,999	85
N-21 (Nov 15-Nov 29)	1,404	17,518	19,606	89
Total	15,255	17,518		

SW – Seasonal Wetland.

[a] *Includes SW objectives from previous flooding periods.*

[b] *Flooded SWs reflect flooding schedules within a shorebird planning region.*

[c] *Cumulative SW Objective/Flooded SWs.*

The total seasonal wetland objective for Tulare Basin in the Fall Flooding Period is 15,255 acres (Figure 6-43). It is unlikely that this objective is currently met for shorebirds. Although the Tulare Basin contains over 20,000 acres of seasonal wetlands, almost all of these habitats would have to provide foraging depths <10 cm to fully meet shorebird needs. This is reflected in the required depth ratio, which exceeds or approaches 1.0 in each 15-day interval of the Fall Flooding Period (Figure 6-44).

Figure 6-43. Seasonal wetland objectives for shorebirds in the Fall Flooding Period by 15-day intervals for the Tulare Basin.

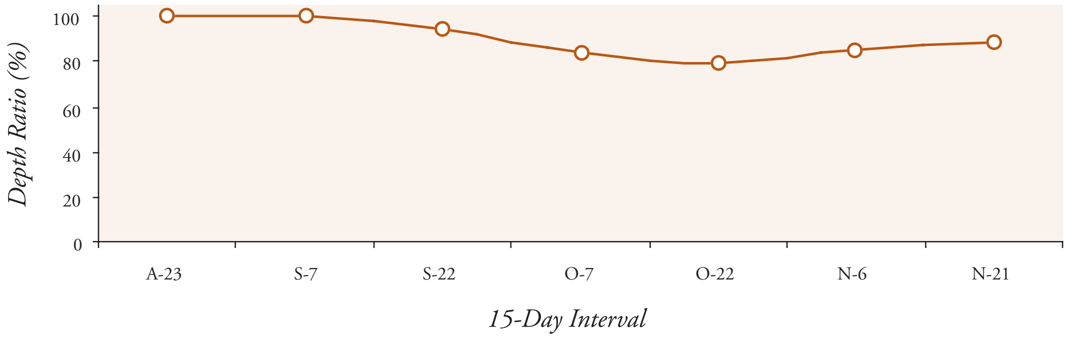


Figure 6-44. Changes in the required depth ratio for seasonal wetlands in the Fall Flooding Period for the Tulare Basin.

Winter Flooding Period (November 30–March 29)

Habitat needs for shorebirds in the Winter Flooding Period range from nearly 750 acres in the January and February intervals, to over 1,700 acres in both March intervals (Table 6-40). The overall seasonal wetland objective for the Winter Flooding Period is 9,216 acres (Figure 6-45). As expected, the required depth ratio remains high through the Winter Flooding Period, as no new wetlands are being flooded and shorebirds deplete food resources on seasonal wetland acres that are managed <10 cm in depth (Figure 6-46).

Table 6-40. Seasonal wetland objectives (acres) for shorebirds in Tulare Basin during the Winter Flooding Period.

Interval	*SW Interval Objective*	*Cumulativea SW Objective*	*Flooded SW's[b]*	*Required Depth[c] Ratio (%)*
D-6 (Nov 30-Dec 14)	1,404	18,922	20,212	94
D-21 (Dec 15-Dec 29)	1,404	20,326	20,212	>100
J-5 (Dec 30-Jan 13)	748	21,074	20,212	>100
J-20 (Jan 14-Jan 28)	748	21,822	20,212	>100
F-4 (Jan 29-Feb 12)	748	22,570	20,212	>100
F-19 (Feb 13-Feb 27)	748	23,318	20,212	>100
M-6 (Feb 28-Mar 14)	1,708	25,026	20,212	>100
M-21 (Mar 15-Mar 29)	1,708	26,734	20,212	>100
Total	**9,216**	**26,734**	**20,212**	

SW – Seasonal Wetland.

[a] *Includes SW objectives from previous flooding periods.*

[b] *Flooded SW's reflect flooding schedules within a shorebird planning region.*

[c] *Cumulative SW Objective/Flooded SW's*

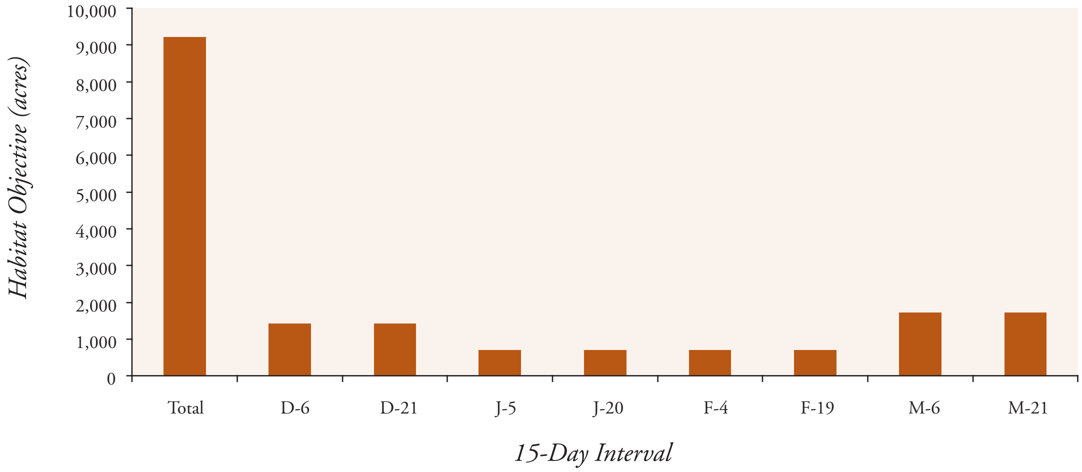


Figure 6-45. Seasonal wetland objectives for shorebirds in the Winter Flooding Period by 15-day intervals for the Tulare Basin.

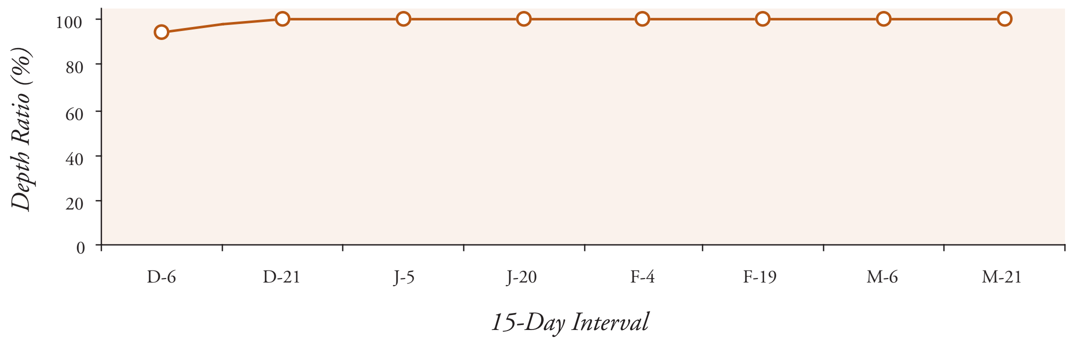


Figure 6-46. Changes in the required depth ratio for seasonal wetlands in the Winter Flooding Period for the Tulare Basin.

Spring Flooding Period (March 30–May 12)

Habitat needs for shorebirds in the Spring Flooding Period range from nearly 2,300 acres in each of the April intervals, to 152 acres in May (Table 6-41). The summed seasonal wetland objective for the Spring Flooding Period is 4,706 acres, with over 95% of these acres needed in the April intervals (Figure 6-47).

Table 6-41. Seasonal wetland objectives (acres) for shorebirds in Tulare Basin during the Spring Flooding Period.

Interval	*SW Interval Objective*	*Cumulative SW[a] Objective*	*Flooded SW[b] Habitat*
A-5 (Mar 30-Apr 13)	2,277	29,011	20,212
A-20 (Apr 14-Apr 28)	2,277	31,288	6,367
M-4 (Apr 29-May 10)	152	31,440	2,628
Total	**4,706**	**31,440**	

SW – Seasonal Wetland.

[a] Includes SW objectives from previous flooding periods.

[b] Flooded SW's reflect flooding schedules within a shorebird planning region.

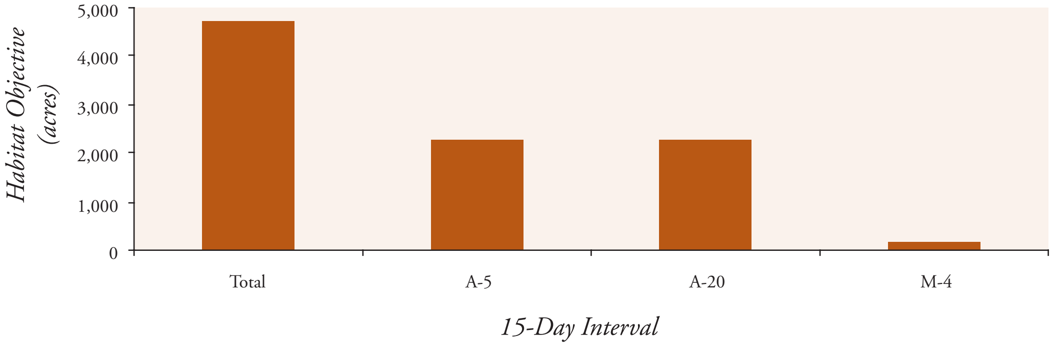


Figure 6-47. Seasonal wetland objectives for shorebirds in Tulare Basin during the Spring Flooding Period by 15-day intervals.

Water Supplies for Wetland Management

Additional water supplies that are needed for shorebirds are based on seasonal wetland needs in the August 8 interval (see earlier description for establishing water supply objectives). Seasonal wetland objectives for shorebirds in the Tulare Basin during the August 8 interval are estimated at 2,263 acres. This equates to a water supply need of 4,526 acre-feet.

Summary

Conservation objectives for managed seasonal and semi-permanent wetlands are summarized for the Tulare Basin in Table 6-42. Seasonal wetland objectives for shorebirds cannot be met even if all currently available habitat provides foraging depths <10 cm during some portion of the wintering period. This obviously does not occur in the Tulare Basin, which may explain the reliance of shorebirds on sub-optimal habitats within this basin.

Table 6-42. Conservation objectives for non-breeding shorebirds in Tulare Basin.

Interval	*Seasonal Wetlands (Acres)*	*Semi-Perm. Wetlands (Acres)*	*Water (Acre-Feet)*
J-7 (July 1-July 15)	0	566	0
J-22 (July 16-July 31)	0	604	0
A-8 (Aug 1-Aug 16)	2,263	0	4,526
A-23 (Aug 17-Aug 31)	2,263	0	0
S-7 (Sept 1-Sept 15)	2,263	0	0
S-22 (Sept 16-Sept 30)	2,263	0	0
O-7 (Oct 1-Oct 15)	2,829	0	0
O-22 (Oct 16-Oct 30)	2,,829	0	0
N-6 (Oct 31-Nov 14)	1,404	0	0
N-21 (Nov 15-Nov 29)	1,404	0	0
D-6 (Nov 30-Dec 14)	1,404	0	0
D-21 (Dec 15-Dec 29)	1,404	0	0
J-5 (Dec 30-Jan 13)	748	0	0
J-20 (Jan 14-Jan 28)	748	0	0
F-4 (Jan 29-Feb 12)	748	0	0
F-19 (Feb 13-Feb 27)	748	0	0
M-6 (Feb 28-Mar 14)	1,708	0	0
M-21 (Mar 15-Mar 29)	1,708	0	0
A-5 (Mar 30-Apr 13)	2,277	0	0
A-20 (Apr 14-Apr 28)	2,277	0	0
M-4 (Apr 29-May 10)	152		0
Total	31,440	1,170	4,526


Dunlin
Photo: Brian Gilmore

Summary

Acre objectives for seasonal wetlands, semi-permanent wetlands, and winter flooded rice are summarized for the entire Central Valley in Tables 6-43 through 6-45. Habitat objectives for shorebirds are strongly dependant on the estimates of invertebrate biomass adopted for wetland and agricultural habitats. Unfortunately, invertebrate biomass estimates do not exist for Central Valley habitats. As a result, the JV had to rely on biomass estimates obtained from other regions of the United States. More importantly, the JV assumed that invertebrate food sources are not renewable in the face of shorebird foraging. In reality, invertebrate populations and biomass may grow or remain stable despite the effects of shorebird foraging (i.e., invertebrate food resources are not depleted in the way seed resources are). If invertebrate populations are wholly or partially renewable, then shorebird habitat objectives may be overestimated. Future efforts to document seasonal changes in invertebrate biomass within the Central Valley should allow the JV to refine these habitat objectives.

Long-billed dowitchers
Photo: Brian Gilmore

Table 6-43. Seasonal wetlands objectives (acres) for shorebirds in the Central Valley.

Interval	*NSV*	*Delta Planning Region*	*San Joaquin Basin*	*Tulare Basin*	*Total*
J-7 (July 1-July 15)	0	0	0	0	0
J-22 (July 16-July 31)	0	0	0	0	0
A-8 (Aug 1-Aug 16)	1,584	340	340	2,263	4,527
A-23 (Aug 17-Aug 31)	1,584	340	340	2,263	4,527
S-7 (Sept 1-Sept 15)	1,584	340	340	2,263	4,527
S-22 (Sept 16-Sept 30)	1,584	340	340	2,263	4,527
O-7 (Oct 1-Oct 15)	990	212	424	2,829	4,455
O-22 (Oct 16-Oct 30)	990	212	424	2,829	4,455
N-6 (Oct 31-Nov 14)	1,483	468	2,497	1,404	5,852
N-21 (Nov 15-Nov 29)	1,483	468	2,497	1,404	5,852
D-6 (Nov 30-Dec 14)	1,483	468	2,497	1,404	5,852
D-21 (Dec 15-Dec 29)	1,483	468	2,497	1,404	5,852
J-5 (Dec 30-Jan 13)	1,684	636	2,095	748	5,163
J-20 (Jan 14-Jan 28)	1,684	636	2,095	748	5,163
F-4 (Jan 29-Feb 12)	1,684	636	2,095	748	5,163
F-19 (Feb 13-Feb 27)	1,684	636	2,095	748	5,163
M-6 (Feb 28-Mar 14)	1,959	151	4118	1,708	7,936
M-21 (Mar 15-Mar 29)	1,959	151	4,118	1,708	7,936
A-5 (Mar 30-Apr 13)	5,223	402	5,491	2,277	13,393
A-20 (Apr 14-Apr 28)	5,223	402	5,491	2,277	13,393
M-4 (Apr 29-May 10)	348	28	366	152	894
Total	35,696	7,334	40,130	31,440	114,600

Table 6-44. Semi-permanent wetland objectives (acres) for shorebirds in the Central Valley.

Interval	*NSV*	*Delta Planning Region*	*San Joaquin Basin*	*Tulare Basin*	*Total*
J-7 (July 1-July 15)	396	85	85	566	1,132
J-22 (July 16-July 31)	423	85	90	604	1,202
Total	**819**	**170**	**175**	**1,170**	**2,334**

Table 6-45. Winter Flooded Rice objectives (acres) for shorebirds in the Central Valley.

Interval	*NSV*	*Delta Planning Region*	*San Joaquin Basin*	*Tulare Basin*	*Total*
J-7 (July 1-July 15)	0	0	0	0	0
J-22 (July 16-July 31)	0	0	0	0	0
A-8 (Aug 1-Aug 16)	0	0	0	0	0
A-23 (Aug 17-Aug 31)	0	0	0	0	0
S-7 (Sept 1-Sept 15)	0	0	0	0	0
S-22 (Sept 16-Sept 30)	0	0	0	0	0
O-7 (Oct 1-Oct 15)	990	212	0	0	2,192
O-22 (Oct 16-Oct 30)	990	212	0	0	1,202
N-6 (Oct 31-Nov 14)	1,483	468	0	0	1,951
N-21 (Nov 15-Nov 29)	1,483	468	0	0	1,951
D-6 (Nov 30-Dec 14)	1,483	468	0	0	1,951
D-21 (Dec 15-Dec 29)	1,483	468	0	0	1,951
J-5 (Dec 30-Jan 13)	1,684	636	0	0	2,320
J-20 (Jan 14-Jan 28)	1,684	636	0	0	2,320
F-4 (Jan 29-Feb 12)	1,684	636	0	0	2,320
F-19 (Feb 13-Feb 27)	1,684	636	0	0	2,320
M-6 (Feb 28-Mar 14)	1,959	151	0	0	2,110
M-21 (Mar 15-Mar 29)	1,959	151	0	0	2,110
A-5 (Mar 30-Apr 13)	0	0	0	0	0
A-20 (Apr 14-Apr 28)	0	0	0	0	0
M-4 (Apr 29-May 10)	0	0	0	0	0
Total	**18,566**	**5,142**	**0**	**0**	**23,708**

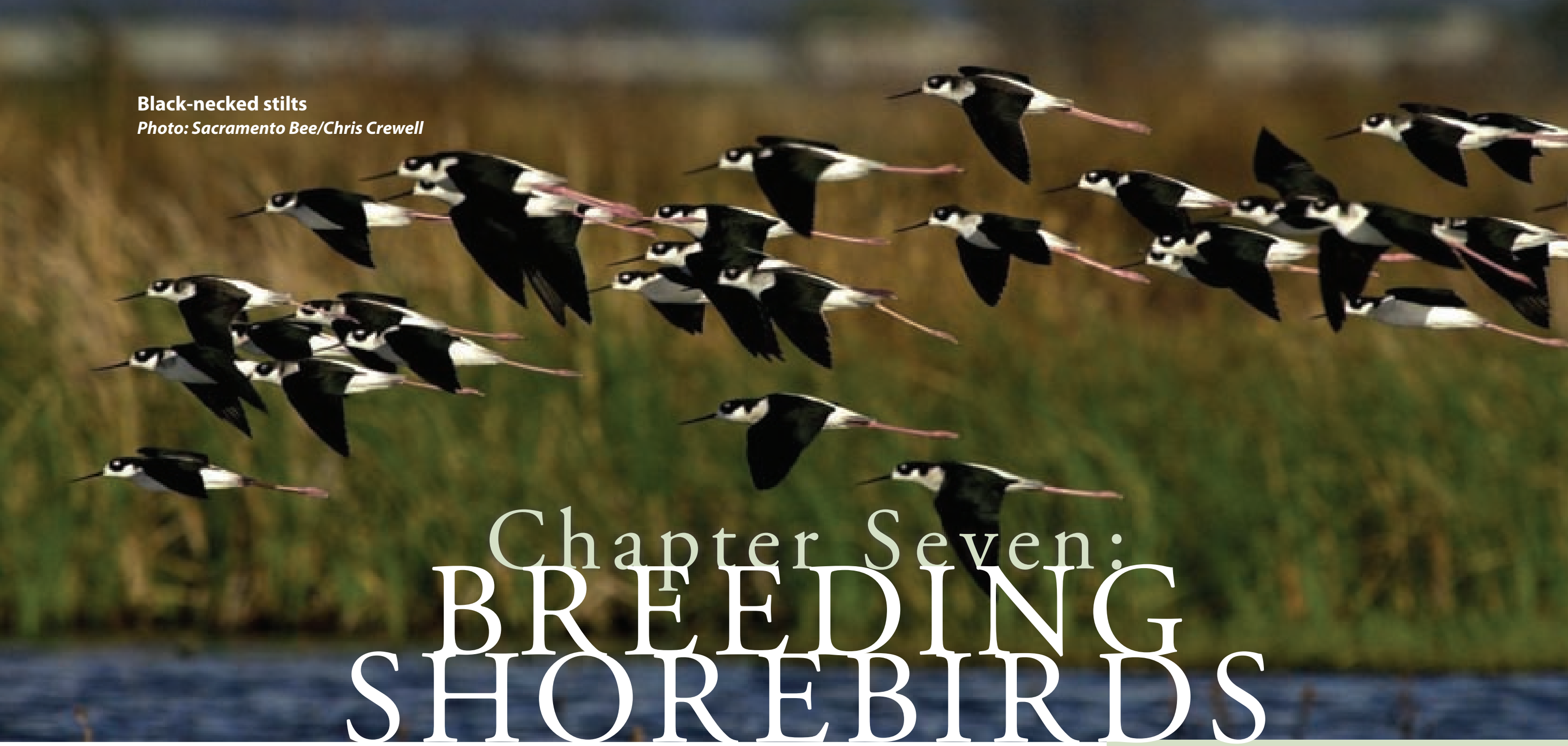
Although shorebird habitat objectives may be conservative, regional differences in habitat objectives and required depth ratios help suggest where the JV should focus its efforts for shorebirds both temporally and spatially. During the Summer Flooding Period (July 1–August 16), shorebird habitat needs in the July intervals may be met through staggered drawdowns of semi-permanent wetlands. Within the SV, Delta, and San Joaquin Basin Planning Regions, only a small percent of existing semi-permanent wetlands must provide habitat <10 cm in depth. It seems likely that shorebird needs are either being met in these regions, or can be met with minor management adjustments. In contrast, a much higher percent of semi-permanent wetlands in the Tulare Basin must provide foraging depths <10 cm during the July drawdowns to meet shorebird needs. Tulare Basin also differs from the other three planning regions during the first half of August (August 8 interval). Over 10% of the existing seasonal wetlands would need to be flooded early to meet shorebird needs during this period. This objective may be especially challenging given the high cost of water in the basin. In contrast, less than 3% of the seasonal wetlands in the SV, Delta, and San Joaquin Basin Planning Regions need to be flooded during the first half of August. The Tulare Basin contains 50% of all shorebirds in the Central Valley during the Summer Flooding Period, and faces unique conservation challenges. As a result, it represents the JVs highest regional priority during this period.

Although shorebird populations in the Tulare Basin decline in the second half of the Fall Flooding Period, the region remains a priority during this time. Required depth ratios in the SV, Delta, and San Joaquin Basin Planning Regions remain relatively low during the Fall Flooding Period. The lower the required depth ratio, the more likely that shorebird habitat needs are being met. In contrast, required depth ratios in the Tulare Basin during the Fall Flooding Period were near or at 100% for all 2-week time intervals.

Required depth ratios increased in the SV, Delta, and San Joaquin Basin Planning Regions during the Winter Flooding Period, and remained near or at 100% for the Tulare Basin. It seems likely that shorebirds may have increasing difficulty in meeting their food energy needs during the Winter Flooding Period as wetlands become fully flooded and the availability of shallow water habitat declines. Drawdown of seasonal wetlands during winter resulted in significant increases in shorebird use, which supports this assumption (Taft et al. 2002).

The Delta Planning Region, San Joaquin Basin, and Tulare Basin are considered priority regions for additional habitat conservation to meet shorebird needs during the Winter Flooding Period. Although required depth ratios in the SV Planning Region were similar to other regions, the abundance of rice habitat in the SV Planning Region makes it more likely that shorebird needs are being met in this region.

Finally, no priority regions were identified for the Spring Flooding Period. Most seasonal wetlands are being drawn down during this period, which may create an abundance of shallow water habitat that exceeds shorebird needs (Taft et al. 2002).



Black-necked stilts
Photo: Sacramento Bee/Chris Crewell

Chapter Seven: BREEDING SHOREBIRDS

This chapter addresses the needs of seven species of shorebirds that breed within the Central Valley.

Introduction

Among the shorebirds breeding within the Central Valley, only the killdeer *(Charadrius vociferous)*, the black-necked stilt *(Himantopus mexicanus)*, and the American avocet *(Recurvirostra americana)* are widespread, numerous, and nest in a variety of wetland, agricultural, and water treatment or storage habitats. Because of their widespread distribution and available survey information, black-necked stilts *(stilts)* and American avocets *(avocets)* form the basis for breeding shorebird habitat objectives in the 2005 Plan. Four other shorebird species also breed in the Central Valley including snowy plover *(Charadrius alexandrinus)*, spotted sandpiper *(Actitis macularia)*, Wilson's snipe *(Gallinago delicata)*, and Wilson's phalarope *(Phalaropus tricolor)*. Although there are no breeding population estimates for these species, future surveys could lay the foundation for additional habitat objectives specific to these shorebird species.

Historical Overview of Central Valley Breeding Shorebird Habitat

Prior to European settlement, the Central Valley contained extensive shallow-water wetland habitat that varied both seasonally and annually depending on the amount of flooding from winter rains and spring runoff. These shallow-water wetlands were highly productive, and when they persisted into spring and summer, provided important habitat for many species of breeding waterbirds, and shorebirds (Shuford et al. 2001). By the mid-1900s, breeding populations of stilts and avocets in California had been reduced commensurate with the loss of interior marshlands (Grinnell and Miller 1944). The loss of breeding habitat for stilts and avocets in the Central Valley was partially offset by the creation of salt ponds in the San Francisco Bay estuary, where nesting populations of both species increased early in the 1900s (Gill 1977).

> "The Central Valley supports thousands of nesting shorebird species such as black-necked stilt, American avocet, and killdeer, as well as populations of snowy plover. These populations are important on both a statewide and regional scale."
>
> **Glenn Olson**
> *Executive Director*
> *Audubon California*


Killdeer
Photo: Dave Feliz, CDFG

In addition to habitat loss, breeding shorebirds in the Central Valley are often exposed to poor or toxic water conditions, because they frequently rely on evaporation and sewage ponds for breeding habitat. In the 1980s, agricultural drain water in the San Joaquin Valley containing high levels of salts and trace elements was delivered to wetlands to provide wildlife habitat and to agricultural evaporation ponds for disposal. This contamination resulted in bioaccumulation of selenium sufficient to harm reproduction of shorebirds, including stilts and avocets (Ohlendorf et al. 1987, 1993; Skorupa and Ohlendorf 1991.

In wetlands, exposure to selenium has been reduced by filling over areas which contained highest concentrations of this element or by providing uncontaminated water for wetland management. Evaporation ponds are now managed to reduce contamination risk to wildlife by: (1) filling some ponds; (2) hazing birds or physically altering ponds to make them less attractive; and (3) creating nearby uncontaminated wetlands as alternative habitat (Moore et al. 1990, Steele and Bradford 1991, Bradford 1992). Despite steady declines in selenium levels, concentrations in some species still exceed those known to impair reproduction (Paveglio et al. 1992, 1997; Hothem and Welsh 1994*a,b*). Monitoring is ongoing to determine shorebird and other bird response to these management actions. (R. Hansen, Hansen's Biological Consulting, unpublished data).

Habitat needs for wintering shorebirds were established using a forage-based model that directly linked population objectives to habitat goals (Chapter 6). However, there is no clear link between population objectives for breeding shorebirds and the amount of habitat needed to support breeding birds. The approach used here establishes five-year habitat objectives that reflect the pace of JV accomplishments in recent years. Five years is the amount of time expected between the 2006 Plan and the next Implementation Plan update. It is important that JV partners recognize that this is a short-term objective that reflects the practical realities of habitat delivery in the Central Valley. Habitat objectives for breeding shorebirds may increase in future plan updates, as a better understanding of the link between population objectives and habitat needs of breeding shorebirds is gained. The remainder of this chapter is divided into two sections: (1) a short review of planning information available for breeding shorebirds in the Central Valley; and (2) conservation objectives for breeding shorebirds in the Central Valley.

A Review of Planning Information Available for Breeding Shorebirds in the Central Valley

The JV used four planning regions within the Central Valley to evaluate breeding shorebird needs and to establish conservation objectives for this bird group: (1) Sacramento Valley, consisting of Colusa, Butte, American, and Sutter Basins; (2) Delta, consisting of Yolo and Delta Basins; (3) San Joaquin Basin; and (4) Tulare Basin. The Suisun Basin was not included, as counts do not exist for this region. However, the Suisun Marsh does provide valuable habitat for breeding shorebirds, and the following conservation actions identified in the *Southern Pacific Shorebird Conservation Plan* may benefit this bird group: (1) maintain or increase current breeding populations of killdeer, black-necked stilt, and American avocet by restoring, enhancing or creating nesting habitat; (2) incorporate shorebird habitat components in tidal marsh restorations; (3) increase tidal circulation and water quality in marshes to enhance invertebrate productivity and shorebird foraging areas; (4) time water drawdowns in managed marshes to correspond with the peak of spring shorebird migration from mid-April to mid-May; (5) manage vegetation in some ponds to provide expanses of open habitat; and (6) increase nesting habitat for black-necked stilt and American avocet in managed marshes through the strategic placement of islands. (PRBO 2003).

Four factors were considered when establishing conservation objectives for breeding shorebirds in the Central Valley: (1) historic patterns of habitat loss; (2) current distribution of breeding shorebirds among planning regions; (3) an estimate of the habitat resources currently available to breeding shorebirds in each planning region; and (4) annual rates of wetland restoration in the Central Valley. Annual wetland restoration rates provide a basis for identifying how much conservation work might be accomplished on behalf of breeding shorebirds in the next five years, while factors one through three provide the basis for distributing this objective in a biologically meaningful way.

Historic Habitat Loss

Although 95% of the Central Valley's wetlands are now gone, loss of shorebird habitat has been particularly high in the Tulare Basin. Prior to European settlement, Tulare Lake represented the largest freshwater body west of the Mississippi River (Johnson et al. 1993, Thelander and Crabtree 1994). Tulare Basin also contained several smaller lakes (Buena Vista, Goose, Kern), that together provided 260,000 acres of seasonal wetlands and over 250,000 acres of semi-permanent marshes (Griggs et al. 1992).

In 2001, the California State University, Chico began to develop a set of historic natural vegetation maps for the Central Valley of California that identify major changes in the valley due in part to hydrologic alterations associated with the Central Valley Project (1945) and the California State Water Project (1973). Preliminary analysis from the *Central Valley Historic Mapping Project* indicates that 96% of the historic wetland and aquatic habitats of the Tulare Basin were lost prior to 1995, and that the loss of these habitat types in the other planning regions of the Central Valley, has ranged between 55% and 87% (http://www.gic.csuchico.edu/historic).

Hydrologic factors varied significantly among basins of the Central Valley, resulting in regional differences in the amount of summer wetland habitat. Despite suffering disproportionately high rates of wetland loss, the Tulare Basin likely contained an abundance of summer wetland habitat relative to other areas of the valley. Because Tulare Basin was a terminal basin, it retained water well into summer, since most water moved slowly out of the basin via evaporation. The timing of flood events was another important factor in producing regional differences in summer wetland habitat. Rainfall induced floods (Dec-Mar) predominated in the Sacramento Valley Planning Region, whereas prolonged snowmelt floods (Apr-June) were the norm in the San Joaquin Valley, particularly in the Tulare Basin (The Bay Institute 1998). Various accounts indicate that Tulare Basin wetland habitats supported large numbers of breeding birds, including pelicans, cormorants, waterfowl, shorebirds, and terns.

Current Shorebird Distribution

Surveys were conducted throughout the Central Valley in 2003 to determine distribution, abundance, and habitat use of breeding stilts and avocets. These two species form the basis for breeding shorebird habitat objectives in the 2006 Plan. The 2003 survey estimated 29,600 stilts and 10,550 avocets in the entire Central Valley, exclusive of Suisun Marsh (Shuford et al. 2004). The distribution of these two species among habitat types and planning regions of the Central Valley is presented in Tables 7-1 and 7-2.

Sixty-four percent of all breeding shorebirds (stilts and avocets combined) were observed in the Sacramento Valley Planning Region, with 32% of all birds counted in the Tulare Basin. Less than 5% were observed in the Delta Planning Region and the San Joaquin Basin. Seventy-four percent of all stilts were observed in the Sacramento Valley Planning Region, with most others (23%) observed in the Tulare Basin. The Delta Planning Region and the San Joaquin Basin each contained less than 3% of all breeding stilts (Table 7-1). Unlike stilts, most avocets (57%) were counted in the Tulare Basin. The Sacramento Valley Planning Region contained 36% of all breeding avocets, while the combined counts from the San Joaquin and Tulare Basins made up less than 8% of all birds (Table 7-2).

The distribution of breeding shorebirds among habitat types also differed by planning region. Ninety-eight percent of all stilts in the Sacramento Valley Planning Region were observed in rice fields and only one percent in managed wetlands. In contrast, thirty-five percent of all stilts in the Tulare Basin were counted in managed wetlands (Table 7-1). Avocets displayed similar geographic variation in their use of habitat types. Nearly 93% of all avocets in the Sacramento Valley Planning Region were observed in rice fields, with less than 4% occurring in managed wetlands. In contrast, nearly half of all avocets in the Tulare Basin were observed in managed wetlands (Table 7-2).

Table 7-1. Numbers (%) of breeding black-necked stilts in various habitat types by planning regions of the Central Valley in 2003 (from Shuford et al. 2004).

	Sacramento Valley	*Delta*	*San Joaquin Basin*	*Tulare Basin*	*Central Valley Total*
Managed wetlands	219 (1.0)	4 (2.5)	307 (44.2)	2,441 (35.3)	2,971 (10.0)
Sewage ponds	133 (0.6)	33 (20.6)	274 (39.4)	1,329 (19.2)	1,769 (6.0)
Rice fields	21,412 (98.1)	72 (45.0)	26 (3.7)	0 (0.0)	21,510 (72.7)
Water storage facilities	42 (0.2)	0 (0.0)	2 (0.3)	820 (11.8)	864 (2.9)
Miscellaneous	21 (0.1)	51 (31.9)	86 (12.4)	202 (2.9)	360 (1.2)
Evaporation ponds	0 (0.0)	0 (0.0)	0 (0.0)	1,170 (16.9)	1,170 (4.0)
Agricultural canals	0 (0.0)	0 (0.0)	0 (0.0)	958 (13.8)	958 (3.2)
Total of all habitat types	**21,827**	**160**	**695**	**6,920**	**29,602**

Table 7-2. Numbers (%) of breeding American avocets in various habitat types by planning regions of the Central Valley in 2003 (From Shuford et al. 2004).

	Sacramento Valley	*Delta*	*San Joaquin Basin*	*Tulare Basin*	*Central Valley Total*
Sewage ponds	121 (3.2)	12 (13.8)	217 (29.6)	614 (10.3)	964 (9.1)
Rice fields	3,469 (92.6)	27 (31.0)	15 (2.0)	0 (0.0)	3,511 (33.3)
Water storage facilities	11 (0.3)	0 (0.0)	1 (0.1)	192 (3.2)	204 (1.9)
Miscellaneous	6 (0.2)	45 (51.7)	104 (14.2)	55 (0.9)	210 (2.0)
Evaporation ponds	0 (0.0)	0 (0.0)	0 (0.0)	1,538 (25.7)	1,538 (14.6)
Agricultural canals	0 (0.0)	0 (0.0)	0 (0.0)	694 (11.6)	694 (6.6)
Total of all habitat types	**3744**	**87**	**732**	**5,983**	**10,546**

Stilts and avocets were more evenly distributed among habitat types in the Tulare Basin than in any other planning region of the Central Valley. Five habitats in the Tulare Basin held >10% of all stilts or avocets. The Tulare Basin was the only planning region where agricultural evaporation ponds, canals ditches, and water storage facilities (water recharge ponds, storm water storage ponds, and reservoirs) supported large numbers of stilts and avocets. The proportion of shorebirds in managed wetlands in the Tulare Basin, and to a lesser degree in the Central Valley as a whole, was weighted heavily by large numbers of stilts and avocets counted in a single compensation wetland in the Tulare Basin that was supplied by saline water from an adjacent agricultural evaporation basin.

Overall, shorebirds in some parts of the Central Valley (e.g., Tulare Basin) rely heavily on habitats that serve the production, water conveyance, storage, treatment, or disposal needs of agriculture, municipalities, or industry. The use of some of these habitats may expose shorebirds to toxic substances. Therefore, reliance on some of these artificial environments is risky as future management practices may serve human efficiencies and economies, but reduce benefits to wildlife. This highlights the need to restore and enhance sufficient summer wetland habitat to meet the needs of breeding shorebirds, and other migratory and resident wildlife.

Existing Habitats

Acres of managed semi-permanent wetlands and planted rice are presented for each of the four planning regions in Table 7-3. These acre estimates are intended to provide an index to the amount of habitat now available to breeding shorebirds in each of these four planning regions. However, the JV recognizes that Table 7-3 does not include all habitat types (e.g., water storage habitats), nor does it distinguish between semi-permanent wetlands that are managed consistent with shorebird needs vs. semi-permanent habitats that are not managed with shorebird needs in mind. Still, the habitat estimates presented in Table 7-3 provide some insight to regional differences in the resources available to breeding shorebirds.

Table 7-3. Existing breeding shorebird habitats (acres) in the Central Valley.

Planning region	*Semi-permanent wetlands*	*Planted rice*
Sacramento Valley	10,488	491,146
Delta	1,121	1,399
San Joaquin Basin	6,779	10,000
Tulare Basin	2,245	0

Half of all semi-permanent wetlands in the four shorebird planning regions occur in the Sacramento Valley Planning Region, with most of the remaining wetlands located in the San Joaquin Basin. Only about ten percent of all semi-permanent wetlands occur in the Tulare Basin, despite this region's importance to breeding shorebirds. Finally, about 5% of all managed wetlands are located in the Delta Planning Region, where breeding shorebird numbers are low relative to other areas of the Central Valley (Table 7-3).

Annual Rates of Wetland Restoration in the Central Valley

Annual tracking of JV accomplishments indicates that wetland restoration in the Central Valley averages about 6,000 acres per year. Between 10% and 15% of these wetlands are managed as semi-permanent wetlands, depending on the basin (U.S. Fish and Wildlife Service 2000). Assuming an average value of 12.5%, approximately 750 acres of semi-permanent wetlands are annually restored in the Central Valley.

Conservation Objectives for Breeding Shorebirds


American avocet
Photo: Brian Gilmore

Although Central Valley shorebirds breed in a variety of habitats (Shuford et al. 2004), there is general agreement that conservation efforts should focus on providing summer wetland habitat (semi-permanent wetlands) that is managed to prevent widespread establishment of robust emergent plant communities. As a result, conservation objectives for breeding shorebirds in the 2006 Plan are limited to: (1) the establishment of semi-permanent wetland objectives (acres) in each of the four planning regions; and (2) the annual water needs of these wetlands. It is assumed that these wetlands will be managed consistent with the needs of breeding shorebirds, including control of robust emergent vegetation, provision of unvegetated nesting islands, provision of shallow foraging habitat for adults and young, and, where appropriate, employing methods to control predation of nests and young (see Shuford et al. 2004 for more specific management recommendations).

Recent surveys of breeding shorebirds in the Central Valley indicate that most birds breed in the Sacramento Valley Planning Region and the Tulare Basin. Of the 40,000 stilts and avocets observed in the 2003 breeding survey, nearly 64% occurred in the Sacramento Valley Planning Region. Tulare Basin accounted for 32% of this total (Tables 7-1 and 7-2). Although both these planning regions are important to breeding shorebirds, they differ in terms of historic habitat loss and existing habitat resources. Loss of historic shorebird breeding habitat appears to be especially high in the Tulare Basin with the loss of terminal lake systems to agriculture. Moreover, Tulare Basin has considerably less summer wetland habitat than occurs in the Sacramento Valley Planning Region. These differences in existing habitat resources are compounded by the difficulty in acquiring water for summer wetland habitat in Tulare Basin because of high costs and low availability.

Wetland Restoration

The conservation objective is to restore 7,500 acres of semi-permanent wetlands over the next five years (Table 7-4). Restoration of semi-permanent wetlands in the Central Valley has averaged about 750 acres per year in recent years. This objective is a two-fold increase over current rates of restoration, and was apportioned among the four planning regions based on the current distribution of breeding shorebirds, historic patterns of wetland loss, and existing wetland resources. While believed to be realistic, this objective will require a substantial effort on the part of JV partners to deliver over the next five years.

Wetland Water Requirements

Annual water needs for semi-permanent wetlands are estimated to average 6.5 acre-feet per acre (U.S. Fish and Wildlife Service 2000). Table 7-5 identifies the annual wetland water needs to meet breeding shorebird requirements based on five year habitat objectives for each planning region.

Summary

Table 7-4. Five-year wetland restoration objectives for breeding shorebirds in the Central Valley.

Planning region	*5-year acre objective*
Sacramento Valley	875
Delta	875
San Joaquin Basin	1,315
Tulare Basin	4,435
Total	**7,500**

Table 7-5. Annual wetland water needs (acre-feet) to meet 5-year breeding shorebird habitat objectives.

Planning region	*Annual acre-feet Need*
Sacramento Valley	5,688
Delta	5,688
San Joaquin Basin	8,548
Tulare Basin	28,828
Total	**48,752**

Overall, meeting the five-year habitat objectives for breeding shorebirds in the Central Valley requires an additional 7,500 acres of semi-permanent habitat to be distributed as described in Table 7-4. Longer-term habitat objectives for breeding shorebird populations will be developed over the next several years by the JV, and will be reflected in future revisions of the 2006 Plan. It is assumed that these acres will be managed in a way that is consistent with breeding shorebird needs (see Shuford et al. 2004 for specific habitat management recommendations). The forthcoming JV monitoring and evaluation plan should outline an approach to monitor the suitability of semi-permanent wetland habitat for breeding shorebirds and population response to habitat increases. In addition, it may suggest monitoring needs for breeding shorebird species not included in this chapter, and an approach to produce additional habitat objectives for those species.

Ibis
Photo: Bob McLandress, CWA

Chapter Eight: WATERBIRDS

This chapter addresses conservation needs within the Central Valley for waterbirds, a large and diverse group that includes seabirds, coastal waterbirds, wading birds and marshbirds that rely on aquatic habitats.

Introduction

The Central Valley provides habitat for thirty-eight species of waterbirds. The North American Waterbird Conservation Plan (NAWCP; Kushlan et al. 2002) provides a continental framework for the conservation and management of 23 families of North American waterbirds. Version 1 of the NAWCP concentrates on colonial nesting species with future versions of the plan to address solitary-nesting waterbirds. The NAWCP outlines four goals with associated strategies and desired results for waterbirds: (1) species and population; (2) habitat; (3) education and information; and (4) coordination and information. The NAWCP also relegates responsibility to regional step-down conservation plans for the development of specific conservation goals at regional scales. In the absence of a completed regional bird conservation plan, this 2005 Plan incorporates appropriate recommendations from the NAWCP Species and Population and Habitat Goals into the JV planning process. This is the first organized effort to explicitly link goals and strategies outlined in the NAWCP with the goals and objectives of the JV. The remainder of this chapter is divided into three sections: (1) approach used to develop conservation objectives for waterbirds; (2) selecting focal species; and (3) conservation objectives for waterbirds.

> "Degradation of Central Valley wetlands undoubtedly collapsed waterbird populations. Recent seasonal wetland and riparian restoration efforts have resulted in an expansion of breeding colonial waterbird nesting. Among species that have made dramatic recoveries are breeding white-faced ibis and wintering great blue heron. However, several other species (least bittern, black tern, and black rail) remain at low levels, and demand further habitat conservation efforts."
>
> **Frederic Reid, Ph.D.**
> *Director of Conservation Planning*
> *Ducks Unlimited, Inc.*

Approach Used to Develop Conservation Objectives for Waterbirds

Version 1 of the NAWCP provides quantitative information for colonial nesting species, the majority of which are long-legged waders and seabirds. The lack of continental and regional population goals and population baseline data on size and distribution is the greatest obstacle to developing population-based habitat goals and objectives. The U.S. Fish and Wildlife Service (USFWS) is currently developing a waterbird conservation plan for Bird Conservation Region (BCR) 32, Coastal California, which wholly encompasses the Central Valley (U.S. NABCI Committee 2000). This plan will establish long term conservation goals and objectives for waterbirds and will provide a basis for establishing long term goals for the next JV implementation plan update. This chapter develops short term (5-year) conservation objectives that include a combination of quantitative habitat objectives and qualitative habitat conservation recommendations to benefit a range of waterbird species that breed and/or winter within the Central Valley. Specifically, this chapter: (1) identifies focal species that serve as an "umbrella" for similar species; (2) identifies factors believed to be limiting their populations; and (3) develops conservation strategies to counter these limiting factors.

Selecting Focal Species


Snowy egret
Photo: Brian Gilmore

The JV selected focal species by reviewing the NAWCP and other documents to determine the distribution of all waterbird species within the JV and subsequently evaluated the current level of conservation concern for these species. Focal species that best serve as "umbrella" species for the family or group of waterbirds that they represent, and that would most likely benefit from JV conservation actions, were selected from this list. This chapter includes a brief overview of the habitat needs and associations of each focal species.

Distribution of Waterbirds in the JV

The NAWCP summarizes available population data for 210 species of North American waterbirds. It also lists the distribution and classification of waterbirds (breeding, wintering, migratory, pelagic) for 52 BCRs and Pelagic Bird Conservation Regions. The JV used range maps from Zeiner et al. (1990) to determine which species found in BCR 32 occur within the boundaries of the JV during summer and/or winter. Because information on waterbirds is lacking at the basin level, the JV combined some basins to form four waterbird planning regions similar to the shorebird planning region units described in chapters 6 and 7 (Figure 8-1). The Sacramento Valley Planning Region includes the Butte, Colusa, Sutter, and American Basins. The Delta Planning Region includes the Yolo and Delta Basins and the Suisun Marsh. The San Joaquin and Tulare basins stand alone as their own planning regions. Thirty-eight species representing eight families of waterbirds occur within the JV (Table 8-1). Twenty-seven of those species winter within one or more planning regions, and 25 occur in one or more planning regions during the breeding season.

Figure 8-1. Waterbird planning regions of the Central Valley Joint Venture.

Table 8-1. Breeding[1] and wintering[2] distribution of waterbirds among waterbird planning regions.

	Sacramento Valley	*Delta*	*San Joaquin*	*Tulare*
Eared grebe	W	B, W	W	B, W
Western grebe	B, W	W	B, W	B, W
Clark's grebe	B, W	W	B, W	B, W
Pied-billed grebe	B, W	B, W	B, W	B, W
American white pelican	W	W	W	W
Double-crested cormorant	B, W	W	W	B, W
Snowy egret	B, W	B, W	B, W	W
Black-crowned night heron	B, W	B, W	B, W	B, W
Green-backed heron	B, W	B, W	B, W	B, W
Great blue heron	B, W	B, W	B, W	B, W
Great egret	B, W	B, W	B, W	B, W
Cattle egret	B,W			
Least bittern	B	B	B	
American bittern	B, W	B, W	B, W	B, W
White-faced ibis	B, W		B, W	B, W
California gull	W	B, W	B, W	B, W
Forster's tern	B	B	B	B
Black tern	B	B	B	B
Bonaparte's gull		W		
Thayer's gull	W	B, W	B, W	
Herring gull	W	W	W	W
Glaucous-winged gull	W	W	W	
Ring-billed gull	W	B, W	B, W	B, W
Mew gull	W	W		
Black rail	B	B, W		
Virginia rail	B, W	B, W	B, W	B, W
Sora rail	B, W	B, W	B, W	B, W
Common moorhen	B, W	B, W	B, W	B, W
American coot	B, W	B, W	B, W	B, W
Sandhill crane	W	W	W	W

1. B = breeding 2. W = wintering

Conservation Status of Waterbirds

The status of waterbird species is tracked in a variety of ways. The NAWCP lists categories of conservation concern for each species as highly imperiled, high concern, moderate concern, low concern, or not currently at risk. The California Department of Fish and Game maintains a list of California Bird Species of Special Concern, and the USFWS periodically publishes a list of Birds of Conservation Concern. The most recent edition of this publication highlights birds of conservation priority at three geographic scales, including the BCR level (U.S. Fish and Wildlife Service 2002). The JV reviewed the status of waterbird species from each of these lists to determine their continental and regional conservation status (Table 8-2).

Table 8-2. Conservation status of selected waterbirds among various bird conservation plans.

Focal Species	*NAWCP*	*BSSC*	*BCC*
Western grebe	moderate		
Snowy egret	high		
Least bittern	N/A	x	
White-faced ibis	low		
Black tern	moderate	x	
Black rail	N/A		x
Sandhill crane	N/A	x	

NAWCP = North American Waterbird Conservation Plan.
BSSC = California bird species of special concern.
BCC = USFWS Birds of Conservation Concern (USFWS 2002).

Identifying Focal Species

To facilitate planning and implementation of conservation programs, the JV used a modification of Lamback's (1997) technique to identify focal species that are representative of groups of species found in the Central Valley. Species were selected from each family, if they met the following criteria: (1) listed as Highly Imperiled or of High Concern in the NAWCP; *or* (2) listed as of Moderate Concern in the NAWCP *and* California Bird Species of Special Concern; *and/or* listed as a USFWS Bird of Conservation Concern. Using this process, the JV identified seven focal species representing six families spanning a range of wetland or riparian conditions: Western grebe (*Aechmophorus occidentalis*); snowy egret (*Egretta thula*); least bittern (*Ixobrychus exilis*); white-faced ibis (*Plegadis chihi*); black tern (*Chlidonias niger*); black rail (*Laterallus jamaicensis*); and Sandhill crane (*Grus Canadensis*). White-faced ibis was included because of the species' visibility as important wetland wildlife to land managers, biologists, and the general public. Western grebes are ranked as "moderate" by the NAWCP, but have few secure breeding opportunities in California. However, they were identified as a focal species because of the recent attention to their conservation needs (Ivey 2004).

Limiting Factors for Waterbird Focal Species

Recognizing the extent of wetland habitat loss in the Central Valley, habitat quantity and quality are assumed to be limiting factors during key life cycle events. Thus, the protection, restoration and/or enhancement of wintering and/or breeding habitat will benefit waterbird populations. The NAWCP evaluated the conservation status of waterbirds based on six factors: (1) population trend; (2) population size; (3) threats to breeding; (4) threats to non-breeding; (5) breeding distribution; and (6) non-breeding distribution. Each of these factors received a score from 1 to 5, in increasing order of severity. The JV examined these factors to help determine those that are potentially limiting to focal species. The term "threats" includes actual threats to populations, as well as declining population status or other vulnerabilities such as small population size and limited distribution. Factors receiving a score of "4" or higher were considered significant threats (Table 8-3). Principal threats were categorized as breeding, non-breeding or both in order to make assumptions concerning the best conservation strategies. For example, western grebes and snowy egrets face significant threats in both breeding and wintering seasons. Black terns face threats during the breeding season.

Table 8-3. North American Waterbird Conservation Plan level of conservation threats to focal waterbird species.

Focal Species	*Population Trend*	*Population Size*	*Threats To Breeding*	*Threats To Non-Breeding*	*Breeding Distribution*	*Non-Breeding Distribution*
Western grebe	3	2	4	4	3	3
Snowy egret	4	2	4	3	3	4
Least bittern	n/a	n/a	n/a	n/a	n/a	n/a
White-faced ibis	2	2	4	3	3	4
Black tern	3	2	4	3	2	2
Black rail	n/a	n/a	n/a	n/a	n/a	n/a
Sandhill crane	n/a	n/a	n/a	n/a	n/a	n/a

Population size, breeding distribution, and non-breeding distribution are based on quantitative information. Population trend, threats to breeding population, and threats to non-breeding population are based on qualitative information. All factors are scaled from 1-5, with 5 indicating the greatest vulnerability. Least bitterns, black rails, and Sandhill cranes are not covered in Version 1 of the NAWCP. Others sources (cited in text) are used to determine conservation threats.

Conservation Objectives for Waterbirds

Without population goals on which to base habitat objectives, the JV's approach was to identify factors believed to be limiting populations, and to target conservation strategies that counter these limiting factors. The JV used a two-step process to develop conservation objectives. First, biologists developed quantitative (i.e., acre) habitat objectives for each of five principal waterbird habitats and distributed them among each waterbird planning region. Secondly, they provided qualitative focal species conservation recommendations.

Habitat Objectives and Distribution

Principal waterbird habitats in the Central Valley include both "natural" habitats like seasonal wetlands, semi-permanent and permanent wetlands, and riparian habitat as well as agricultural habitats like rice, other cropland and irrigated pasture. Table 8-6 details the recommended distribution of habitats and associated focal species among waterbird planning basins. Conservation objectives are general in nature (i.e., acres of semi-permanent wetlands) and do not account for micro-habitat needs or specific best management practices for focal species. The JV's approach for establishing conservation varies by habitat as described below. For some habitats, acreage objectives were developed based on a 25-33% increase over current rates of restoration. These objectives are believed to be realistic, but will require a substantial effort on the part of JV partners to deliver over the next five years. In general, objectives for natural habitats (i.e., wetlands, riparian) are for new habitat while agricultural habitat objectives seek to maintain current conditions. Table 8-4 provides a quick reference to habitat associations, and Table 8-5 summarizes conservation objectives for waterbirds.

Table 8-4. Seasonal habitat use by focal waterbird species in the Central Valley of California.

Habitat	*Breeding*	*Non-Breeding*
Seasonal Wetlands		Snowy egret, White-faced ibis, Sandhill crane
Permanent/ Semi-permanent Wetlands	Western grebe, Black tern, Black rail, White-faced ibis, Least bittern	Black rail, Snowy egret, White-faced ibis
Rice	Black tern, White-faced ibis, Least bittern)	Sandhill crane, White-faced ibis
Irrigated Crop & Pasture		Sandhill crane, White-faced ibis
Riparian	Snowy egret	Snowy egret

Table 8-5. Five-year conservation objectives for breeding and non-breeding waterbirds in the Central Valley of California.

Waterbird Planning Region	*Seasonal Wetlands (Acres)*	*Semi-Perm Wetlands (Acres)*	*Rice (Acres)*	*Riparian (Acres)*
Sacramento Valley	43,000[1]	1,000	276,000[1]	2,800
Delta	22,000[1]	1,000	31,000[1]	1,100
San Joaquin	20,000[1]	1,500		1,000
Tulare	19,000[1]	1,500		100
Total	**104,000[1]**	**5,000**	**307,000[1]**	**5,000**

[1] *Acre needs are not additive to those reported in Chapter 4 for wintering waterfowl.*

Seasonal Wetlands

Seasonal wetlands provide important habitat for non-breeding snowy egrets, white-faced ibis, and associated waterbirds. Habitat objectives for wintering waterfowl include restoration of 104,000 acres of seasonal wetlands. The JV assumes that these seasonal wetlands will provide the range of micro-habitats needed by a range of waterbirds and that resource competition between waterbirds and waterfowl using seasonal wetlands is negligible. Therefore, no additional habitat objectives for seasonal wetlands are proposed.

Semi-permanent Wetlands

The objective of 5,000 acres of restored semi-permanent wetlands was established to benefit breeding black rails, black terns, white-faced ibis, western grebe, and least bittern; and non-breeding snowy egrets and white-faced ibis. For habitat tracking purposes, semi-permanent and permanent wetlands have been combined, and are hereafter referred to as semi-permanent wetlands. Collectively, these wetlands currently comprise 15% of the total wetland base in the Sacramento Valley and Delta Planning Regions, and 10% of the wetland base in the San Joaquin and Tulare Basins. Waterbird habitat objectives have been adjusted to increase the apparent relative shortfall in semi-permanent wetlands in the two southernmost regions. The objective of 5,000 acres represents a 33% increase over current rates of restoration for semi-permanent wetlands, to include 1,000 acres in both the Sacramento Valley and Delta Planning Regions and 1,500 acres in both the San Joaquin and Tulare Basins.

Rice

Rice fields provide important habitat for breeding black terns and white-faced ibis and for wintering white-faced ibis and Sandhill cranes. Habitat objectives for wintering waterfowl include enhancement of 170,000 acres of rice by winter flooding. Similar to seasonal wetlands, negligible resource competition is assumed between these waterbirds and wintering waterfowl. Therefore, no additional habitat objectives for rice are proposed.

Cropland and Irrigated Pasture

Irrigated cereal grains, alfalfa, and pasture provide the primary foraging habitat for wintering Sandhill cranes in the Central Valley. Foraging habitat is threatened by a number of factors including urbanization, conversion to orchards and vineyards, and other changing agricultural practices. These habitats are especially at risk in the Delta Planning Region, an area of traditionally high use by wintering Sandhill cranes, and the region where estimates of irrigated cropland loss (18.3% by 2040) and human population growth (> 2 million by 2040) are highest. Sandhill cranes show high site fidelity to roost sites and are slow to colonize new roosting areas. Therefore, conservation objectives for cropland and irrigated pasture include the acquisition of agricultural easements on suitable foraging sites within three miles of nocturnal roost sites (Littlefield and Ivey 2000).

Native pasture, Folsom
Photo: Dale Garrison, USFWS

Riparian

Restoration of riparian habitat, especially in proximity to foraging areas is a high priority need for breeding and non-breeding snowy egrets and associated species. The objective of restoring 5,000 acres of riparian habitat represents a 25% increase over current rates of restoration. Most of the remaining riparian habitat and a large percentage of restored riparian habitat occur in the Sacramento Valley and Delta Planning Regions. Because the San Joaquin and Tulare Basins collectively comprise about 18% of the existing riparian habitat in the Central Valley, the JV adjusted habitat objectives to attempt to make up for the apparent shortfall in the southern Central Valley by allotting acreage objectives as follows: Sacramento Valley-1,000 acres, Delta-1,000 acres, San Joaquin-1,500 acres, Tulare-1,500 acres.

Focal Species Conservation Recommendations

Some conservation practices are applicable to many focal species. For example, favorable water management regimes are critical for successful breeding of most waterbirds. Waterbird survival and productivity can be increased by stabilizing water levels during the nesting season to protect nests from flooding, and by implementing the appropriate timing of drawdown in semi-permanent wetlands. Information below provides conservation recommendations specific to individual focal species. Project managers are considered best equipped to make decisions regarding site-specific application of practices geared towards specific focal species. An overview of habitat requirements and conservation actions for each focal species is provided to assist planners and managers in their efforts to integrate waterbirds with other conservation programs. Table 8-6 summarizes conservation needs of focal species. Many other species receive benefits from conservation actions undertaken for focal species, though no attempt was made to compile a list of all such species. When appropriate, specific birds of conservation interest [i.e., tricolored blackbird *(Agelaius tricolor)]* or species that are taxonomically similar (i.e., Clark's grebe, western grebe) that may receive benefits are mentioned.

Table 8-6. Summary of conservation needs of focal waterbird species of the Central Valley Joint Venture.

Focal Species	*Conservation Need*	*Planning Regions*
Western grebe	Stabilize water levels during breeding; protect nesting areas from disturbance.	Sacramento Valley
Snowy egret	Restoration and enhancement of riparian habitat in proximity to riceland and wetland complexes.	All
Least bittern	Enhancement and restoration of dense emergent (primarily cattail) permanent and semi-permanent wetlands.	Sacramento Valley, Delta, San Joaquin
White-faced ibis	Enhancement and restoration of permanent and semi-permanent wetlands and securing water for established nest colony sites.	Sacramento Valley, Tulare
Black tern	Protection, restoration and enhancement of large permanent/semi-permanent wetlands or wetland complexes with short to medium height vegetation [12-20 ha. (~30-50 acres) Min.].	All
Black rail	Protection, restoration and enhancement of permanent/semi-permanent wetlands and similar protection and restoration of upland habitats for escape cover during flood events.	Delta, Sacramento Valley
Sandhill crane	Protection, restoration and enhancement of seasonal wetlands in proximity to foraging habitat, esp. rice, cereal grains, irrigated pasture and alfalfa. Protection of roosts and nearby foraging habitat.	All

Western grebe

Western grebes nest colonially on floating vegetation in or near sparse emergent habitat, usually hardstem bulrush, adjacent to open water. During winter, open water in the Central Valley serves as resting and foraging habitat for these birds. Recommended conservation activities for breeding birds include reducing water fluctuations and protecting nesting areas from disturbance. Specific conservation actions for this species at the Thermolito Afterbay, below Lake Oroville, (and for other sites in California) are described in Ivey (2004). Clark's grebes will also benefit from conservation activities implemented for western grebes.

Snowy egret

Snowy egrets nest colonially in riparian habitats with dense woody vegetation, as well as in permanent and semi-permanent wetlands with dense emergent vegetation (Zeiner et al. 1990, Parsons and Master 2000). Ideal nesting sites offer nearby foraging habitat, therefore restoration and enhancement of riparian habitat in proximity to riceland and wetland complexes is the primary conservation need. Snowy egrets associate with other colonial wading bird species during breeding and foraging activities (Parsons and Master 2000). Specific objectives include the restoration of 5,000 acres of riparian habitat distributed among the following waterbird planning regions: Sacramento Valley-2,800 acres; Delta-1,100 acres; San Joaquin-1,000 acres, Tulare-100 acres. These regional goals are based on the proportion of potential restorable riparian habitat among the four planning regions.

Least bittern

Least bitterns differ from other members of the heron family found in the Central Valley as they rarely nest or perch in trees (Zeiner et al. 1990), preferring instead to breed in dense emergent cattail marsh. Conservation of this habitat type is the primary conservation need for least bitterns in the in the Central Valley. Both least and American bitterns are generally solitary nesters and interaction between the two species while feeding or nesting is rare. American bitterns generally prefer slightly less densely vegetated and somewhat shallower wetlands for breeding and foraging (Gibbs et al. 1992) but will also nest in uplands (M. Wolder, United States Fish & Wildlife Service, personal communication). Though each species prefers different microhabitats, both are commonly found within the same wetlands, and actions benefiting least bitterns should also benefit American bitterns.

White-faced ibis

White-faced ibis
Photo: Dale Garrison, USFWS

White-faced ibis breed colonially in shallow permanent and semi-permanent wetlands in the Central Valley, often nesting in "islands" of emergent vegetation (Ryder and Manry 1994). They forage in flooded rice fields, flooded or partially flooded pastures, and cropland, especially alfalfa at all times of the year (Ryder and Manry 1994). During winter, white-faced ibis forage in seasonal wetlands and roost in both semi-permanent and seasonal wetlands. Enhancement and restoration of permanent and semi-permanent wetlands is a priority conservation action for white-faced ibis. Obtaining reliable water for established colonial nesting sites is an important conservation strategy for this species (Ryder and Manry 1994). Enhancing emergent growth in permanent or semi-permanent wetlands adjacent to rice or irrigated alfalfa may benefit tricolored blackbirds as well.[1]

Black tern

Black terns breed widely in the Sacramento Valley almost exclusively in rice fields, and locally in rice fields in Merced and northern Fresno counties within the San Joaquin Basin. They rarely breed elsewhere and if so, mainly in ephemeral habitat (D. Shuford, personal communication). Breeding habitat use is different in the Central Valley than in much of the range, where they nest in permanent and semi-permanent wetlands (Shuford et al. 2001). Black terns are somewhat area sensitive during the breeding season, selecting wetlands or wetland complexes with a minimum size of 12-20 ha (~30-50 acres). Top conservation actions for black terns include protecting and restoring wetland habitat, and adapting wetland management practices to integrate optimal black tern habitat with the needs of other wetland dependent birds (Shuford 1999).

Black rail

Black rails breed and winter in higher parts of tidal marshes, freshwater marshes, and wet meadows within portions of the Delta Planning Region. Recent discoveries of black rails in Butte, Yuba, and Nevada counties may provide conservation opportunities in small wetland areas along the base of the foothills in the Butte and American Basins. Black rails will utilize habitats with shallower water regimes than other rails, and will tolerate some degree of flooding, provided that suitable upland escape cover is available during flood events (Eddleman et al. 1994). Conservation needs include protection, restoration, and enhancement of wetlands in the Delta Planning Region, and similar protection and restoration of upland habitats that serve as vital escape cover during flood events.

[1] *Tricolored blackbirds are a high profile, priority species at state and federal levels, and are the focus of conservation efforts supported by many JV partners. The white-faced ibis is considered a suitable umbrella species for this species in wetland habitats, as they overlap in their nesting requirements, and to some extent in foraging habitat as well. Tricolored blackbirds nest in the same emergent marshes as white-faced ibis, and forage in adjacent rice fields and irrigated alfalfa. Although tricolored blackbirds are not a focal species in this plan, the JV is a partner in the conservation of this species and will work to implement conservation measures on public and private lands as they are more fully developed.*

Lesser Sandhill cranes
Photo: Dale Garrison, USFWS

Sandhill crane

Sandhill cranes populating the Central Valley include both the greater Sandhill crane (G.c. tabida) and lesser Sandhill crane (G.c. canadensis). The greater Sandhill crane is listed as threatened under the California Endangered Species Act, while the lesser Sandhill crane is considered a Bird Species of Conservation Concern by the State of California. Both greater and lesser Sandhill cranes roost in shallow seasonal wetlands and forage in cropland and irrigated pasture (Tacha et al. 1994). Conservation of key roosting wetlands and protection and enhancement of irrigated cropland for foraging habitat are the greatest conservation needs for Sandhill cranes in the JV (Tacha et al. 1992, Littlefield and Ivey 2000). Suitable foraging habitats include a variety of crop types. Grain fields are of foremost importance as they provide a ready source of high-energy carbohydrates (rice, corn, wheat, barley, oats, rye, sorghum, buckwheat, etc). Legume crops (e.g., beans, peas) irrigated pasture, alfalfa and seasonal wetlands also provide foraging habitat and are sources of proteins which can be limited in grain crops. Lesser Sandhill cranes are particularly attracted to alfalfa fields. Due to the reliance on agricultural lands for foraging habitat, agricultural easement focus areas are recommended for each waterbird planning region. The JVs Agricultural Wildlife Enhancement Committee should place particular emphasis on the northeast Delta and Cosumnes River/Stone Lakes National Wildlife Refuge portions of the Delta Planning Region. Ivey (2005; also see Littlefield and Ivey 2000) provides specific conservation and management information for Sandhill cranes in each waterbird planning region.

Sacramento Regional County Sanitation District's Bufferlands
Photo: Brian Gilmore

Chapter Nine: BREEDING RIPARIAN SONGBIRDS

This chapter provides quantified population and habitat objectives for riparian songbirds in the Central Valley, and is based on a suite of focal bird species that breed primarily in riparian habitat.

Introduction

Over 225 species of birds, mammals, reptiles, and amphibians depend on California's riparian habitats. The Central Valley provides essential breeding and wintering habitat, migration stopover areas, and corridors of dispersal for riparian-associated songbirds (Cogswell 1962, Gaines 1977, Humple and Geupel 2002, Flannery et al. 2004, Fleskes et al. 2005). Sixty-two species of songbirds have regularly bred in Central Valley riparian areas over the last 13 years (PRBO Conservation Science unpublished; see Ballard et al. 2003 for criteria used). Riparian vegetation is vital to the quality of in-stream habitat. It significantly promotes the aquatic food chain by providing shade, food, and nutrients, (Jensen et al. 1993) thus providing food resources for migratory songbirds as well.

While riparian habitat makes up less than 0.5% of California's total land area (approximately 360,000 acres; CDF 2002), decades of research indicate that riparian habitat supports ecosystem integrity and function across landscapes (Sands 1977, Katibah 1984, Faber 2004, RHJV 2004). Over 98% of riparian habitat in the Central Valley has been lost or severely degraded in the past 150 years (Smith 1977, Katibah 1984). Riparian habitat loss may be the most important cause of population declines among songbird species in western North America (DeSante and George 1994), including the decline and extirpation of many riparian species formerly common in the Central Valley.

> "California's semi-arid Central Valley harbors the largest rivers in the state, areas that are vitally important to riparian birds and a multitude of other species. These rivers are to the health of the larger watershed what arteries are to the human body. When degraded, the entire system is put at risk, but when rehabilitated, a richness of life is conserved."
>
> **Gregory Golet, Ph.D.**
> *Senior Ecologist*
> *The Nature Conservancy*

Riparian habitats are transitional areas between terrestrial and aquatic ecosystems. In the Central Valley and lower foothills of the Cascade, Sierra Nevada, and Coast ranges, these habitats occur along streams, ranging from swift rapids and waterfalls of steep canyons to slow moving water in floodplains of the Central Valley floor. Riparian vegetation is structurally complex and may contain a canopy, subcanopy, and understory layers. Dominant trees include valley oak, cottonwood, California sycamore, box elder, and Oregon ash. Shrub layer plants include willows, wild grape, wild rose, California blackberry, blue elderberry, poison oak, and buttonbush. The herbaceous layer is diverse.

Broad-scale interest in songbird conservation began in December of 1990 with the advent of Partners in Flight (PIF). PIF is a voluntary international coalition formed in response to growing concerns about declining populations of neotropical migrants across North America. Its expanded mission now includes all songbirds and seeks to help species at risk, keep common birds common, and promote voluntary partnerships on behalf of birds, habitat, and the public. Recently, PIF synthesized a continental perspective on conservation priorities with *The North American Land Bird Conservation Plan* (Rich et al. 2004). Species, habitat, geographic priorities and global population estimates for all songbirds in North America north of Mexico are included in the plan. Population size estimates are important conservation tools and innovative approaches to population estimates for songbirds have been developed by Rosenberg and Blancher (in press); a similar approach is used here. Survey data from the North American Breeding Bird Survey (Robbins et al. 1986) were used to derive estimated global populations (Rich et al. 2004) and regional population estimates (Rosenberg and Blancher in press, Bart in press). The use of this approach will allow future investigations to compare how population estimates presented in this chapter contribute to continental objectives presented by Rich et al. (2004) and future regional objectives [e.g., by Bird Conservation Region (BCR); U.S. NABCI Committee 2000].

This chapter presents populations objectives based on a suite of focal bird species that primarily breed in riparian habitat. The suite of species presented here is unique among many multi-specie planning efforts, in that it does not focus only on species with threatened and endangered status. Instead species were chosen whose requirements define different spatial attributes, habitat characteristics (e.g., young willows vs. old cottonwoods) and management regimes believed to be representative of a healthy riparian system (Chase and Geupel 2005). Furthermore, thanks to coordinated efforts of many individuals and agencies under the auspices of Partners in Flight, highly standardize methods for collecting data on landbirds (Ralph et al. 1993) have resulted in a wealth of current and comparable information across the Central Valley and the state. (http://www.prbo.org/calpif/htmldocs/riparian.html [Ballard et al. 2003]). This current and repeatable information provides the scientific foundation for the development of biological objectives that guide effective conservation efforts (Pashley and Geupel 2003, Elliot et al. 2003).

The remainder of this chapter is divided into three sections: (1) Use of focal species to establish conservation objectives for breeding riparian songbirds; (2) Methods for setting conservation objectives for breeding riparian songbirds; and (3) Conservation objectives for breeding riparian songbirds in the Central Valley.

Use of Focal Species to Establish Conservation Objectives for Breeding Riparian Songbirds

Basic biological data are not available for all species of riparian-dependent songbirds. Therefore, conservation planners frequently develop management and planning objectives using a single or subset of species, commonly called "focal species," for which biologists have better information, and that represent critical ecosystem and habitat elements. Biological knowledge about these species then guides habitat restoration, enhancement, protection, and evaluation. Biologists assume that the implementation of these recommendations should maintain overall biodiversity (Chase and Geupel 2005). This approach is considered by many conservation biologists as valuable, providing assumptions underlying the choice of focal species that are stated explicitly and subjected to scientific testing (Soulé 1995, Caro and O'Doherty 1999, Poiani et al. 2001, Lindenmayer et al. 2002).

Focal species may be used to guide several components of conservation planning: (1) the selection and design of protected areas or a reserve system; (2) habitat restoration and management; and (3) population monitoring, both of population trends over time and effects of management actions. Planning areas for protection involves selecting which sites should be considered and determining their configuration on the landscape. Thus, the distribution and ecological needs of one or more focal species may be useful in site selection and reserve configuration (Margules and Pressey 2000). However, to ensure the persistence of species, conservation planners must also identify effective forms of habitat restoration and active habitat management to maintain desired conditions. One way to accomplish this is to design restoration and management to benefit multiple focal species. Monitoring is also an essential component of conservation planning, especially when management takes place in an adaptive manner.

Focal species are frequently selected on the basis of their regulatory status (e.g., threatened or endangered), largely because these species have the strongest legal protection. However, species at risk are not necessarily the most effective focal species, due in part to the inability to collect sufficient data to statistically measure population response (Franklin 1994). Several relatively common species (i.e., abundant and widely distributed) are also included as focal species in order to promote greater scientific rigor in statistical design and analysis and to allow conservation actions to be evaluated.

The Riparian Bird Conservation Plan (RBCP; RHJV 2004), a collaborative effort of the Riparian Habitat Joint Venture and California Partners in Flight, was developed to guide riparian conservation in California and provides a critical link between science and habitat management (Golet 2001). It relies on the biological needs of seventeen species that were selected by a consensus of ornithologists based on criteria described below. These species collectively depend on various stages of vegetative succession and/or critical ecosystem elements found in riparian systems (Geupel and Elliott 2001, Golet 2001, RHJV 2004; Figure 9-1). Each species has a detailed, species account summarizing information on conservation needs and management recommendations on the California Partners in Flight web site (http://www.prbo.org/calpif/htmldocs/riparian.html). To produce the *Riparian Bird Conservation Plan* (RBCP; RHJV 2004), species account authors and other resource managers synthesized the recommendations made in the individual species accounts to develop habitat-based recommendations that will influence multiple species. An example is the recommendation to restore and manage riparian forests to increase the volume and diversity of understory. These recommendations may reduce brown-headed cowbird parasitism rates, and provide nest substrate for declining species.

Figure 9-1. Preferred nesting substrates of selected songbird species breeding in California riparian habitat illustrating the diversity of vegetation and structure utilized (RHJV 2004).

Of the seventeen species presented in the RBCP, the JV selected seven focal species to develop its riparian conservation objectives. Six of the seven species (song sparrow [*Melospiza melodia*], yellow-breasted chat [*Icteria virens*], black-headed grosbeak [*Pheucticus melanocephalus*], common yellowthroat [*Geothlypis trichas*], yellow warbler [*Dendroica petechia*], and western yellow-billed cuckoo [*Coccyzus americanus*]) were selected based on the approach used by Chase and Geupel (2005). The seventh species, spotted towhee (*Pipilo maculatus*) was included for a variety of reasons that are discussed in the text below.

Suitable focal species meet at least one of the following criteria:

- Use riparian habitat as a principal breeding habitat in most basins throughout the Central Valley.
- Warrant special management status, or have experienced reduction in breeding range or populations in the Central Valley.
- Are useful for monitoring effects of management actions because they are:

  Abundant in riparian habitats throughout the Central Valley or basin (i.e., provide adequate sample sizes for statistically valid analyses).

  Amenable to monitoring (e.g., nests can be found and adults are tolerant of researcher disturbance).

  Indicate quick, strong and/or consistent responses to habitat management or restoration.

The following species descriptions are based upon RBCP species accounts (http://www.prbo.org/calpif/htmldocs/riparian.html) and new information presented later in this chapter.

Song sparrow

The estimated current populations of song sparrows in riparian habitat of the American, Butte, Sutter, Colusa, and Yolo Basins are exceptionally low (< 1000 pairs per basin). Creating suitable habitat (emergent dense understory) within and adjacent to riparian zones for this species should be a high priority in these basins. Populations of song sparrows in the Delta, San Joaquin, and Tulare Basins are much more abundant. In these basins song sparrows are generally found in newly restored riparian sites within two years of restoration.

Yellow-breasted chat

Although once common throughout the Central Valley, the yellow-breasted chat (a California Species of Special Concern) has declined considerably in recent years. Central Valley populations appear highest in American, Butte, Colusa, Sutter and Yolo Basins. Only the Butte Basin has a current population estimate of more than 1,000 individuals. This species prefers low, extremely dense riparian thickets. Thus, projects that focus on restoring woody shrubs–especially large patches of native blackberry—in the riparian forest understory should facilitate recovery of this species in these basins and possibly in the Delta Basin along the Cosumnes and Mokelumne rivers.

Black-headed grosbeak

Black-headed grosbeaks are relatively common throughout the American, Butte, Colusa, Sutter and Yolo Basins. Highest densities of existing populations occur in the Butte and Colusa basins, where appropriate conservation actions may significantly increase populations. In contrast, populations within Delta, San Joaquin, and Tulare Basins occur in much lower densities and are not likely to respond as well to conservation actions. Black-headed Grosbeaks are excellent indicators of a healthy riparian forest sub-canopy and will respond significantly to restoration within 5 years (Figure 9-2, Gardali et al. in press).

Common yellowthroat

Although this species may be locally common, its overall population size remains low throughout the year in the Central Valley. Common yellowthroats prefer the ecotone between wetland habitats and riparian forest edges. This species may respond rapidly to restoration (normally within 2 years) and may increase with conservation efforts targeted near existing populations in the Colusa, Delta, and San Joaquin Basins.

Yellow warbler

Yellow warbler (a California Species of Special Concern) populations are exceedingly low and have been extirpated in most basins of the Central Valley. Recent re-colonization of a few pairs along the main stem of the Sacramento River (in Butte Basin) and a new and increasing population (14 pairs in 2004) within the San Joaquin River National Wildlife Refuge (in San Joaquin Basin; Wood et al. 2005) suggest that the species may be returning to historical breeding sites in the Central Valley. A short-term goal should be to establish a minimum of 100 pairs each in the American, Butte, Colusa, Sutter, Delta, and San Joaquin Basins. They have been known to respond quickly to restoration in riparian forest understory through fencing or planting, and in areas managed for dense willow cover near water (Wood et al. 2001, Krueper et al. 2003).

Western yellow-billed cuckoo

The current western yellow-billed cuckoo population is about 60 to 100 pairs statewide (Halterman et al. 2001), with the only increase recorded in the western United States occurring in the Sacramento Valley (Halterman et al. 2003). This increase is likely an artifact of new sampling methodologies and the recent discovery that the species will nest in restored riparian habitat as young as

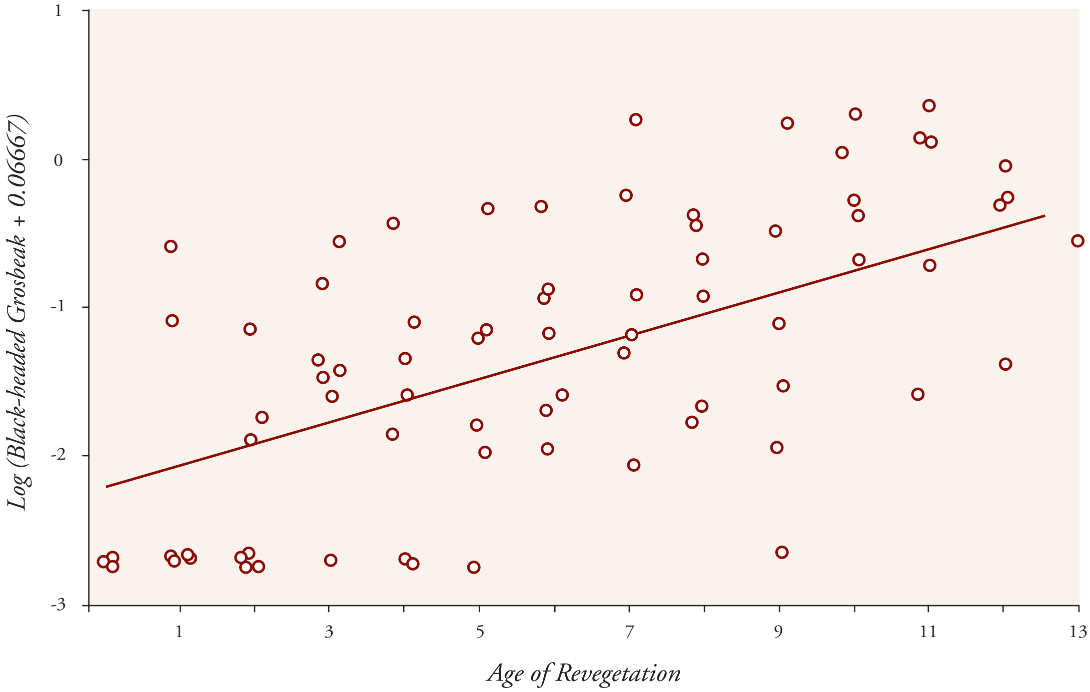


Figure 9-2. Black-headed grosbeak trend in response to age of restoration on the Sacramento River. Trend (%) = 15.72, 95% CI = 9.12 - 22.73. $P < 0.0001$, R2 = 0.65. (from Gardali et al. 2006).

eight years old (Small et al. 1999). Considering the number of acres that have been restored in the Butte and Colusa Basins (including the Sacramento River), populations may continue to increase. The RBCP recommends restoring habitat in 25 locations to support 625 pairs (25 pairs per location). Simulation modeling indicates that populations of less than 10 pairs have a high probability of being ephemeral (RHJV 2004). At least 25 pairs in a subpopulation and corridors to other subpopulations may prevent local extirpations. Since territory size for a pair averages 20 to 25 hectares[1] (a minimum of 10 hectares), the optimal goal for each population is to protect and restore habitat in minimum 20-hectare patches that collectively total 500 hectares within a watershed or stream section. Yellow-billed cuckoos have used willow-cottonwood habitat of any age with high humidity and a habitat breadth of 325 feet (100 m) (Gaines and Laymon 1984). Nesting groves at the South Fork Kern River are characterized by higher canopy closure, higher foliage volume, intermediate basal area, and intermediate tree height when compared to random sites with less than 40% canopy closure are unsuitable, those with 40%-65% are marginal to suitable, and those with greater than 65% are optimal (Laymon 1998).

[1] Hectares are used as a unit of area measurement in this chapter, since most riparian research is reported in metric units. One hectare equals 2.47 acres.

Spotted towhee

Although regularly found in habitats other than riparian, the spotted towhee *(Pipilo maculatus)* was included due to its common and wide spread occurrence in the Central Valley riparian habitats and its usefulness for monitoring the effects of management actions (Nur 2004). The spotted towhee occurs in relatively high densities in all basins and is an indicator of vigorous ground cover, which is associated with regular flooding events.

Quantifiable population objectives for other riparian species that are known to have (or have had) significant breeding populations in the Central Valley (for example, spotted sandpiper, bank swallow, tree swallow, and blue grosbeak) are lacking because current information on population size is not available or surveys are limited. However current management recommendations for these species are described thoroughly in the RBCP species accounts (http://www.prbo.org/calpif/htmldocs/riparian.html).

Methods for Setting Conservation Objectives for Breeding Riparian Songbirds

Acreage objectives should be derived from estimates of habitat needed to achieve population goals. However, simply achieving acreage objectives does not guarantee that population goals will be met. Surrounding landscape factors also determine whether bird populations respond. Seemingly "suitable" habitat for many riparian species (e.g., yellow-billed cuckoo, yellow warbler and song sparrow) remains unoccupied in many areas of the Central Valley. Thus, the use of numerical population targets provides a useful index of potential change in habitat quality within a dynamic environment where natural and human-mediated disturbances can alter habitat quality quickly (Donovan et al. 2000).

Most songbirds are territorial during their breeding seasons. Thus, data collected from the breeding season are more reliable than data collected during other times of the year. Standardized methods for monitoring abundance (point counts), population size, and density (spot-maps), are established across California (Ralph et al. 1993, Ballard et al. 2003). Thus simple population estimates can be derived by multiplying appropriate estimates (birds per acre) by the area of current available habitat, as mapped by the best available GIS vegetation layers. Population targets may be derived by multiplying an appropriate target density by the area of potentially restorable habitat, also based on GIS-based historic habitat layers.

There are several potential sources of variation associated with this method. The density estimate is influenced by observer bias during surveys, detection probability, differences in habitat quality across sites, annual variation, intrinsic variation in bird habitat selection, and other factors. Therefore a sample variance around each density estimate was calculated.

Population objectives based on monitoring data were developed for six species that commonly breed in the riparian areas of the Central Valley (see above). The method to develop population objectives for the state threatened yellow-billed cuckoo differed from other species due to its small population size and low rate of survey detections. For this species, minimum management goals for populations in each basin were developed using population simulation models (Halterman et al. 2001; RHJV 2004).

These population objectives helped to develop and prioritize riparian habitat objectives for eight of the nine basins in the Central Valley: American, Butte, Colusa, Sutter, Yolo, Delta, San Joaquin, and Tulare. Sufficient data to develop population objectives for riparian species in the Suisun Marsh are lacking.

Inputs Used for Setting Conservation Objectives

Several sources of information serve as inputs for setting habitat objectives for riparian songbirds: (1) existing and restorable riparian habitat; (2) population estimates and targets; (3) recommended values of nest success; (4) species distribution and richness; and (5) annual rates of riparian restoration.

Information on existing and restorable riparian habitat identifies on a regional scale where future restoration projects can have the greatest impact. This information is also the basis for developing population targets and quantifying conservation objectives by basin.

Recommended values of nest success, and species distribution and richness provide a measure of relative habitat quality, and help to determine which conservation actions will have the most impact.

Estimated annual rates of riparian restoration help to develop realistic habitat objectives. A combination of these inputs provides each basin with an importance rank for riparian birds (Table 9-1). This section describes how these factors and rankings were derived and outlines the assumptions made for riparian songbirds in the Central Valley.

Table 9-1. Current and potentially restorable riparian habitat and number of bird point count stations per basin.

Basin	*Valley*	*Current Riparian Acres*	*Potentially Restorable Riparian Acres*	*Total Riparian Acres*	*Proportion of Restorable Riparian Area Currently with Riparian habitat*	*Number of Riparian Point Count Stations*
American Basin	Sacramento	16,364	82,757	99,121	0.20	191
Butte Basin	Sacramento	32,535	143,230	175,765	0.23	146
Colusa Basin	Sacramento	19,708	207,149	226,857	0.10	202
Sutter Basin	Sacramento	3,641	79,378	83,019	0.05	51
Yolo Basin	Sacramento	3,569	68,394	71,963	0.05	121
Delta Basin	San Joaquin	14,840	132,548	147,388	0.11	97
San Joaquin Basin	San Joaquin	12,249	188,394	200,643	0.07	175
Tulare Lake Basin	San Joaquin	7,195	15,835	23,030	0.45	42
Central Valley Totals		**110,100**	**917,687**	**1,027,786**	**0.12**	**662**

[1] JV derived species density estimates in basins with fewer than 30 stations using point count data from the entire respective valley (Sacramento or San Joaquin). These point count sample sizes are 365 and 314, respectively.

Existing and Potentially Restorable Riparian Habitat

Several GIS data sources were combined to produce a single representation of Central Valley riparian habitat (Figure 9-3). The 31-meter grid layer was derived by combining the areas mapped as riparian habitat by one of the following five partially overlapping data sources:

a. California Department of Fish and Game's (CDFG) Central Valley Wetlands layer (from Landsat and Spot images taken from 1986 to 1993)
b. California Department of Water Resources' (DWR) land use layers (developed from 1986 to 1999);
c. California State University's (Chico campus), riparian mapping for the Sacramento River, prepared for the California Bay-Delta Authority, DWR, U.S. Bureau of Reclamation, and CDFG (from aerial photos of varying scale, taken between 1991 and 1998);
d. DWR's riparian vegetation of the San Joaquin River for the San Joaquin River Riparian Habitat Restoration Program (from 1998 aerial photos); and
e. Jones & Stokes' riparian vegetation mapping for Placer County (based on 2002 aerial photos).

Merging all areas classified as riparian habitat by at least one of these layers likely represents a liberal estimate of current riparian forest and shrub habitat.

The amount of potentially restorable riparian habitat possible in each basin was estimated using historic vegetation map layers compiled by the Bay Institute's Sierra to the Sea mapping project (TBI 1998). This GIS layer, derived from multiple sources represents the historical extent of Central Valley riparian forests and the extent of soil types that likely supported riparian forest before 1800. All habitat types with potential for restoration, including agricultural fields, were totaled as potential riparian habitat. Areas that have been developed and/or urbanized were assumed to be permanently lost as riparian habitat and were excluded from acreage calculations.

Common yellowthroat
Photo: Partners in Flight

For planning purposes, the JV assumed that 110,010 acres of riparian habitat remains in the Central Valley (Table 9-1) based on the GIS data described above. Sutter, Yolo and San Joaquin basins have the least, while American, Butte, and Colusa Basins have the most riparian habitat remaining. These results should be interpreted with caution, as most of this habitat is highly degraded and disconnected from the floodplain. Low species richness (Figure 9-4), poor vital rates, and low abundance of songbirds at many remnant sites reflect the loss of riparian habitat integrity.

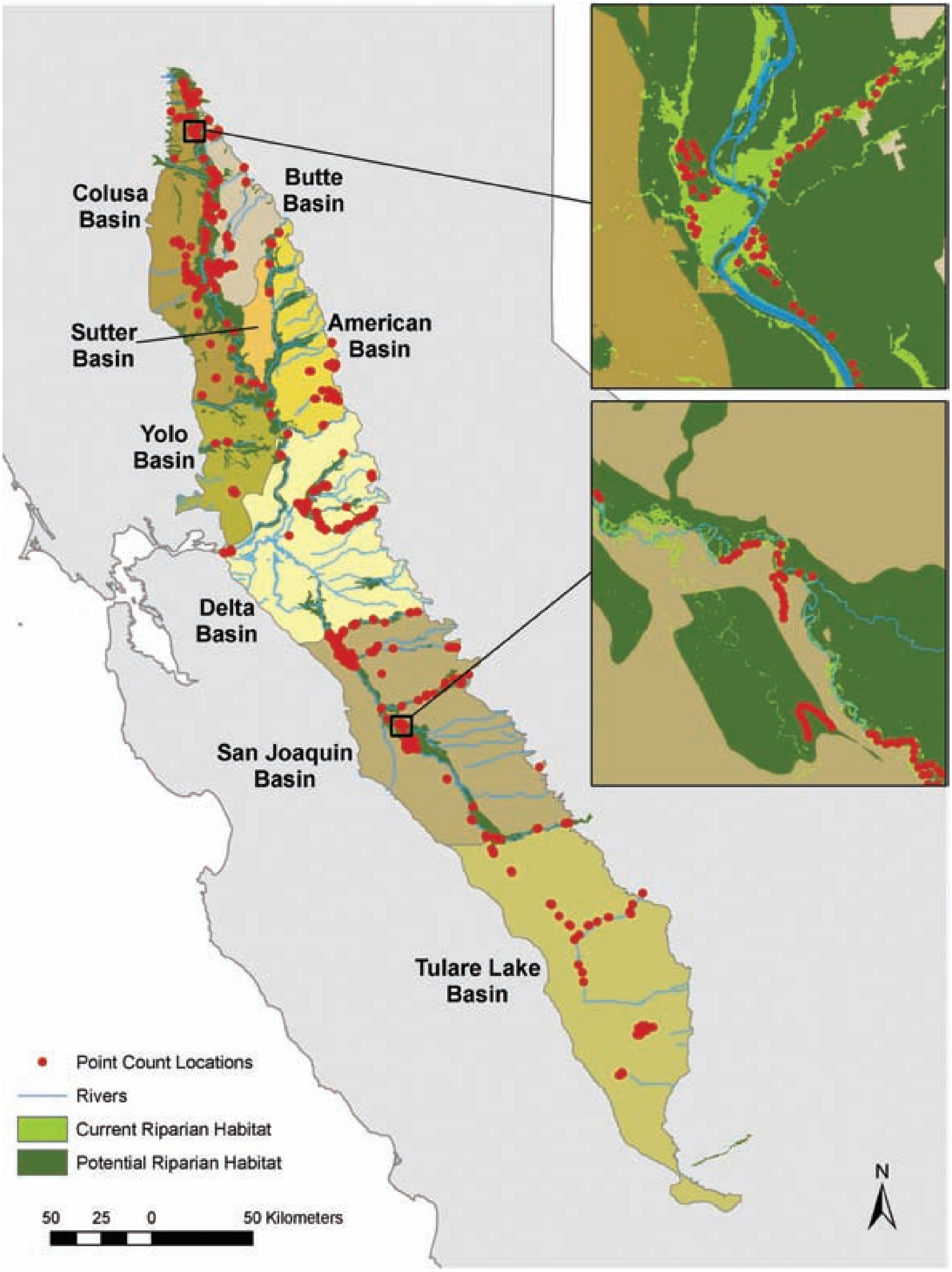


Figure 9-3. Existing and potentially restorable riparian habitat within the Central Valley.

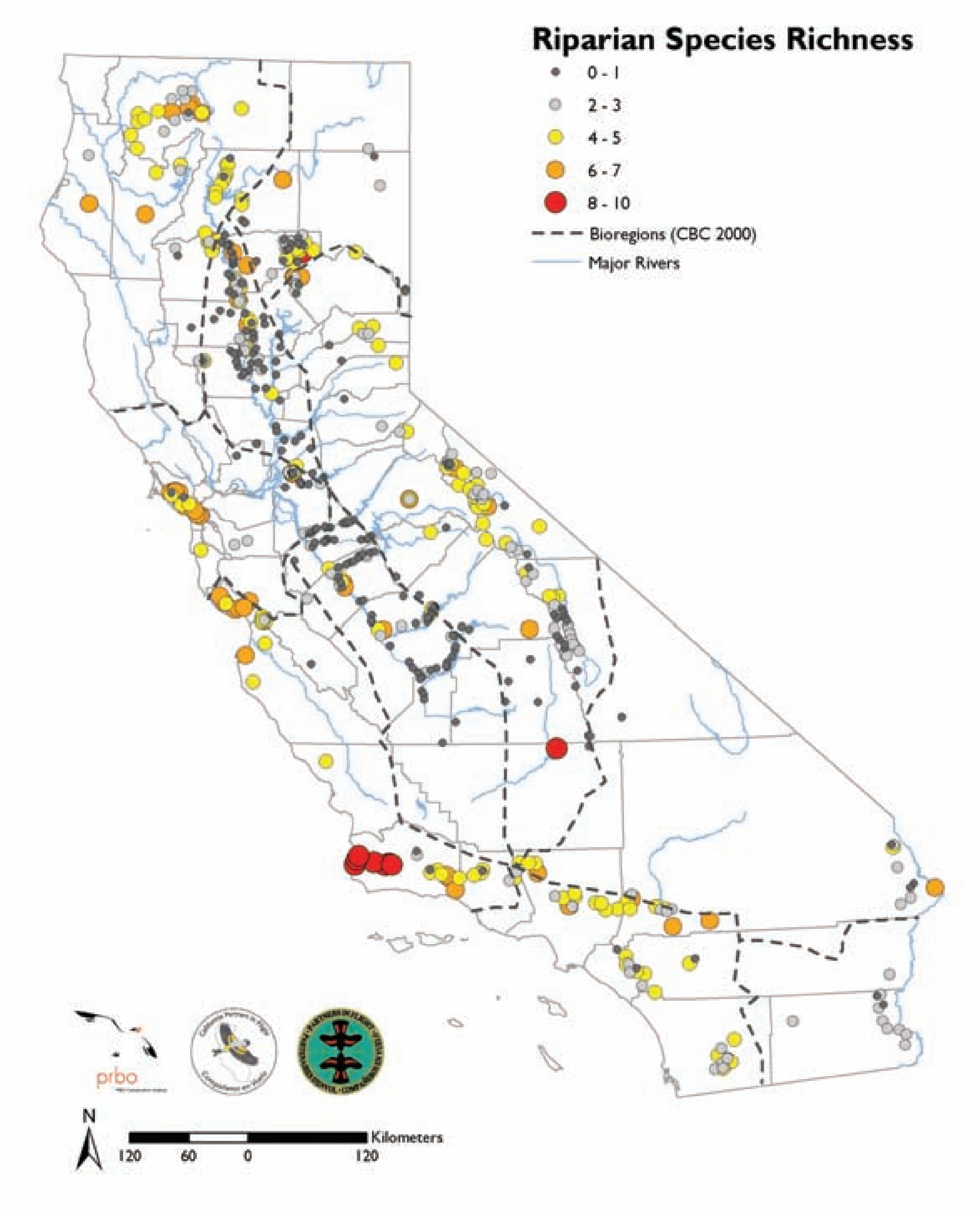


Figure 9-4. Species richness indices for riparian songbirds at sites with standardized bird monitoring in California (from RHJV 2004).

Population Estimates and Targets

Population objectives are an estimate of potential population size or "targets." Methods used to develop objectives for each focal species are described below.

The current population size of each focal species ("population estimates") was estimated by multiplying basin-specific estimates of bird density by basin-specific estimates of current riparian habitat acres. Density estimates were based on point count surveys conducted between 1994 and 2003 (Small et al. 1999, Gardali et al. 2004). Initial point count-level densities were calculated by dividing the number of detections within 50 meters by the area of the 50-meter radius circle (0.785 hectares). To account for detectability differences across species, these point-count level estimates were then multiplied by species-specific detectability coefficients derived by comparing more accurate, but spatially limited, spot-map data with overlapping point count data (Table 9-2). Mean adjusted densities (± standard error) were calculated for each the five basins with sufficient point count stations (n>30); overall means for the entire Sacramento and San Joaquin valleys were used to estimate densities in basins with fewer than 30 point count stations.

Table 9-2. Detectability coefficients derived from sites where point counts overlaid spot-mapping plots ('double sampling') Values = point count-derived birds per hectare divided by # of spot-map-derived birds per hectare.

Species	*Value*
Song sparrow	1.33
Spotted towhee	1.55
Yellow-breasted chat	2.93
Black-headed grosbeak	1.06
Common yellowthroat	1.17

The potential population size of each focal species ("population target") was estimated using a similar approach as for current populations, but using historic vegetation layers rather than current vegetation layers. Estimates of potentially restorable habitat in each basin were based on historic vegetation map layers corrected for habitat permanently lost to urban development (Table 9-1).

If sufficient, data from basin-specific or valley-specific point count surveys were used to estimate potential densities; otherwise (for song sparrows and yellow warblers), spot-map densities from a reference study site with good quality habitat (Cosumnes and Clear Creek, respectively) were used instead. To develop population targets, potential density estimates were based on the 75th percentile of the survey data instead of the mean (used for current density estimates). Use of the 75th percentile assumed that future densities would more appropriately be based on high quality, rather than currently degraded, riparian habitat, and assumed that high densities equate to high quality habitat (Bock and Jones 2004). As with current density estimates, detectability coefficients (Table 9-2) provided target populations, as in the following formula:

Target population = (potential habitat x potential density), where potential habitat is current habitat plus restorable habitat and density is corrected by an appropriate detectability coefficient.

Figures 9-5 to 9-8 represent potential population change in each basin if all potential habitat was restored. Certain basins have higher potential for specific species (e.g., black-headed grosbeaks in the Colusa Basin).

The process to develop population objectives for the state threatened yellow-billed cuckoo differed from other species due to its exceptionally low current population size and difficult sampling methodology. Instead, a minimum management goal for populations in each basin was established (Table 9-3).

Table 9-3. Minimum management goals for subpopulations, pairs, and reforestation of suitable habitat, based on 40 hectares per pair, for western yellow-billed cuckoos. (from RHJV 2004).

Locality	*Subpopulations*	*Number of Pairs*	*Current Suitable (hectares)*	*Reforestation Suitable (hectares)*
Sacramento River	6	150	2,370	3,700
Feather River	1	25	240	770
Stanislaus River	1	25	240	770
Cosumnes River	1	25	0	1,010
Merced River	1	25	0	1,010
Kings River	1	25	0	1,010
Mendota	1	25	0	1,010
Total	**12**	**300**	**2850**	**9,280**

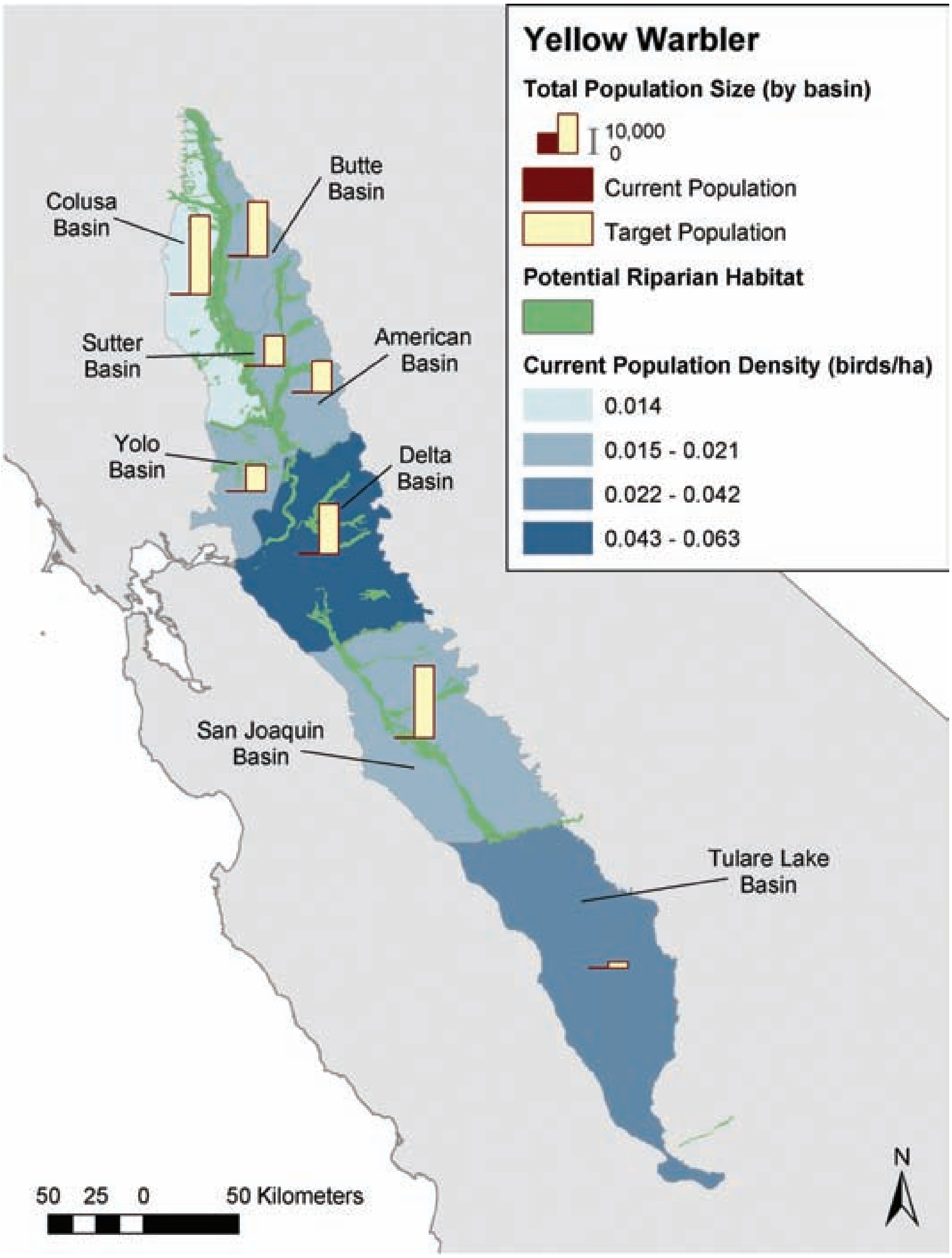


Figure 9-5. Yellow warbler current populations and targets.

Recommended Values of Nest Success

Population growth models require measures of survival and productivity as inputs. These are often referred to as vital rates. A critical vital rate in modeling population growth (lambda) is nest success. By including a nest success objective, the persistence of a population can be gauged, thereby providing a link between population size and habitat condition (Martin 1995, Sherry and Holmes 2000). Bird density may be a misleading indicator of habitat quality (Van Horne 1983 but see Bock and Jones 2004). Thus, setting target values for specific demographic parameters (primarily nest success and adult survivorship) will provide a more meaningful biological objective and thereby ensure better habitat quality and a higher probability of conservation success. Reproductive success and adult survival are key parameters used in population models (Pulliam 1988, Faaborg 2002).

To determine whether a population is growing or declining, the value of population change (lambda) generated from the following equation needs to be greater than one:

Lambda = Adult survival + ([number of nestlings/successful nest] x nest success x number of nest attempts x juvenile survival)/2.[1]

Estimates for nest success and adult survivorship for the spotted towhee and black-headed grosbeak are based on data from the Sacramento Valley (Geupel et al. 1997, Small et al. 1999, Gardali and Nur 2006). Nest success estimates for song sparrows are based on Central Valley data and over 20 years of data from coastal California (Chase and Geupel 2005). Other values for nest success are presented in Table 9-4.

For song sparrows in the Central Valley, nest success has ranged from 5% to 28%, with an average of 16%. This suggests that at most locations in the Central Valley, song sparrows are not producing enough young to keep up with annual mortality and will likely continue to decline in the absence of immigration. To achieve lambda of over 1.0, nest success would need to be at least 27%, thus 25-30% is the recommended value of nest success for song sparrows (Table 9-4). Recommended values for black-headed grosbeaks and spotted towhees are also presented in Table 9-4. With more ongoing demographic monitoring throughout the Central Valley (in the form of nest monitoring and constant-effort mist netting), data for more species will likely be available in the near future (Gardali et al. 2004).

Table 9-4. Observed Mayfield (1975) estimates of survival by planning regions and recommend values of nest success and adult survivorship as determined by source-sink (lambda) models.

	OBSERVED NEST SUCCESS				
Species	*Sacramento Valley*	*Delta*	*San Joaquin Valley*	*Recommended nest success*	*Recommended adult survival*[5]
Yellow warbler	0.32[1]		–	–	–
Common yellowthroat	–		0.63[3]	–	–
Spotted towhee	0.28[2], 0.05[1]		0.43[3]	0.25 to 0.35	0.50 to 0.60
Song sparrow	–	0.28[4]	0.58[3]	0.25 to 0.30	0.50 to 0.60
Black-headed grosbeak	0.27[2], 0.33[1]		–	0.50 to 0.60	0.60 to 0.70

[1]*Wood et al. 2001 (Clear Creek),* [2]*Small et al. 1999 (lower Sacramento River),* [3]*Haff et al. 2001 (Consumes River)*
[4]*Hammond and Geupel 2000 (Cosumnes River),* [5]*Gardali and Nur 2006.*

Species Distribution and Richness

The occurrence and persistence of a high diversity of focal species provides an indication of high quality habitat and restoration success (Chase and Geupel 2005, Gardali et al. in press, Dobkin et al. 1998). Restoring riparian habitat near existing sites of high species richness should increase the potential for species recolonization. Data on the number of sites with relatively high focal species richness for each basin were examined to help prioritize conservation efforts among basins.

Annual Rates of Riparian Restoration and Enhancement in the Central Valley

Riparian habitat restoration in the Central Valley generally involves planting trees and shrubs in areas where riparian forests have been cleared for agricultural production. The modification of the Central Valley's natural hydrology makes riparian re-establishment very difficult in many areas because natural flooding has been reduced substantially by flood control dams, bank stabilization rip-rap projects, and diversion of natural stream flows for irrigated agriculture. Irrigation, weed control, and maintenance of irrigation infrastructure usually are required for up to three years after initial plantings in order for restoration efforts to be successful. This can be viewed as a form of enhancement. While the JV has not developed separate enhancement goals for riparian habitat, restoration objectives and associated costs presented here include three years of post planting enhancement.

In order to develop habitat objectives that are challenging but realistic, current costs and annual rates of riparian restoration for the Central Valley were examined. Estimates range from $500 to $5,000 per acre for restoring riparian habitat on the valley floor, which commonly entails vegetative plantings and/or restoration by reconnecting the flood plain. Current estimates from groups actively engaged in restoration and enhancement indicate 1,500 to 2,000 acres could be restored and enhanced annually for the next 5 years (7,500-10,000 acres total).

[1] *If the other values are held constant based on actual observed values (from monitoring data in the Central Valley and coast) the value lambda is less than 1; 0.60 (adult survival) + (2.82 (number of nestlings) x 16% (mean of observed estimates of nest success) x 2.20 (number of nest attempts) x 0.40 (juvenile survival)) / 2 = 0.79 (Lambda).*

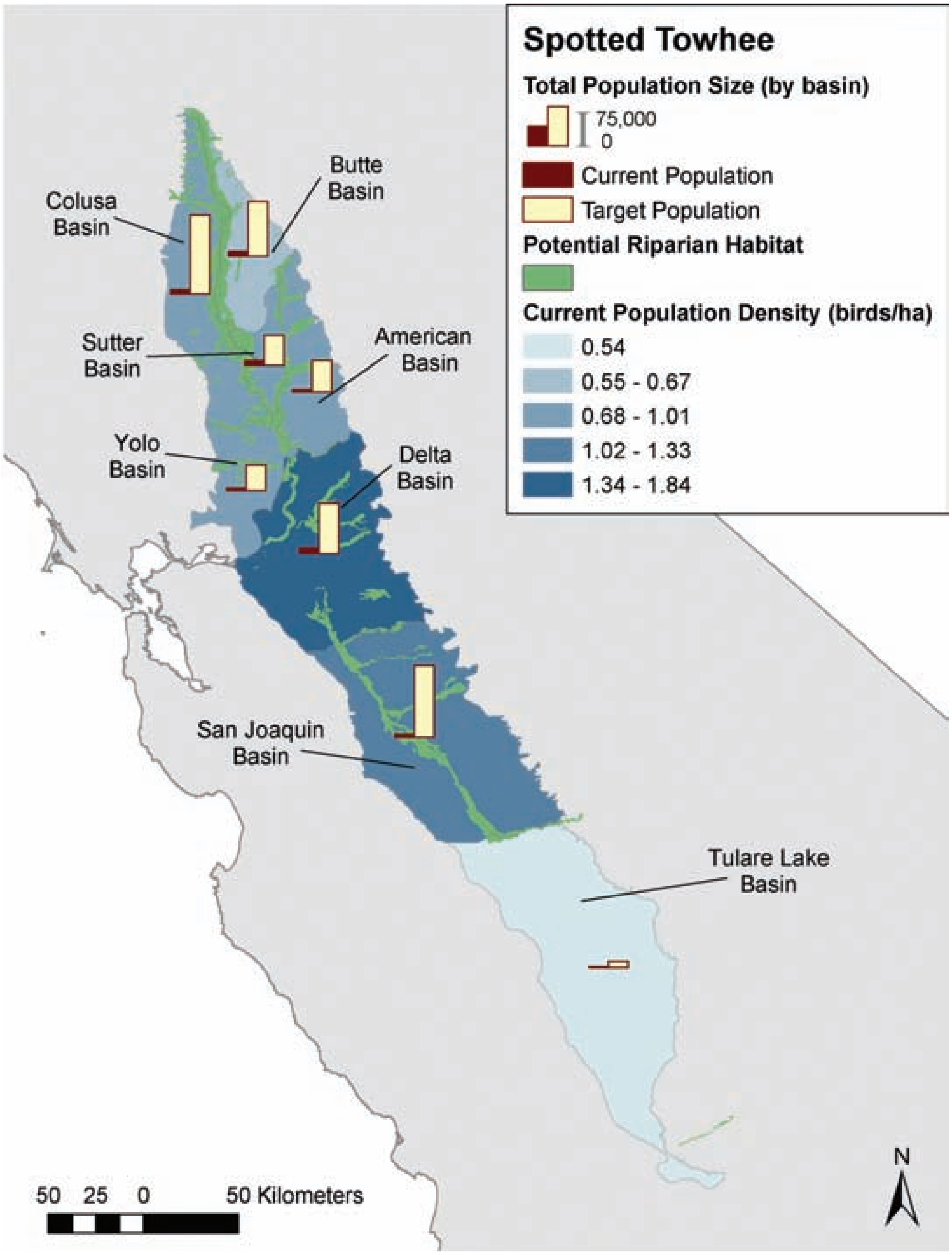


Figure 9-6. Spotted towhee current populations and targets.

Conservation Objectives for Breeding Riparian Songbirds in the Central Valley

Riparian Habitat Objectives

Population targets are based upon total potential habitat, and are considered long term targets. It is unrealistic to expect these targets to be reached in the short term, therefore 5-year objectives for restoration of riparian habitat were developed.


Yellow-breasted chat
Photo: Steve Zach

Table 9-5. Five-year riparian restoration and enhancement objectives for breeding riparian songbirds in the Central Valley.[1]

Planning Region	*Five-year Acre Objectives*
American Basin	675
Butte Basin	1,125
Colusa Basin	1,350
Sutter Basin	675
Yolo Basin	675
Delta Basin:	
Mokulmne River	900
Cosumnes River	600
San Joaquin Basin	2,500
Tulare Basin	200
Total	**8,700**

[1] Sources include The Nature Conservancy, River Partners, Wildlife Conservation Board, U.S. Fish and Wildlife Service, Natural Resources Conservation Service and San Joaquin RCD.

This plan calls for restoring 8,700 acres of riparian habitat for breeding riparian songbirds in the Central Valley over the next 5 years, which is within the 7,500-10,000 acre range of what could be restored and enhanced annually. Conservation objectives for breeding riparian songbirds are listed in Table 9-5. The Delta Basin is further broken down into objectives for the Mokulumne and Consumnes Rivers. The Sacramento Valley has an objective of 4,500 acres, which has been partitioned among its five basins based on the proportion of restorable habitat. Table 9-5 identifies conservation objectives for riparian songbirds by basin.

Population Targets for Focal Species

Tables 9-6 through 9-11 provide population targets for focal species by basin. The difference in bar heights in Figures 9-5 to 9-8 provides an indication of potential change in population in each basin, if all potentially restorable habitat was restored. Certain basins have higher potential for specific species (e.g., black-headed grosbeaks in Colusa Basin).

Table 9-6. Current and potential population densities and population targets for song sparrow.

Basin	*Current Birds/Ha (± SE)*[1]	*Current Population Size (± SE)*	*Target Birds/Acre*[2]	*Target Population Size*
American Basin	0.0493 (± 0.0115)	327 (± 76)	0.40	33,170
Butte Basin	0.0520 (± 0.0216)	685 (± 285)	0.40	57,408
Colusa Basin	0.0299 (± 0.0142)	239 (± 113)	0.40	83,027
Sutter Basin	0.0493 (± 0.0115)	73 (± 17)	0.40	31,816
Yolo Basin	0.0493 (± 0.0115)	71 (±17)	0.40	27,413
Delta Basin	0.7377 (± 0.0764)	4,432 (± 459)	0.68	90,690
San Joaquin Basin	1.161 (± 0.088)	5,757 (± 438)	0.68	128,901
Tulare Lake Basin	1.166 (± 0.196)	3,396 (± 572)	0.68	10,835

[1] Current density estimates were based on PRBO point count data. If a basin contained fewer than 30 point count stations, estimates were derived from all stations in the respective valley (Sacramento or San Joaquin).

[2] Target densities were based on the 75th percentile value of all point counts in each valley, adjusted by a detectability coefficient.

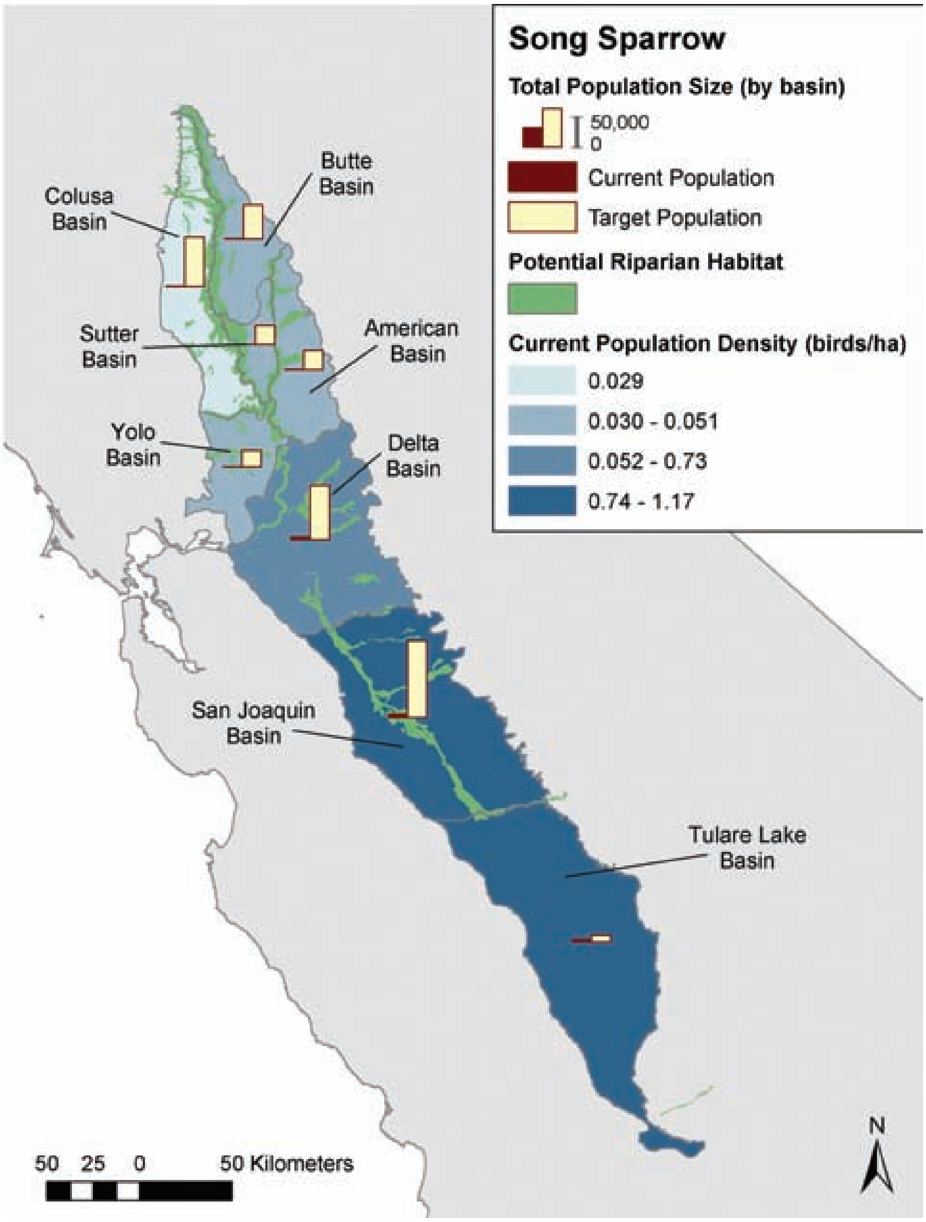


Figure 9-7. Song sparrow current populations and targets.

Table 9-7. Current and potential population densities and population targets for yellow-breasted chat.

Basin	*Current Birds/Ha (± SE)*[1]	*Current Riparian Acres*	*Current Population Size (± SE)*	*Target Birds/Acre*[2]	*Restorable Riparian Acres*	*Target Population Size*
American Basin	0.1377 (± 0.0096)	16,364	912 (± 64)	0.38	82,757	31,160
Butte Basin	0.2104 (± 0.0222)	32,535	2,771 (± 292)	0.38	143,230	53,929
Colusa Basin	0.0465 (± 0.0054)	19,708	371 (± 43)	0.38	207,149	77,995
Sutter Basin	0.1377 (± 0.0096)	3,641	203 (± 14)	0.38	79,378	29,887
Yolo Basin	0.1377 (± 0.0096)	3,569	199 (± 14)	0.38	68,394	25,752
Delta Basin	0.0055 (± 0.0019)	14,840	33 (± 11)	0.21	132,548	28,441
San Joaquin Basin	0.00	12,249	0	0.21	188,394	40,425
Tulare Lake Basin	0.00	7,195	0	0.21	15,835	3,398

[1] *Current density estimates were based on PRBO point count data. If a basin contained fewer than 30 point count stations, estimates were derived from all stations in the respective valley (Sacramento or San Joaquin).*

[2] *Target densities were based on the 75th percentile value of all point counts in each valley, adjusted by a detectability coefficient.*

Table 9-8. Current and potential population densities and population targets for black-headed grosbeak.

Basin	*Current Birds/Ha (± SE)*[1]	*Current Riparian Acres*	*Current Population Size (± SE)*	*Target Birds/Acre*[2]	*Restorable Riparian Acres*	*Target Population Size*
American Basin	0.5956 (± 0.0395)	16,364	3,946 (± 262)	0.54	82,757	44,897
Butte Basin	0.5452 (± 0.0699)	32,535	7,181 (± 920)	0.54	143,230	77,704
Colusa Basin	0.6905 (± 0.0554)	19,708	5,509 (± 442)	0.54	207,149	112,380
Sutter Basin	0.5956 (± 0.0395)	3,641	878 (± 58)	0.54	79,378	43,064
Yolo Basin	0.5956 (± 0.0395)	3,569	861 (± 57)	0.54	68,394	37,105
Delta Basin	0.2442 (± 0.0411)	14,840	1,467 (± 247)	0.15	132,548	20,392
San Joaquin Basin	0.1485 (± 0.0282)	12,249	736 (± 140)	0.15	188,394	28,984
Tulare Lake Basin	0.1921 (± 0.0820)	7,195	560 (± 239)	0.15	15,835	2,436

[1] Current density estimates were based on PRBO point count data. If a basin contained fewer than 30 point count stations, estimates were derived from all stations in the respective valley (Sacramento or San Joaquin).

[2] Target densities were based on the 75th percentile value of all point counts in each valley, adjusted by a detectability coefficient.

Table 9-9. Current and potential population densities and population targets for common yellowthroat.

Basin	*Current Birds/Ha (± SE)*[1]	*Current Riparian Acres*	*Current Population Size (± SE)*	*Target Birds/Acre*[2]	*Restorable Riparian Acres*	*Target Population Size*
American Basin	0.1338 (± 0.0173)	16,364	866 (± 115)	0.10	82,757	8,376
Butte Basin	0.1340 (± 0.0316)	32,535	1,765 (± 416)	0.10	143,230	14,497
Colusa Basin	0.1766 (± 0.0266)	19,708	1,409 (± 212)	0.10	207,149	20,967
Sutter Basin	0.1338 (± 0.0173)	3,641	197 (± 25)	0.10	79,378	8,034
Yolo Basin	0.1338 (± 0.0173)	3,569	193 (± 25)	0.10	68,394	6,923
Delta Basin	0.1815 (± 0.0300)	14,840	1,090 (± 181)	0.20	132,548	26,832
San Joaquin Basin	0.0910 (± 0.0201)	12,249	451 (± 100)	0.20	188,394	38,137
Tulare Lake Basin	0.00	7,195	0	0.20	15,835	3,206

[1] Current density estimates were based on PRBO point count data. If a basin contained fewer than 30 point count stations, estimates were derived from all stations in the respective valley (Sacramento or San Joaquin).

[2] Target densities were based on the 75th percentile value of all point counts in each valley, adjusted by a detectability coefficient.

Table 9-10. Current and potential population densities and population targets for yellow warbler.

Basin	*Current Birds/Ha (± SE)*[1]	*Current Riparian Acres*	*Current Population Size (± SE)*	*Target Birds/acre*[2]	*Restorable Riparian Acres*	*Target Population Size*
American Basin	0.0208 (± 0.0103)	16,364	138 (± 68)	0.13	82,757	10,758
Butte Basin	0.0185 (± 0.0176)	32,535	244 (± 231)	0.13	143,230	18,620
Colusa Basin	0.0147 (± 0.0095)	19,708	117 (± 76)	0.13	207,149	26,929
Sutter Basin	0.0208 (± 0.0103)	3,641	31 (± 15)	0.13	79,378	10,319
Yolo Basin	0.0208 (± 0.0103)	3,569	31 (± 15)	0.13	68,394	8,891
Delta Basin	0.0627 (± 0.0693)	14,840	377 (± 417)	0.13	132,548	17,231
San Joaquin Basin	0.0218 (± 0.0163)	12,249	108 (± 81)	0.13	188,394	24,491
Tulare Lake Basin	0.042 (± 0.0671)	7,195	122 (± 196)	0.13	15,835	2,059

[1] Current density estimates are derived from PRBO point count surveys, If a basin contained fewer than 30 point count stations, estimates were derived from all stations in the respective valley (Sacramento or San Joaquin).

[2] Target densities were based on spot-map densities from Clear Creek study plots, which are outside CVJV basins.

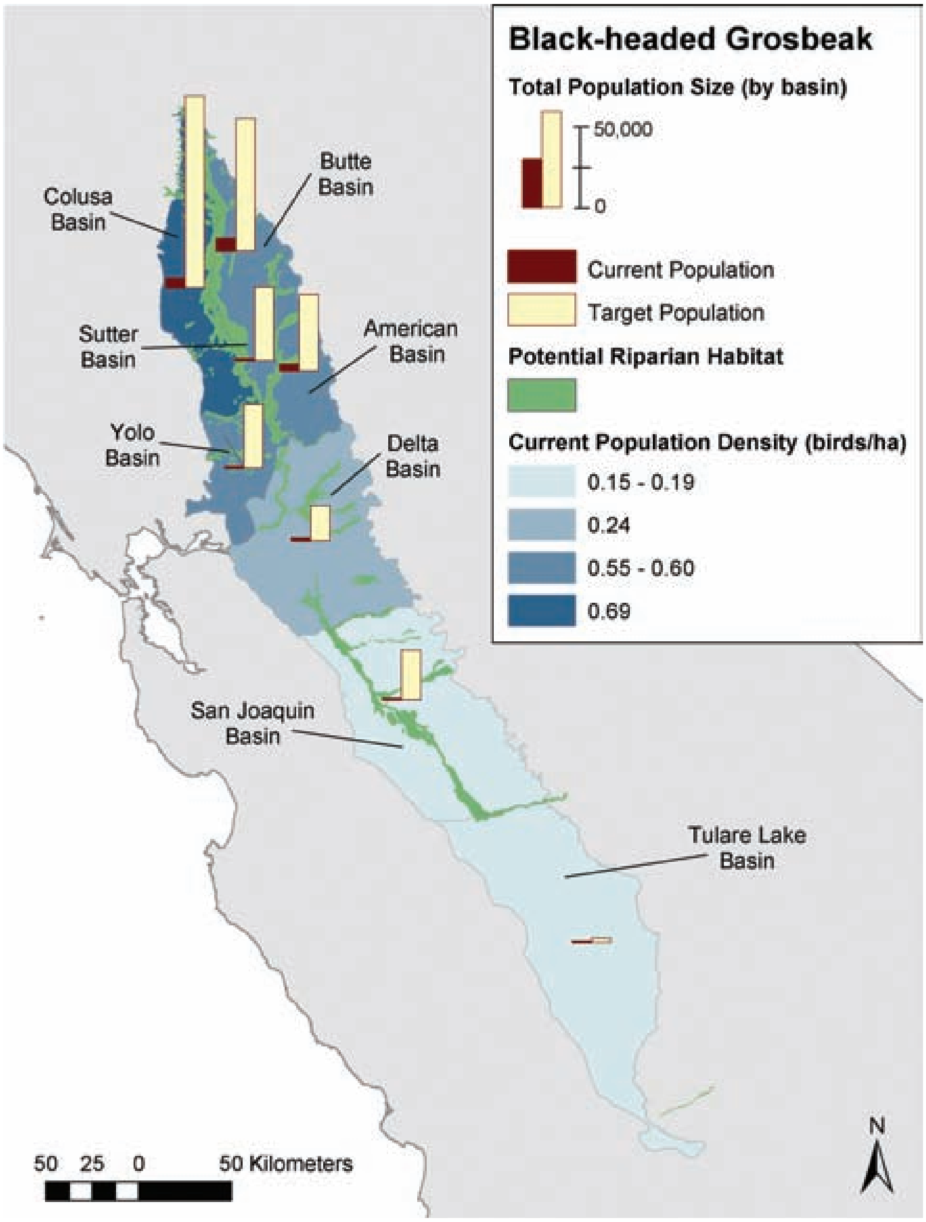


Figure 9-8. Black-headed grosbeak current populations and targets.

Table 9-11. Current and potential population densities and population targets for spotted towhee.

Basin	*Current Birds/Ha (± SE)*[1]	*Current Riparian Acres*	*Current Population Size (± SE)*	*Target Birds/Acre*[2]	*Restorable Riparian Acres*	*Target Population Size*
American Basin	0.7999 (± 0.0342)	16,364	5,299 (± 227)	0.78	82,757	64,330
Butte Basin	0.6779 (± 0.0552)	32,535	8,929 (± 727)	0.78	143,230	111,337
Colusa Basin	1.019 (± 0.0509)	19,708	8,129 (± 406)	0.78	207,149	161,023
Sutter Basin	0.7999 (± 0.0342)	3,641	10,536 (± 451)	0.78	79,378	61,703
Yolo Basin	0.7999 (± 0.0342)	3,569	6,382 (± 273)	0.78	68,394	53,165
Delta Basin	1.837 (± 0.1038)	14,840	11,037 (± 624)	0.78	132,548	103,033
San Joaquin Basin	1.337 (± 0.0787)	12,249	6,629 (± 390)	0.78	188,394	146,444
Tulare Basin	0.5486 (± 0.1088)	7,195	1,598 (± 317)	0.78	15,835	12,309

[1] *Current density estimates were based on PRBO point count data. If a basin contained fewer than 30 point count stations, estimates were derived from all stations in the respective valley (Sacramento or San Joaquin).*

[2] *Target densities were based on the 75th percentile value of all point counts in each valley, adjusted by a detectability coefficient.*

Conservation Priorities for Breeding Riparian Songbirds

Prioritization of habitat restoration work by basin is subjective and can vary depending on goals of the conservation action and opportunities on the ground. Basins were ranked according to six different criteria, with highest rank corresponding to the lowest score. Using this method, the Butte, Colusa, and San Joaquin Basins, ranked respectively are the most important basins in the conservation of riparian songbirds in the Central Valley. Table 9-12 ranks basins in order of importance to riparian birds based on a variety of factors.

By comparing amounts of acreage to be restored in specific projects and multiplying those acreages by current population densities, proposals may be evaluated and ranked on their contribution to overall basin population targets established for each species (or a suite of species). For example, Table 9-13 identifies a ranking system for North American Wetland Conservation Act grant proposals submitted in the spring 2003 grant cycle. This system provides a quantitative way to rank projects based on their potential to influence riparian songbird populations.

Table 9-12. Basins ranked in order of importance to riparian birds based on inputs for setting conservation objectives.

Basin	*Current Riparian Acres*	*Restorable Riparian Acres*	*Proportion of current to restorable*	*Nest Success (4 = no data)*	*Number of Sites with focal species richness > 4-5 (# of sites)*	*Current Focal Species Distribution (# of species)*	*Overall Basin Rank (total score)*
American	3	5	3	4	5 (1)	6 (7)	4 (21)
Butte	1	3	2	4	3 (4)	1 (12)	1 (14)
Colusa	2	1	5	3	2 (8)	2 (11)	2 (15)
Sutter	8	6	7	4	6 (0)	5 (8)	7 (36)
Yolo	7	7	7	4	6 (0)	6 (7)	8 (37)
Delta	4	4	4	2	4 (4)	4 (9)	5 (22)
San Joaquin	5	2	6	1	1 (9)	3 (10)	3 (18)
Tulare	6	8	1	4	6 (0)	7 (6)	6 (32)

Table 9-13. Comparison of NAWCA proposals submitted spring 2003, based on contribution to riparian songbird targets.

CVJV NAWCA Proposals	*Basin*	*Riparian Habitat Goal (acres)*	*Proposed amount of riparian to be restored/ enhanced (acres)*	*Projected Increase of 6 focal species (in total # of individuals)*	*Contribution to population target for 6 focal species (%)*	*Projected increase in total number of Yellow Warbler*	*Contribution to Yellow Warbler population target (%)*
Proposal # 1	Colusa	207,149	5,000	19,711	1.8	615	1.7
Proposal # 2	San Joaquin	188,394	2,628	12,402	1.3	323	1.3
Proposal # 3	San Joaquin	188,394	1,878	8,863	0.9	231	1.0

Summary of Conservation Objectives by Basin

The RBCP contains specific information on factors (e.g., plant species) that positively influence the occurrence of focal riparian bird species. It provides multi-species management recommendations for protection, restoration, and enhancement. The RBCP provides a wealth of current information to guide songbird habitat conservation efforts and should be consulted as an authoritative reference for detailed restoration planning.

American Basin – The American Basin currently has 16,364 acres of riparian habitat and approximately 83,000 acres of restorable habitat. The five-year restoration objective for the American Basin is 675 acres. Current and target bird population and density data for focal species are provided in Tables 9-6 through 9-12.

Butte Basin – The Butte Basin currently has 132,535 acres of riparian habitat and approximately 143,000 acres of restorable habitat. The five-year restoration objective for the Butte Basin is 1,125 acres. Current and target bird population and density data for focal species are provided in Tables 9-9 through 9-14.

Colusa Basin – The Colusa Basin currently has 19,708 acres of riparian habitat and approximately 207,000 acres of restorable habitat. The five-year restoration objective for the Colusa Basin is 1,350 acres. Current and target bird population and density data for focal species are provided in Tables 9-9 through 9-14.

Sutter Basin – The Sutter Basin currently has 3,641 acres of riparian habitat and approximately 79,000 acres of restorable habitat. The five-year restoration objective for the Sutter Basin is 675 acres. Current and target bird population and density data for focal species are provided in Tables 9-9 through 9-14.

Yolo Basin – The Yolo Basin currently has 3,569 acres of riparian habitat and approximately 68,000 acres of restorable habitat. The five-year restoration objective for the Yolo Basin is 675 acres. Current and target bird population and density data for focal species are provided in Tables 9-9 through 9-14.

Delta Basin – The Delta Basin currently has 14,840 acres of riparian habitat and approximately 132,548 acres of restorable habitat. The five-year restoration objective for the Delta Basin is 1,500 acres with 900 acres along the Mokulmne River and 600 acres along the Cosumnes River. Current and target bird population and density data for focal species are provided in Tables 9-9 through 9-14.


Song sparrow
Photo: Brian Gilmore

San Joaquin Basin – The San Joaquin Basin currently has 12,249 acres of riparian habitat and approximately 188,000 acres of restorable habitat. The five-year restoration objective for the San Joaquin Basin is 2,500 acres. Current and target bird population and density data for focal species are provided in Tables 9-9 through 9-14.

Tulare Basin – The Tulare Basin currently has 7,195 acres of riparian habitat and approximately 15,000 acres of restorable habitat. The five-year restoration objective for the Tulare Basin is 200 acres. Current and target bird population and density data for focal species are provided in Tables 9-9 through 9-14.

Snow geese at Sutter National Wildlife Refuge
Photo: Ducks Unlimited

Chapter Ten: WETLAND WATER SUPPLIES

This chapter outlines the requirements for Central Valley managed wetland water supplies and the current conditions in the valley for obtaining water supplies to meet objectives stated in the 2006 Plan. The chapter also summarizes the history of wetland water supplies in the valley, the significant changes to supplies over time, and the most current and pressing water-related issues within each of the valley's nine basins.

Introduction

Ensuring reliable and affordable water supplies for wetland management may be the Central Valley Joint Venture's (JV) greatest challenge. Since publication of the 1990 Central Valley Habitat Joint Venture Implementation Plan (1990 Plan; Central Valley Habitat Joint Venture 1990), human demand for water in the Central Valley has increased at an alarming rate. At the same time, complex factors have caused the reduction of available water supplies for many wetlands. These include in-stream dedication for threatened and endangered fish species, human population growth, and urbanization. The economic and political competition for water has become intense, and the cost of water in some basins has risen 400% since 1993 (D. Garrison, U.S. Fish and Wildlife Service, personal communication). Stakeholders with competing agricultural, urban, and environmental interests are lobbying on many fronts for reallocation of existing supplies.

Water shortages in California currently approach 1.6 million acre-feet in an average water year and 5.1 million acre-feet in drought years. This deficit is expected to increase to 2.4 million acre-feet in average years and to 6.2 million acre-feet in drought years by 2020 (California Department of Water Resources 1998).

The challenge facing both private and public wetland managers in the Central Valley is two-fold: (1) increasing the reliability of water sources for wetland management; and (2) ensuring that funds for water supplies cover the increasing costs of water in an increasingly

"Although the 2006 Plan provides an estimate of the water needed to meet integrated bird habitat objectives, the current and future availability of wetland water supplies remains unclear. Site specific investigations are needed to evaluate wetland water supplies, both for existing wetlands and for wetlands that will be restored to meet bird habitat objectives."

Dale Garrison
Refuge Water Supply Coordinator
U.S. Fish and Wildlife Service

competitive water market. 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 part of low-priority contracts with water purveyors. Increasing the reliability of these water sources is a priority for the JV, but water reliability does not guarantee long-term affordability. Wetland managers who continue to have access to reliable water supplies may ultimately be unable to afford water as prices increase. This chapter identifies JV efforts needed to secure reliable and accessible water supplies for Central Valley wetlands.

This chapter has three sections: (1) the history of Central Valley wetland water supplies; (2) water supplies needed to meet integrated bird habitat objectives; and (3) water issues and proposed actions.

The History of Central Valley Wetland Water Supplies

Historical Overview

The loss of wetlands in the Central Valley since the 1850s has been well documented by a variety of publications and reports. Surveys in the 1850s estimated there to be over four million acres of wetlands in the valley. The resulting influx of immigrants into California following the discovery of gold, initiated the changes that led to the conversion of over 90% of Central Valley wetlands. Human settlement increased the need to control annual flooding of the major valley 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 this demand for agricultural products and other services. By the 1950s, expanding agricultural development had decreased Central Valley wetlands to an estimated 290,000 acres (Central Valley Habitat Joint Venture 1990).

The continued decline of Central Valley wetlands occurred between 1950 and 1970. 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 historic agreements continue to this day. 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 (NWR), which receive water through agreements with Glenn-Colusa Irrigation District; and the Gray Lodge Wildlife Area (WA), 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 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-feet of water (if and when available) for wetlands within the Grassland Water District (GWD) during the fall and winter months. The California Department of Fish and Game (CDFG) also negotiated agreements with the U.S. Bureau of Reclamation (USBR) and various local water districts for many of its wildlife areas. 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. This situation continued during the 1970s until a severe drought during the latter part of the decade greatly reduced wetland water supplies and, in some instances, eliminated all wetland water deliveries.

Wetland Water Supply Studies

The combination of drought and poor wetland water supply reliability resulted in significant impacts to wetland habitat and waterbird populations, and in particular, wintering waterfowl. By the end of the decade, political pressure from concerned landowners and wildlife agencies resulted in publication of the *Total Water Management Study for the Central Valley Basin of California* (U.S. Bureau of Reclamation unpublished report). This study included Working Document No. 12, "Fish and Wildlife Problems, Opportunities, and Solutions" (U.S. Bureau of Reclamation 1978), a survey of major fish and wildlife problems and improvement opportunities within the geographical area encompassed by the Central Valley Project (CVP)[1]. As a result of the study's findings, the USBR initiated the *Central Valley Fish and Wildlife Management Study of 1979* (U.S. Bureau of Reclamation 1979). The goal of the study was the development of a comprehensive baseline of Central Valley fish and wildlife resources and to recommend specific solutions to water related issues.

[1] *The Central Valley Project is a federal water project initially authorized in 1935 as a long-term plan to utilize water in California's Central Valley. The original goals of the project were flood control, improved transportation of water, and the development of water supplies for industrial, municipal, and agricultural use. Fish and wildlife needs were eventually added as goals, with the CVPIA furthering this objective through the allocation of CVP water supplies for specific fish and wildlife purposes.*

These studies continued into the early 1980s and resulted in a report that addressed waterfowl and wetland habitat, *Central Valley Fish and Wildlife Management Study: Refuge Water Supply, Central Valley Hydrologic Basin, California 1986* (U.S. Bureau of Reclamation 1986). This study served as the basis for the *Report on Refuge Water Supply Investigations, Central Valley Hydrologic Basin, California* (1989 Report; U.S. Department of Interior 1989).

As these investigations progressed, other actions were underway that would significantly affect Central Valley wetlands. The *North American Waterfowl Management Plan* (U.S. Fish and Wildlife Service 1986), 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 JV was subsequently formed in 1988, and based upon the findings of the 1989 Report, one of the objectives stated in the 1990 Plan was to secure firm, reliable water supplies for publicly-owned Central Valley wetlands and the privately managed wetlands located within the Grassland Resource Conservation District (GRCD) and elsewhere in the valley.

The Central Valley Project Improvement Act

CVPIA Mandates Water for Wetlands

Efforts to secure reliable and accessible sources of water started with ecologically sound estimates of wetland water needs for optimal habitat management and were identified as Level 4 water supplies in the 1989 Report. Due to an investment in the legislative process by JV partners, provisions were made in the 1992 Central Valley Project Improvement Act (CVPIA) Title 34 of Public Law 103-575 Section 3406 (d)(1-5) to meet this need. This law authorized water supplies for those wetland areas covered by the 1989 Report and the San Joaquin Basin Action Plan (Action Plan; U.S. Bureau of Reclamation et a l. 1989), a plan developed to mitigate for the habitat losses resulting from the Kesterson NWR selenium contamination of the 1980s, and to implement the objectives of the JV.

Another specific provision of the CVPIA, 3406 (d)(6)(A,B), required the investigation of water and conveyance needs for private wetlands not covered by the provisions of CVPIA 3406 (d)(1-5) of the act. The *Central Valley Wetlands Water Supply Investigations, CVPIA 3406 (d)(6)(A,B), A Report to Congress* (Water Report; U.S. Fish and Wildlife Service 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 admitted that agriculture would have priority if water shortages develop.

The CVPIA statutorily obligates the Secretary of Interior to consult with the JV in matters involving wetland water acquisition and delivery. Considering this obligation, the JV maintains a unique responsibility to consider water supply issues related to the implementation of this 2006 Plan by participating in forums where water issues and policies are being discussed, to assure that policy makers address wetland water needs.

To date, the CVPIA is one of the most important legislative actions taken to protect and restore Central Valley wetland habitat, and has laid the foundation for many significant and beneficial conservation activities in subsequent years. Since 1992, delivery of water supplies of adequate quality and quantity 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, colonial waterbirds, and several threatened and endangered species. These benefits have been documented in annual reports to Congress and in a variety of studies and reports conducted by the U.S. Fish and Wildlife Service (USFWS) and CDFG, which are summarized here:

- A 300% increase in waterfowl food production within the GRCD;
- An 89% reduction in avian disease outbreaks on the Sacramento NWR Complex since 1992;
- A 49% increase in fall shorebird use Central Valley-wide;
- An increase in bird use days on private lands in the San Joaquin Valley from 38,000 to 115,000; during the first year of CVPIA implementation, and today, the San Joaquin Valley hosts 500,000 to 1 million birds each year;
- A 50% increase in the number of heron and egret rookeries in the San Joaquin Valley;
- A 61% increase in visitor use on the Sacramento NWR Complex between 1992 and 2006;
- Increases in threatened or endangered species (western pond turtles, tricolored blackbirds, and giant garter snakes);

- Marked increases in white-faced ibis and Sandhill cranes (e.g., white-faced ibis populations increased from 100 birds in 1991 to 15,000 in 2002 at the Sutter NWR);
- 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.

These habitat improvements have led to research studies by universities, government agencies, and non-governmental conservation organizations such as the California Waterfowl Association; Ducks Unlimited, Inc.; PRBO Conservation Science; University of California, Davis; United States Geological Survey's Biological Research Division, Dixon Field Station; and others.

Several long-term water conveyance/supply contracts and agreements were negotiated during the 1990s that increase the reliability of CVPIA water supplies being delivered for the next 25 years. These contracts and agreements called for the establishment of an Interagency Refuge Water Management Team (Team). Comprised of USBR, USFWS, CDFG, and the GRCD, the Team 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.

CVPIA Mandate Falls Short of Realization

The CVPIA mandated delivery of historic water supplies (Level 2 supplies) and two-thirds of the full water supply requirements for lands identified in the Action Plan from the CVP. In addition, Level 4 water supplies were to be acquired through purchase from willing sellers and provided in 10% increments per year until 2002, when full water supply requirements were authorized. These full water levels have not been 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 "spot market"). Budgetary constraints within USBR's annual CVPIA Restoration Fund and the state's 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. These budget shortfalls also have 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, and in the case of the Action Plan lands, wetland restoration has still not been completed. Some wetland areas still lack sufficient infrastructure to beneficially use their incremental Level 4 water supplies, even if delivered to the property boundary.

Water costs have escalated as water acquisitions to meet CVPIA, CALFED, urban, and agricultural needs have influenced sharp increases in spot market prices, further stressing limited budgets. USBR is currently studying the potential of increasing groundwater usage on CVPIA wetlands to offset both funding and supply limitations.

Water Supplies Needed to Meet Integrated Bird Habitat Objectives

The 2006 Plan addresses the habitat needs of six bird groups. To increase the efficiency of bird conservation in the Central Valley, the habitat needs of these bird groups were integrated at the basin scale where possible. Chapter 11 (Summary Chapter) provides a full description of these integrated habitat objectives and how they were obtained. The water needs associated with these integrated objectives are presented here.

Estimated annual water supplies needed to properly manage state, federal and GRCD seasonal and semi-permanent wetlands for each basin were identified in the 1989 Report and the Interagency Coordinated Program (ICP) task force report, *An Interagency Coordinated Program for Wetland Water Use Planning: Central Valley, California* (ICP Report; U.S. Bureau of Reclamation et al. 1998). These annual water needs, as well as the amount of water needed for winter-flooded agricultural habitat, are described in Table 10-1.

The water needs that are associated with integrated bird objectives are a function of the amount of existing habitat, as well as the amount of additional habitat that must be restored to fully meet bird needs in the Central Valley. Table 10-2 presents the annual water needs that are associated with existing wetland habitats in the Central Valley, based on acre-feet per acre requirements identified in Table 10-1.

CVPIA Level II supplies currently total 422,252 acre-feet or 37% of annual water needs of existing wetlands. Full Level 4 supplies total 555, 515 acre-feet, or 49% of existing wetland need (the reliability of Level 4 deliveries is directly related to annual spot market water costs, water availability, and Restoration Fund revenue levels for that year).

Table 10-1. Annual water requirements (acre-feet per acre) by habitat type and basin.

Basin	*Seasonal Wetlands[a] (acre-feet/acre)*	*Semi-Permanent[a] Wetlands (acre-feet/acre)*	*Winter Flooded[b] Agriculture (acre-feet/acre)*
American	5.0	7.4	2.5
Butte	5.6	7.4	2.5
Colusa	5.0	7.4	2.5
Sutter	5.0	7.4	2.5
Yolo	5.0	7.4	2.5
Delta	4.75	7.4	2.5
Suisun	4.75	7.4	0
San Joaquin	5.45	7.4	0
Tulare	5.25	8.0	0

[a] *U.S. Fish and Wildlife Service 2000; U.S. Bureau of Reclamation et al., 1998.*

[b] *Dale Garrison, U.S. Fish and Wildlife Service, personal communication.*

Beyond CVPIA Level 2 and 4 supplies, the reliability of water supplies needed to meet the full 1,129,151 acre-feet need of these wetlands remains largely unknown. Table 10-3 presents the annual water needs of additional seasonal and semi-permanent wetlands (new wetlands) that must be restored to achieve integrated habitat objectives for bird groups included in the 2006 Plan. These represent new water needs above and beyond the water being supplied to existing wetlands. Finally, Table 10-4 presents the combined water requirements of existing wetlands and wetlands that must be restored to fully meet integrated habitat objectives for the Central Valley. This overall estimate also includes the water needed for winter-flooding of agricultural habitats that must be maintained even when wetland objectives are fully met. Although this overall estimate of about 2.3 million acre-feet includes "new" water that is needed for wetlands yet to be restored, much of this water need is currently being met on existing wetland and agricultural habitats. However, the long-term reliability of these supplies remains uncertain.

Table 10-2. Total annual water needs for existing wetland habitats in the Central Valley.

Basin	*Seasonal Wetlands (acres)*	*Seasonal Wetland Water Needs (acre-feet)*	*Semi-Permanent Wetlands (acres)*	*Semi-Permanent Wetland Water Needs (acre-feet)*	*Total Water Needs (acre-feet)*
American	3,187	15,935	562	4,159	20,094
Butte	23,340	130,704	4,119	30,481	161,185
Colusa	22,390	111,950	3,951	29,237	141,187
Sutter	1,951	9,755	344	2,546	12,301
Yolo	8,558	42,790	1,512	11,189	53,979
Delta	6,349	30,158	1,121	8,295	38,453
Suisun	32,232	153,102	5,688	42,091	195,193
San Joaquin	61,013	332,521	6,779	50,165	382,686
Tulare	20,212	106,113	2,245	17,960	124,073
Total	**179,232**	**933,028**	**26,321**	**196,123**	**1,129,151**

Table 10-3. Total annual water needs for additional wetland habitats that must be restored to fully meet integrated bird habitat objectives.

Basin	*Seasonal Wetlands (acres)*	*Seasonal Wetland Water Needs (acre-feet)*	*Semi-Permanent Wetlands (acres)*	*Semi-Permanent Wetland Water Needs (acre-feet)*	*Total Water Needs (acre-feet)*
American	20,396	101,980	425	3,145	105,125
Butte	17,396	97,418	425	3,145	100,563
Colusa	2,396	11,980	425	3,145	15,125
Sutter	4,396	21,980	425	3,145	25,125
Yolo	3,170	15,850	508	3,759	19,609
Delta	19,170	91,058	1,208	8,939	99,997
Suisun	0	0	333	2,464	2,464
San Joaquin	20,340	110,853	2,815	20,831	131,684
Tulare	21,263	111,631	5,935	47,480	159,111
Total	**108,527**	**562,750**	**12,500**	**96,053**	**658,803**

Table 10-4. Total annual water needs for wetland and winter-flooded agricultural habitats in the Central Valley when integrated bird habitat objectives are met.

Basin	*Seasonal Wetlands (acre-feet)*[a]	*Semi-Permanent Wetlands (acre-feet)*[b]	*Agricultural Winter Flooding (acre-feet)*[c]	*Total Water (acre-feet)*[d]
American	117,915	7,304	125,000	250,219
Butte	228,122	33,626	155,000	416,748
Colusa	123,930	32,382	112,500	268,812
Sutter	31,735	5,691	25,000	62,426
Yolo	58,640	14,948	7,500	81,088
Delta	121,215	17,234	72,500[e]	210,949
Suisun	153,102	44,555	0	197,657
San Joaquin	443,374	70,996	0	514,370
Tulare	217,744	65,440	0	283,184
Total	**1,495,777**	**292,176**	**497,500**	**2,285,453**

[a] *Annual water needs for managed seasonal wetlands (public and private) when seasonal wetland objectives are met for the Central Valley.*

[b] *Annual water needs for managed semi-permanent wetlands (public and private) when semi-permanent wetland objectives are met for the Central Valley.*

[c] *Annual water needs for winter-flooded agriculture (predominantly rice) when seasonal wetland objectives are met for the Central Valley.*

[d] *Sum of seasonal wetland, semi-permanent wetland, and winter-flooded agriculture water needs.*

[e] *Although there is not a winter-flooding objective for the Delta Basin, this figure represents current estimates of winter-flooded corn in the basin.*

Although the 2006 Plan provides an estimate of the water needed to meet integrated bird habitat objectives, the current and future availability of wetland water supplies remains unclear. Site specific investigations are needed to evaluate wetland water supplies, both for existing wetlands and for wetlands that will be restored to meet bird habitat objectives. This is a key information need for all basins in the Central Valley, and will be critical as JV partners attempt to secure reliable and affordable water supplies for all of the region's wetlands.

Water Issues and Proposed Actions

Current Issues and Challenges

Water Supplies for New Wetlands

Since the passage of CVPIA, additional wetlands have been added to NWRs and WAs that also need to be addressed, as well as the water supply needs of private wetlands within key basins. They include: Llano Seco Unit of the Sacramento River NWR, San Joaquin River NWR, Stone Lakes NWR, Butte Sink NWR, Upper Butte Basin WA, private wetlands within the Tulare Basin, and others. They contribute to the JV wetland restoration objective and utilize water supplies that were authorized when these properties were acquired. However, in many instances after the acquisition, the agencies lacked the funding to pay for the pumping, and/or conveyance of water supplies for these newly purchased wetlands.

Likewise, additions to San Joaquin Valley WAs such as North Grasslands and Volta WAs have varying reliability of supplies. For example, the Gadwall Unit addition to the North Grasslands WA falls within the GRCD and is entitled to CVPIA authorized water supplies, while recent additions to the Volta WA do not currently appear to have access to adequate water supplies.

Spotlight on Tulare Basin Wetlands

Interest in restoring historic wetland habitat conditions within the Tulare Basin has greatly increased since the passage of the CVPIA. While private wetlands within this area did not directly benefit from provisions of the CVPIA, the vast improvements that have resulted in other wetland basins that receive CVPIA water supplies has sparked renewed discussion at regional, state and federal levels in the Tulare Basin. A major initiative has resulted from these discussions, focusing on a combination of factors that could result in significant habitat restoration within the Tulare Basin.

These factors include:

- Historic wetland areas and soil types;
- Availability of water supplies, including cooperation from overlying agricultural water agencies and conjunctive use of available water resources for multiple purposes (including flood control);
- Cooperating private landowners who maintain interest in the re-establishment of wetlands on their property or willingness to protect the wildlife values of their property through state or federal ownership or conservation easements;
- Conjunctive use of existing and restored natural landscapes to provide endangered species benefits as well as wetland benefits;
- A high degree of cooperation among state and federal agencies, conservation organizations, and the agricultural community, with varying missions and authorizations.

High annual variation in runoff from the west slope of the Sierra Nevada into the southern San Joaquin Valley causes the Tulare Basin to experience the greatest fluctuation in water supplies in the Central Valley. For example, the annual runoff from the Kaweah River (a tributary to the Tulare Lake) over the past 100 years of record has ranged from approximately 93,000 acre-feet in 1977 to over 1.4 million acre-feet in 1983. Such vast fluctuations call for a strategy that takes into account this highly variable hydrology and establishes flexible wetland restoration goals within the region.

The Tulare Basin is the heart of some of the most intensively farmed and agriculturally productive lands in the world. It is also one of the fastest growing regions in California. There is no "silver bullet" strategy for finding more water for wetlands in Tulare Basin as may have been the case with implementation of the CVPIA elsewhere in the Central Valley. The basin suffers from chronic water shortages, and the impacts of having its imported water supplies significantly reduced, as a result of new laws or regulations, have not been resolved. It is facing significant new water demands for river and fishery habitat restoration and, due to its proximity to urban Southern California, has the potential to become a new source of water to meet the increasing water needs of that region. Only now are the existing and future wetlands needs of the Tulare Basin getting serious consideration in state and federal water and environmental forums.

Water Management Programs and Policies Affecting Wetland Water Supplies

Along with increases in wetland acreage in the Central Valley during the past decade, various activities have occurred that have the serious potential to impact the quantity and quality of water supplies to many wetland areas throughout the valley.

Federal Programs and Actions

The U.S. Department of Agriculture, through the Natural Resources Conservation Service, has restored privately-owned wetlands throughout the Central Valley through the Wetlands Reserve Program. Most of these restored wetlands utilize water supplies that were available to the landowner prior to restoration. In many instances, reliability of these water supplies is unknown, yet must be clarified as part of an overall re-evaluation of wetland water supplies for the Central Valley.

The Department of the Interior's decision to decrease the amount of Colorado River supplies for Southern California has also affected water supplies in the Central Valley. This decision initiated the search for additional municipal and industrial water supplies by the Metropolitan Water District (MWD), which supplies water to the Los Angeles and San Diego metropolitan areas. MWD has become very active in locating and acquiring water supply options, both north and south of the Sacramento San Joaquin River Delta (Delta), to help meet anticipated future demands for its service area. Typically, urban water users can pay prices that are an order of magnitude greater than can be afforded by government agencies, conservation organizations, and private landowners, resulting in the unintended consequence of "out-bidding" wetland managers.

Endangered Species Act decisions have also affected agricultural water supplies that must be diverted and pumped south of the Delta. Reduced pumping from the Delta to protect listed fish species has decreased water supplies previously available to CVP and State Water Project districts. These decreased supplies have generated an energetic water transfer program between agricultural water districts in the San Joaquin Valley. These transfers have greatly increased the demand for surplus water supplies that become available in certain years. As the demand has increased, so has the cost of acquiring these limited water supplies. These increased costs have placed additional burdens on limited public funding available to acquire necessary water supplies for private and public wetlands.

CALFED Program

Approximately half of California's surface water flows through the Delta. Half of this water is diverted for urban, agricultural and environmental use. Remaining water is discharged into the Pacific Ocean through the San Francisco Bay (Bay). The Bay-Delta ecosystem is affected by these water diversions, and courts have intervened to assure that adequate freshwater supplies enter the system. State and federal agencies are working with local water districts and other stakeholders to improve conditions in the Bay-Delta, while continuing efforts to meet California's diverse water needs. These efforts are intended to be coordinated through the CALFED Program, which was initiated following the 1994 interagency Bay-Delta Accord. The program focuses on water quality standards, coordination of State Water Project and CVP operations; and long-term solutions to problems in the Bay-Delta Estuary.

CALFED, along with several CVPIA programs and various court decisions have brought about changes in water management programs throughout the Central Valley. CALFED includes water programs that could result in less water for wetlands in some areas, while potentially increasing wetland water supplies elsewhere in the Central Valley. A major CALFED program is the Environmental Water Account (EWA). The EWA was established to replenish water supplies required for management of federally threatened or endangered fish and to improve water quality in the Delta. The water needed for increasing water transfers, the EWA, and the Vernalis Adaptive Management Plan, a plan to meet flow objectives for migrating salmon within the San Joaquin River Basin (EA Engineering, Science, and Technology 1999) have all contributed to increased competition for limited environmental water supplies.

Regional Water Quality Standards

Wetland water quality issues are affected by various Regional Water Quality Control Board (RWQCB) programs and standards. Water quality supply issues are quickly becoming more important as regulations regarding outflow from agriculture and managed wetlands increase, and wetland managers are being held accountable for discharge from their properties, regardless of its source of origin. RWQCBs are developing and adopting programs which regulate managed wetland drainage through waivers to Waste Discharge Requirements, such as the Central Valley RWQCB's Irrigated Lands Conditional Waiver Program, and development of load restrictions, including total maximum daily loads (TMDLs) of mercury, salt and boron. As discharge restrictions increase, source water quality becomes more of a concern in order to meet new restrictions.

Water Use Planning Efforts

State and federal agencies have responded to increasing concerns by wetland managers regarding water supplies. CDFG's Lands Committee examines water availability and potential use as part of its review of potential land acquisitions. The USFWS conducts a similar review prior to land acquisition that is more comprehensive than has been the case in the past. The ICP task force was established in 1998 and consists of the USFWS, USBR, GRCD, and CDFG, advised in the development of the ICP Report, a document examining water use and providing a process for the identification of effective water regimes for Central Valley wetlands.

Many agricultural and urban water districts have completed water conservation plans to comply with USBR contract requirements. The USFWS, CDFG, and GWD have completed water management plans for those NWRs, WAs, and GRCD lands with authorized CVPIA wetland water supplies. These planning efforts are designed to improve water use efficiency and conservation efforts to the benefit of all water users.

Future Issues and Challenges

Securing firm, reliable water supplies for managed wetlands in the Central Valley will become even more challenging in the future. Demand for limited water supplies will increase with continued population growth in California, and wetlands will compete for a legitimate allocation to meet wetland dependent resource needs. Wetland habitats cannot properly function without access to year-round water supplies to meet management objectives. Thus, issues and challenges that are faced today will continue and become more important as additional issues arise in future years.

Some of the most significant barriers to acquiring future water supplies for Central Valley wetlands include:

- Delta export and pumping constraints;
- Increasing competition to purchase limited water supplies;
- Increasing regulation of managed wetland water discharge;
- Capacity limitations of existing water delivery systems;
- Balance between supply and demand;
- Cost of acquiring annual and long-term water supplies;
- Current and future, state, federal, and private budget shortfalls that impact acquisition efforts;
- The State of California's ability to meet their 25% cost-share obligations under the CVPIA;
- Unreliable quality and quantity of groundwater supplies;
- Increased groundwater pumping costs;
- Annual and long-term water transfers that may adversely affect managed wetlands and fish and wildlife resources.

Water Issues by Basin

Current and future water issues affecting managed wetlands vary among basins in the Central Valley, and many of them are outlined here.

Butte Basin

- Reliance upon groundwater at Gray Lodge WA as part of Level 4 water supplies;
- A shift from optimal wetland management to the implementation of best management practices, in order to comply with vector control regulations;
- Insufficient infrastructure to deliver Level 2 and Level 4 water supplies to Gray Lodge WA;
- Ensuring that water supplies are attached to the property when protecting managed wetland habitat.

Colusa Basin

- Potential competition for water between post-harvested rice and managed wetlands, particularly during drought years;
- Timing of water use on shared conveyance systems;
- Quality issues related to surface water delivery and discharge at Sutter, Colusa, and Sacramento NWRs (e.g., boron and mercury);
- Equitable sharing of monitoring costs by those participating in water quality coalitions;

- Potential increased groundwater use (e.g., Delevan NWR);
- A shift from optimal wetland management to the implementation of best management practices, in order to comply with vector control regulations;
- Management impacts resulting from re-route of the Colusa Drain;
- Transfer of permanent water rights to out of basin agricultural and urban users (potential adverse impact to wetlands and Level 4 water supplies associated with long-term out-of-basin water transfers);
- Ensuring that water supplies are attached to the property when protecting managed wetland habitat.

Sutter Basin

- Current conveyance system at Sutter NWR is insufficient to convey Level 4 water supplies;
- Timing of water on shared conveyance systems;
- Improving the facilitation of intra-basin and inter-basin water transfers among state and federally managed wetlands;
- A shift from optimal wetland management to the implementation of best management practices, in order to comply with vector control regulations;
- Ensuring that water supplies are attached to the property when protecting managed wetland habitat.

Yolo Basin

- Competing water use and loss of habitat due to urban growth in and around the city of Woodland;
- Increased regulatory requirements on managed wetland areas as a result of new mercury TMDL standards;
- Increasing competition for water between agricultural and habitat interests due to conveyance capacity limitations (e.g., Toe Drain and Putah Creek) at Yolo Bypass WA;
- Ensuring that water supplies are attached to the property when protecting managed wetland habitat.

American Basin

- Competing water use and loss of habitat (e.g., ricelands) due to urban growth in and around the cities of Yuba City and Marysville;
- Need for more protection of open space (e.g., agricultural easements);
- No current reliable supply of water for most managed wetlands within the basin;
- Ensuring that water supplies are attached to the property when protecting managed wetland habitat.

Delta Basin

- Balancing endangered species (e.g., Delta smelt) recovery needs with wetland water supply needs;
- Saltwater intrusion into fresh water wetland habitat;
- Challenges in maintaining existing levee system;
- Increased regulatory requirements on managed wetland areas within the basin as a result of new mercury TMDL standards;
- Competing water use and loss of habitat due to urban growth in and around the primary zone of the Delta.

Suisun Basin

- Maintenance of existing salinity standards established to sustain a brackish water marsh capable of producing high-quality forage and habitat conditions suitable for waterfowl and other wetland related wildlife;
- Negative impacts to wetland water quality and habitat conditions due to potential reduction of Delta outflows and increases in state and federal water project deliveries;
- Maintenance and improvement of 220 miles of exterior levee for the protection and enhancement of diked wetland habitats and the protection of Delta water quality;
- Lack of a maintenance program to protect and support publicly and privately managed wetland resources;
- Increased stress on the levee system and the threat to diked managed wetlands due to predicted rise in sea level;
- Potential localized salinity variations due to planned tidal restoration of diked areas, and associated negative impacts to adjacent waterfowl habitat management areas;

- Increases in salinity resulting in a decrease in the life expectancy of existing water management infrastructure, and a reduction of diversity and productivity in diked wetlands;
- Concerns over water quality constituents in the marsh including, but not limited to, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, organophosphate pesticides, methyl mercury, dissolved oxygen, organic matter, and heavy metals.

San Joaquin Basin

- Lack of sufficient above ground water storage dedicated to environmental purposes;
- Groundwater issues including access, poor water quality, overdraft, and subsidence.;
- Rapid urbanization in the region is likely to shift surface water use from agricultural to urban uses;
- Lack of pumping and conveyance capacity in the existing system to transport water south through the Delta to San Joaquin Basin wetlands;
- Low priority for conveyance of Level 4 water supplies through state and federal pumping facilities in the Delta;
- Lack of conveyance system to receive Level 2 or Level 4 water supplies at East Bear Creek unit of San Luis NWR;
- Stricter RWQCB standards for wetland discharges into the San Joaquin River. (e.g., boron, mercury, salinity, dissolved oxygen and selenium);
- Federal budget shortages for CVPIA water supplies due to increased competition for Restoration Fund dollars and increased costs of purchasing annual spot market water;
- Increasing water costs, especially during periods of drought;
- Lack of willing sellers of affordable long-term water rights;
- Timing of water use on shared conveyance systems;
- Degraded water quality from use of agricultural tail-water or poor quality groundwater;
- Inability of wetland managers to plan their yearly water use due to sporadic water purchases throughout any given year;
- Lack of year round conveyance affected by the current condition of Mendota Dam affects conveyance ability to deliver Level 4 water supplies to Mendota WA and reduces conveyance capacity for the GWD;
- Ensuring that water supplies are attached to the property when protecting managed wetland habitat.

Tulare Basin

- Groundwater issues including: lack of access, poor water quality, overdraft, and subsidence;
- Lack of a conveyance system to deliver Level 4 water supplies to Pixley NWR;
- Potential impacts to water quality, habitat, and wildlife from the introduction of municipal sludge onto agricultural lands adjacent to wetland habitat;
- Continued reliance upon purchasing spot market water;
- Increasing water costs, especially during periods of drought;
- Federal budget shortages for CVPIA water supplies due to increased competition for Restoration Fund dollars;
- Degraded water quality from using agricultural tail-water or poor quality groundwater;
- Dependence upon coordinating water management with adjacent landowners in order to effectively de-water Kern NWR;
- Inability of wetland managers to plan their yearly water use due to sporadic water purchases throughout any given year;
- Lack of reliable water supplies and inadequate conveyance systems to deliver water to the private wetlands within the basin;
- Ensuring that water supplies are attached to the property when protecting managed wetland habitat.

Recommended Actions and Strategies to Secure Wetland Water Supplies

Additional water supplies may be developed through expanded storage in existing reservoirs, groundwater banking, new water storage facilities, and coastal and Central Valley desalination plants. The JV partners can play a role in exploring these options and should consider implementation of the following strategies aimed at increasing future wetland water supplies and improving wetland water supply reliability.

- Establish and fund one or more positions that would be responsible for working with relevant agencies, NGO's and water entities, to collaborate and cooperate on realistically resolving wetland water supply needs (including matters involving wetland water quality), assuring that wetland needs are integrated into regional, state and federal water discussions. The position(s) would track water transfers that may have impacts on wetland water supplies, as well as monitor water quality issues that could effect JV wetland restoration and enhancement objectives;

- Work closely with agencies and organizations conducting wetland restoration to ensure reliable water supplies are accessible to target properties;
- Seek additional state and federal funding to acquire and develop wetland water supplies, maintaining fulfillment of long-term CVPIA Level 4 water supplies as a top priority;
- Establish a public outreach program to educate the public and public officials of: (1) the benefits derived from CVPIA wetland water supplies; (2) the need to develop new sources of supply to meet the objectives of this Plan.

Summary

Since publication of the 1990 Plan, Central Valley water demands have dramatically increased. Competition for water has become intense, and the cost of obtaining wetland water supplies in some basins has risen by nearly 400%. Agricultural, urban and environmental stakeholders are aggressively lobbying on many fronts for reallocation of existing water supplies. The 2006 Plan outlines a new strategy for the conservation of migratory birds and their habitats in a rapidly changing socio-political environment. Much of this strategy is dependent upon available and affordable water supplies. It is therefore essential for JV partners to participate in the many forums where water issues are being addressed to assure that wetland water needs are fully considered. Moreover, JV partners will need to carefully consider availability of water supplies when planning habitat acquisition, restoration and enhancement activities associated with the implementation of the 2006 Plan.


Gray Lodge Wildlife Area water control structure
Photo: Ducks Unlimited

White-faced ibis
Photo: Carley Sweet, TRC Essex

Chapter Eleven: SUMMARY

This chapter collates conservation objectives by habitat, and by basin or regional planning unit, for all bird groups addressed in this Plan. Table 11-1 lists these objectives by habitat type.

Table 11-1. Central Valley-wide conservation objectives and strategies combined across all bird groups for all basins.

Central Valley-wide Objectives by Habitat Type		
Habitat type	Strategy	**Objective**
Seasonal wetlands	Protection	Protect all unprotected wetlands with fee or conservation easements
Seasonal wetlands	Restoration	108,527 acres
Seasonal wetlands	Enhancement	23,884 acres annually[a]
Semi-permanent wetlands	Restoration	12,500 acres
Riparian areas	Restoration	10,000 acres
Rice cropland	Enhancement[b]	170,000 acres
Waterfowl-friendly agricultural crops	Enhancement	307,000 acres

[a] *Annual enhancement needs when restoration goals have been met.*

[b] *Post-harvest (winter flooding) of rice cropland.*

[c] *Type I agricultural easements: easements that protect waterfowl food sources, focused in American, Butte, and Sutter Basins.*

[d] *Type II agricultural easements: easements that buffer existing wetlands from urban and residential development, focused in American, Butte, Sutter, Delta, and San Joaquin Basins.*

> "New habitat objectives for the four major bird initiatives identified in this Implementation Plan will direct the JV's future activities, and are based upon the very best available science. The JV partners must work more effectively than ever to implement essential conservation measures in the face of extraordinary growth, and associated competition for land and water resources in the Central Valley. The JV has accomplished much. Our future success will depend upon the continued strength of our partnership, diverse funding programs, and a widely recognized need to protect, enhance and restore internationally important wetland, riparian, and agricultural resources."
>
> **Bob Shaffer**
> *Coordinator*
> *Central Valley Joint Venture*

Introduction

This Plan addresses the habitat needs of six bird groups including: (1) wintering waterfowl; (2) breeding waterfowl; (3) wintering shorebirds; (4) breeding shorebirds; (5) waterbirds; and (6) riparian songbirds. This chapter provides a summary of the conservation objectives associated with each of these bird groups. Where possible, conservation objectives for all bird groups are then integrated at the basin scale to improve the efficiency of all-bird conservation in the Central Valley. The cost of meeting these conservation objectives is also estimated. Finally the ability of existing conservation programs to meet integrated bird conservation objectives for the Central Valley is reviewed, and the need for additional programs is assessed. This chapter is divided into four sections: (1) conservation objectives by bird group; (2) integrating bird conservation objectives; (3) estimated costs of meeting integrated bird conservation objectives; and (4) conservation delivery options.

Conservation Objectives by Bird Group

Conservation objectives for wintering waterfowl, breeding waterfowl, and riparian songbirds were established for each of the nine Central Valley's basins. However, some basins were combined into larger planning regions when establishing conservation objectives for wintering shorebirds, breeding shorebirds, and waterbirds. The need to combine basins was largely driven by the lack of information available for these bird groups at the basin scale.

Two broad planning regions that contained multiple basins are recognized in this Plan: (1) the Sacramento Valley Planning Region; and (2) the Delta Planning Region. For wintering shorebirds and waterbirds, the Sacramento Valley Planning Region includes the American, Butte, Colusa, and Sutter Basins. For breeding shorebirds, the Sacramento Valley Planning Region includes these four basins and the Yolo Basin (Table 11-2). For wintering shorebirds, the Delta Planning Region includes the Yolo and Delta Basins, while the Delta Planning Region for waterbirds includes these two basins and Suisun Basin. Conservation objectives were established for all bird groups in the San Joaquin and Tulare Basins (Table 11-2).

Table 11-2. Scale at which conservation objectives were established for each bird group.

<table>
<tr><th>Basin</th><th>Wintering Waterfowl</th><th>Breeding Waterfowl</th><th>Wintering Shorebirds</th><th>Breeding Shorebirds</th><th>Waterbirds</th><th>Riparian Songbirds</th></tr>
<tr><td>American[ab]</td><td>•</td><td>•</td><td rowspan="4">•</td><td rowspan="5">•</td><td rowspan="4">•</td><td>•</td></tr>
<tr><td>Butte[ab]</td><td>•</td><td>•</td><td>•</td></tr>
<tr><td>Colusa[ab]</td><td>•</td><td>•</td><td>•</td></tr>
<tr><td>Sutter[ab]</td><td>•</td><td>•</td><td>•</td></tr>
<tr><td>Yolo[bcd]</td><td>•</td><td>•</td><td rowspan="2">•</td><td rowspan="3">•</td><td>•</td></tr>
<tr><td>Delta[cd]</td><td>•</td><td>•</td><td>•</td><td>•</td></tr>
<tr><td>Suisun[d]</td><td>•</td><td>•</td><td>NC</td><td>NC</td><td>NC</td></tr>
<tr><td>San Joaquin</td><td>•</td><td>•</td><td>•</td><td>•</td><td>•</td><td>•</td></tr>
<tr><td>Tulare</td><td>•</td><td>•</td><td>•</td><td>•</td><td>•</td><td>•</td></tr>
</table>

[a] Basins included in the Sacramento Valley Planning Region for wintering shorebirds and waterbirds.
[b] Basins included in the Sacramento Planning Region for breeding shorebirds.
[c] Basins included in the Delta Planning Region for wintering shorebirds.
[d] Basins included in the Delta Planning Region for waterbirds.
NC – No conservation objectives.

Wintering Waterfowl

Wintering waterfowl includes migrating and wintering ducks and geese that rely on Central Valley habitats between August and March. Seasonal wetland restoration objectives total 104,000 acres for the Central Valley and vary widely among basins (Table 11-3). Proper water management is critical to producing large amounts of food in seasonal wetlands. However, water control structures, levees, and ditch networks used to manage water levels must be periodically repaired or enhanced to maintain or improve food production. The JV assumes that managed seasonal wetlands need some form of enhancement on average every twelve years. As a result, wetland enhancement objectives are expressed perpetually as one-twelfth of the total wetland acres. Annual wetland enhancement objectives for the Central Valley total 23,603 acres when wetland restoration objectives have been met (Table 11-3).

The agricultural enhancement objective for wintering waterfowl is divided into two sub-objectives: (1) waterfowl-friendly agriculture, and (2) winter-flooded rice. Waterfowl-friendly agriculture includes: winter-flooded rice; rice that is not deep plowed following harvest and remains dry; corn that is winter-flooded; and corn that is not deep plowed following harvest and remains dry. Most waterfowl-friendly agriculture consists of rice habitat, except in the Delta Basin where corn is prevalent. Habitat objectives for waterfowl-friendly agriculture are 307,000 acres. Habitat objectives for winter flooded rice are 170,000 acres. (Table 11-3). The need for agriculture easements that protect waterfowl food sources (Type I) was identified for the American, Butte, and Sutter Basins. The need for agricultural easements that buffer existing wetlands from urban and residential development (Type II) was identified for the American, Butte, Sutter, Delta, and San Joaquin Basins (Table 11-3).

Table 11-3. Conservation objectives for wintering waterfowl in the Central Valley.

Basin	*Seasonal Wetland Restoration (acres)*	*Seasonal Wetland Enhancement (acres)*	*Waterfowl-friendly Agriculture (acres)*[a]	*Winter Flooded Rice (acres)*[b]	*Type I*[c] *Easements*	*Type II*[d] *Easements*
American	20,000	1,932	69,000	50,000	Needed	Needed
Butte	17,000	3,362	104,000	62,000	Needed	Needed
Colusa	2,000	2,033	85,000	45,000		
Sutter	4,000	496	18,000	10,000	Needed	Needed
Yolo	3,000	963	8,000	3,000		
Delta	19,000	2,112	23,000	0		Needed
Suisun	0	2,686	0	0		
San Joaquin	20,000	6,751	0	0		Needed
Tulare	19,000	3,268	0	0		
Total	**104,000**	**23,603**	**307,000**	**170,000**		

[a] *Waterfowl-friendly agriculture is defined as the amount of winter flooded rice plus rice and corn acres that are not flooded and are not deep plowed following harvest.*

[b] *The amount of harvested rice that must be flooded to meet wintering duck needs when wetland restoration objectives are met for the Central Valley.*

[c] *Agricultural easements that maintain waterfowl food resources on agricultural lands.*

[d] *Agricultural easements that buffer existing wetlands from urban and residential development.*

Breeding Waterfowl

Most waterfowl that breed in the Central Valley are mallards, therefore, recommendations for breeding waterfowl in this Plan focus on this species. However, habitat acre objectives were not established for breeding waterfowl in this Plan, rather, general recommendations were made to increase semi-permanent wetlands and/or upland cover to improve the success of breeding waterfowl populations. These recommendations were based on an assessment of existing landscape conditions. In general, this Plan calls for increases in semi-permanent wetlands and upland cover in the northern basins of the Central Valley. Increases in semi-permanent wetlands are recommended for the remaining basins (Table 11-4). Specific areas of each basin where increases in semi-permanent wetlands and/or upland cover are suggested were identified in Chapter 5.

Table 11-4. Conservation objectives for breeding waterfowl in the Central Valley.

Basin	*Semi-Permanent Wetlands*	*Semi-Permanent Wetland & Upland Cover*
American		Increase
Butte		Increase
Colusa		Increase
Sutter		Increase
Yolo		Increase
Suisun	Increase	
Delta	Increase	
San Joaquin	Increase	
Tulare	Increase	

Wintering Shorebirds

Wintering shorebirds include migrating and wintering birds that rely on the Central Valley between July and May. Habitat objectives for wintering shorebirds were established for seasonal wetlands, semi-permanent wetlands, and winter-flooded rice (Table 11-5). Seasonal wetland restoration objectives are high throughout the Central Valley and represent the amount of seasonal wetland habitat that must be managed at depths <10 cm (~4 inches) to meet shorebird needs. Although seasonal wetlands are not available in July, most semi-permanent wetlands are being drawn down during this month. Draining these wetlands can create favorable foraging conditions for shorebirds as water levels are reduced. Acre objectives for semi-permanent wetlands represent the amount of shallow water habitat that must be provided by these habitats during the July drawn down period. Finally, winter-flooded rice is available to shorebirds between October and March in the Sacramento and Delta Planning Regions. Acre objectives for winter-flooded rice represent the amount of flooded agricultural habitat <10 cm in depth that is needed for wintering shorebirds.

Table 11-5. Conservation objectives for wintering shorebirds in the Central Valley.

Basin	*Seasonal Wetlands*	*Semi-Permanent Wetlands*	*Winter-Flooded Rice*
American[a]	35,696	819	18,566
Butte[a]			
Colusa[a]			
Sutter[a]			
Yolo[b]	7,334	170	5,142[c]
Delta[b]			
Suisun	NC	NC	NC
San Joaquin	40,130	175	0
Tulare	31,440	1,170	0
Total	**114,600**	**2,334**	**23,708**

[a] *Basins included in the Sacramento Planning Region for wintering shorebirds.*

[b] *Basins included in the Delta Planning Region for breeding shorebirds.*

[c] *Winter-flooded corn may substitute for winter-flooded rice in the Delta Planning Region.*

NC – No conservation objective.

Breeding Shorebirds

The 2006 Plan recommends a 7,500 acre increase in semi-permanent wetlands for breeding shorebirds over the next five years (Table 11-6). This is considered a short term objective that will be updated in future JV implementation plans, as more information on breeding shorebird habitat needs is developed. The need for increases in semi-permanent wetlands is highest in the San Joaquin and Tulare Basins, and reflects the optimum distribution of breeding shorebirds in the Central Valley.

Table 11-6. Conservation objectives for breeding shorebirds in the Central Valley.

Basin	*Semi-Permanent Wetlands*
American[a]	875
Butte[a]	
Colusa[a]	
Sutter[a]	
Yolo[a]	
Delta	875
Suisun	0
San Joaquin	1,315
Tulare	4,435
Total	**7,500**

[a] Basins included in the breeding shorebird Sacramento Valley Planning Region.

Waterbirds

The 2006 Plan recommends a 5,000 acre increase in semi-permanent wetlands and riparian habitat for waterbirds over the next five years (Table 11-7). This is considered a short term objective that will be updated in future JV implementation plans, as more information on waterbird habitat needs is developed. Semi-permanent wetland and riparian habitat objectives were distributed to increase the relative shortfall of these habitats in the two southernmost regions.

Table 11-7. Conservation objectives for waterbirds in the Central Valley.

Basin	*Semi-Permanent Wetlands*	*Riparian Habitat*
American[a]	1,000	1,000
Butte[a]		
Colusa[a]		
Sutter[a]		
Yolo[b]	1,000	1,000
Delta[b]		
Suisun[b]		
San Joaquin	1,500	1,500
Tulare	1,500	1,500
Total	**5,000**	**5,000**

[a] Basins included in the Sacramento Planning Region for waterbirds.
[b] Basins included in the Delta Planning Region for waterbirds.

Riparian Songbirds

The 2006 Plan recommends an 8,700 acre increase in riparian habitat for songbirds over the next five years (Table 11-8). This is considered a short term objective that will be updated in future JV implementation plans, as more information on riparian songbird habitat needs is developed. Habitat objectives are distributed based generally on the potential for restoring riparian habitat within basins.

Table 11-8. Conservation objectives for riparian songbirds in the Central Valley.

Basin	*Riparian Habitat*
American	675
Butte	1,125
Colusa	1,350
Sutter	675
Yolo	675
Delta	1,500
Suisun	0
San Joaquin	2,500
Tulare	200
Total	**8,700**

Integrating Bird Conservation Objectives

Conservation objectives for each bird group included in this Plan were developed separately (Chapters 4 through 9). However, 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 species, and identifying these areas of overlap may increase the efficiency of all-bird conservation. The JV identified eight conservation objectives that collectively meet the needs of bird groups included in this Plan; (1) restoration of seasonal wetlands; (2) enhancement of seasonal wetlands; (3) restoration of semi-permanent wetlands: (4) restoration of riparian habitat; (5) winter flooding of harvested rice; (6) maintenance of waterfowl-friendly agriculture which includes winter-flooded rice, and non-flooded rice and corn fields that are not deep plowed following harvest; (7) acquisition of easements that maintain agricultural food sources; and 8) acquisition of agricultural easements that buffer existing wetlands from residential growth and development.

The JV used the following process to integrate bird needs for each of these eight conservation objectives. First, all bird groups associated with a conservation objective were identified. For example, objectives for winter-flooded rice were established for wintering waterfowl and wintering shorebirds, but not for the other four bird groups. Secondly, the bird group with the largest acre objective was identified in each basin or planning region as in the following example. The winter-flooded rice objective for wintering shorebirds in the Sacramento Planning Region is 18,566 acres (Table 11-5). Winter-flooded rice objectives for waterfowl in basins included in this shorebird planning region total 167,000 acres (Table 11-3). Finally, the JV assessed whether meeting the larger acre objective of one bird group would meet the needs of other bird groups. For example, within the 167,000 acre waterfowl objective are there enough acres managed at depths that are suitable for shorebirds? If the answer is yes, then flooded rice objectives for wintering waterfowl and wintering shorebirds may completely overlap in the Sacramento Valley Planning Region. If the answer is no, then flooded rice objectives for shorebirds may be partially or wholly additive to those for waterfowl. (Obtaining better information on water depths in rice fields prior to the next implementation plan update will allow the JV to better address this issue).

Seasonal Wetland Restoration

Acre objectives for seasonal wetlands were established for wintering waterfowl and wintering shorebirds. For waterfowl, acre objectives were established for all nine basins. For shorebirds, acre objectives were established for the Sacramento Valley and Delta Planning Regions and for the Suisun, San Joaquin, and Tulare Basins (Table 11-5). Wetland restoration objectives for waterfowl represent new wetland acres. Where possible, seasonal wetland objectives for shorebirds will be met through management of existing wetlands and management of seasonal wetlands that are restored for wintering waterfowl. However, seasonal wetland flooding schedules are not always consistent with shorebird needs (Chapter 6). Most or all seasonal wetlands in the Central Valley are flooded after mid-August (defined as conventional flooding). However, wetland objectives for wintering shorebirds include seasonal wetlands that are flooded prior to this mid-August date (defined as early flooding). Seasonal wetland objectives for shorebirds in this early flooding period are considered additive to those for waterfowl, while wetland objectives for waterfowl and shorebirds in the conventional flooding period are assumed to overlap.

Sacramento Valley Planning Region

Seasonal wetland objectives for wintering shorebirds in the Sacramento Valley Planning Region total nearly 36,000 acres during the conventional flooding period and nearly 1,600 acres during the early flooding period. Seasonal wetland restoration objectives for waterfowl in Sacramento Valley Planning Region basins total 43,000 acres (Table 11-9). There are currently 51,000 acres of seasonal wetlands in this region (Table 3-1). This figure increases to 94,000 acres if wetland objectives for waterfowl are met. However, shorebirds require 1,584 acres of seasonal wetlands prior to mid-August, when most or all of these habitats are dry (Table 11-9). Thus, 38% of seasonal wetland acres in the Sacramento Valley Planning Region basins (36,000/94,000) should be managed at depths consistent with shorebird needs, and nearly 1,600 of these acres should be provided in the early flooding period (Table 11-9). These early-flooded acres are considered additive to seasonal wetland objectives for waterfowl, while seasonal wetland objectives for waterfowl and shorebirds in the conventional flooding period are assumed to overlap.

Delta Planning Region

Seasonal wetland objectives for wintering shorebirds in the Delta Planning Region total 6,994 acres in the conventional flooding period and 340 acres in the early flooding period. Seasonal wetland objectives for waterfowl in the Delta Planning Region basins total 22,000 acres (Table 11-9). There are currently 15,000 acres of seasonal wetlands in the Delta Planning Region basins (Table 3-1). This figure increases to 37,000 acres if wetland objectives for waterfowl are met. Thus, 20% of seasonal wetlands in these basins (7,300 / 37,000) should be managed <10 cm in depth and 340 of these acres should be provided in the early flooding period. These early-flooded acres are considered additive to seasonal wetland objectives for waterfowl, while wetland objectives for waterfowl and shorebirds in the conventional flooding period are assumed to overlap (Table 11-9).

San Joaquin Basin

Wintering shorebirds in the San Joaquin Basin require over 40,000 acres of seasonal wetland habitat as no winter-flooded rice is available. Three hundred and forty acres must be provided during the early flooding period. Seasonal wetland objectives for wintering waterfowl total 20,000 acres (Table 11-9). There are now 61,000 acres of seasonal wetlands in the San Joaquin Basin (Table 3-1). This figure would increase to 81,000 acres if seasonal wetland objectives are met for waterfowl. Overall nearly 50% of seasonal wetlands in the San Joaquin Basin should be managed at depths that meet shorebird needs, with 340 of these acres provided in the early flooding period (Table 11-9).

Tulare Basin

Wintering shorebirds in Tulare Basin require over 31,000 acres of seasonal wetland habitat. Nearly 2,300 acres must be provided in the early flooding period (Table 11-9). Seasonal wetland objectives for wintering waterfowl total 19,000 acres. Seasonal wetlands now total 20,212 in the Tulare Basin and meeting wetland restoration objectives for wintering waterfowl will increase this figure to nearly 40,000 acres. Over 75% of these acres would have to be managed <10 cm deep to meet shorebird needs, with 2,300 of these acres provided in the early flooding period. These early-flooded acres are considered additive to seasonal wetland objectives for waterfowl, while wetland objectives for waterfowl and shorebirds in the conventional flooding period are assumed to overlap (Table 11-9).

Table 11-9. Integrated seasonal wetland objectives (acres) for wintering waterfowl and wintering shorebirds in the Central Valley.

Basin	*Wintering Waterfowl*[c]	*Wintering Shorebirds Conventional Flooding*[d]	*Wintering Shorebirds Early Flooding*[e]	*Basin Totals*[f]
American[a]	20,000	34,112	1,584	20,396
Butte[a]	17,000			17,396
Colusa[a]	2,000			2,396
Sutter[a]	4,000			4,396
Yolo[b]	3,000	6,994	340	3,170
Delta[b]	19,000			19,170
Suisun	0	NC	NC	0
San Joaquin	20,000	39,790	340	20,340
Tulare	19,000	29,177	2,263	21,263
Total	**104,000**	**110,073**	**4,527**	**108,527**

[a] *Basins included in the Sacramento Planning Region for wintering shorebirds.*

[b] *Basins included in the Delta Planning Region for breeding shorebirds.*

[c] *Seasonal wetland restoration objectives for wintering waterfowl. These represent new wetland acres to be added to the landscape.*

[d] *Seasonal wetland objectives for wintering shorebirds in the conventional flooding period (flooded after mid-August). The JV assumes that seasonal wetland objectives for shorebirds in this flooding period can be met through management of existing wetlands and wetlands that are restored for wintering waterfowl.*

[e] *Seasonal wetland objectives for wintering shorebirds in the early flooding period (flooded prior to mid-August). The JV assumes that seasonal wetland objectives for shorebirds in this flooding period are additive to that of waterfowl.*

[f] *Integrated seasonal wetland objectives equal the sum of waterfowl objectives and shorebird objectives in the early flooding period. Seasonal wetland objectives for shorebirds in the early flooding period are distributed equally among basins included in a shorebird planning region when integrating objectives for the two bird groups. (e.g. the 1584 acre objective in the Sacramento Valley Planning Region is distributed equally among the four basins included in the region).*

NC – No conservation objective.

Butte basin
Photo: Bob McLandress

Seasonal Wetland Enhancement

Water control structures, levees, and ditch networks used to manage seasonal wetlands must be periodically repaired or enhanced to maintain the quality of these habitats. The JV assumes that managed seasonal wetlands need some form of enhancement on average every twelve years. As a result, wetland enhancement objectives are expressed perpetually as one-twelfth of the total wetland acres. Table 11-10 lists: (1) the amount of seasonal wetland habitat that will be present in the Central Valley when integrated seasonal wetland objectives are met for wintering waterfowl; and (2) wintering shorebirds, and the annual wetland enhancement objectives that are associated with this seasonal wetland base.

Table 11-10. Integrated seasonal wetland enhancement objectives for wintering waterfowl and wintering shorebirds in the Central Valley.

Basin	*Seasonal Wetlands[a] (acres)*	*Annual Seasonal Wetland[b] Enhancement Objectives (acres/year)*
American	23,583	1,957
Butte	40,736	3,381
Colusa	24,786	2,057
Sutter	6,347	527
Yolo	11,728	973
Delta	25,519	2,118
Suisun	32,232	2,675
San Joaquin	81,353	6,752
Tulare	41,475	3,442
Total	**287,759**	**23,884**

[a] Seasonal wetlands that are present in a basin when integrated seasonal wetland objectives are met for wintering waterfowl and wintering shorebirds.

[b] Annual seasonal wetland enhancement objectives assume that all seasonal wetlands need some form of enhancement on average every twelve years.

Semi-Permanent Wetlands

Acre objectives for semi-permanent wetlands were established for wintering shorebirds, breeding shorebirds, and waterbirds (Table 11-11). The JV assumes that semi-permanent wetland objectives for wintering shorebirds will be met through management of existing wetlands (Chapter 6). In contrast, semi-permanent wetland objectives for breeding shorebirds and waterbirds represent new wetland acres. Semi-permanent wetlands managed for breeding shorebirds are typically more open and contain less emergent vegetation that wetlands used by waterbirds (see Chapter 7 and Chapter 8). As a result, the JV assumes that semi-permanent wetland objectives for breeding shorebirds and waterbirds are additive (Table 11-11).

Although increases in semi-permanent wetlands were recommended for breeding waterfowl, these increases were not quantified (Table 11-4). Semi-permanent wetland objectives for breeding shorebirds and waterbirds total 12,500 acres. This represents a nearly fifty-percent increase in the 26,000 acres of semi-permanent wetlands now available in the Central Valley. Meeting this 12,500 acre objective would substantially improve habitat conditions for breeding waterfowl throughout the Central Valley, and is consistent with the general objective of increasing semi-permanent wetlands in each basin (Table 11-11).

Table 11-11. Integrated semi-permanent wetland objectives for breeding waterfowl, wintering shorebirds, breeding shorebirds, and waterbirds in the Central Valley.

Basin	*Breeding Waterfowl*	*Wintering[e] Shorebirds (acres)*	*Breeding Shorebirds[f] (acres)*	*Waterbirds[g] (acres)*	*Basin[h] Totals (acres)*
American[a,b]	Increase	819	875	1,000	425
Butte[a,b]	Increase				425
Colusa[a,b]	Increase				425
Sutter[a,b]	Increase				425
Yolo[b,c,d]	Increase	170		1,000	508
Delta[c,d]	Increase		875		1,208
Suisun[d]	Increase	NC	NC		333
San Joaquin	Increase	175	1,315	1,500	2,815
Tulare	Increase	1,170	4,435	1,500	5,935
Total		**2,334**	**7,500**	**5,000**	**12,500**

[a] *Basins included in the Sacramento Valley Planning Region for wintering shorebirds and waterbirds.*

[b] *Basins included in the Sacramento Valley Planning Region for breeding shorebirds.*

[c] *Basins included in the Delta Planning Region for wintering shorebirds.*

[d] *Basins included in the Delta Planning Region for waterbirds.*

[e] *JV assumes that semi-permanent wetland objectives for wintering shorebirds will be met through management of existing wetlands.*

[f] *Semi-permanent wetland objectives for breeding shorebirds represent new wetland acres to be added to the landscape.*

[g] *Semi-permanent wetland objectives for waterbirds represent new wetland acres to be added to the landscape.*

[h] *Sum of the semi-permanent wetland objectives for breeding shorebirds and waterbirds. Semi-permanent wetland objectives for a planning region are divided equally among the basins included in a planning region.*

NC – No conservation objective.

Riparian Habitat

Acre objectives for riparian habitat were established for riparian songbirds and waterbirds. The JV assumed that these bird groups require similar types of riparian vegetation. For songbirds, acre objectives were established for all basins except Suisun Basin. For waterbirds, riparian habitat objectives were established for the Sacramento Valley, the Delta Planning Region, and the San Joaquin and Tulare Basins (Table 11-2). Riparian habitat objectives for waterbirds in the Sacramento Valley total 1,000 acres, while objectives for songbirds in Sacramento Valley basins total 3,825 acres (Table 11-12). Riparian objectives for waterbirds in the Delta Planning Region total 1,000 acres, while objectives for riparian songbirds in Delta Planning Region equal 2,175 acres (Table 11-12). The riparian habitat objective for waterbirds is 1,500 acres in the San Joaquin Basin and 1,500 acres in the Tulare Basin, while riparian objectives for songbirds in the San Joaquin and Tulare Basins equal 2500 acres and 200 acres respectively (Table 11-12).

Meeting riparian objectives for waterbirds will meet riparian objectives for songbirds in the Tulare Basin, whereas meeting riparian objectives for songbirds will meet riparian objectives for waterbirds in the remaining basins. As a result, the JV assumed that riparian habitat objectives for these two bird groups completely overlap.

Winter Flooded Rice

Acre objectives for winter-flooded rice were established for wintering waterfowl and wintering shorebirds. For waterfowl, acre objectives were established for five basins: American, Butte, Colusa, Sutter, and Yolo (Table 11-13). For shorebirds, acre objectives were established for the Sacramento Valley and Delta Planning Regions (Table 11-13). Winter-flooded rice objectives for shorebirds in the Sacramento Valley Planning Region total 18,566 acres, while winter-flooded rice objectives for waterfowl in these basins total 167,000 acres (Table 11-13). The winter-flooded rice objective for shorebirds in the Delta Planning Region is 5,142 acres, while the flooded rice objective for waterfowl in these basins is 3,000 acres (Table 11-13).

Flooded rice objectives for waterfowl in Sacramento Valley basins exceed rice objectives for shorebirds by over 148,000 acres (167,000-18,566). Approximately eleven percent of the 167,000 acre waterfowl objective must be managed at depths <10 cm to meet shorebird needs (167,000 / 18,566). Average water depths have been measured for rice fields in the Central Valley (Elphick 1998). Water depths averaged 20 to 25 cm (~8-10 inches) in November and December, and <10 cm from January through March (Elphick 1998). These depth estimates indicate that winter-flooded rice objectives for shorebirds in the Sacramento Valley Planning Region can be addressed by meeting the larger waterfowl objective. Most of the 167,000 acres of flooded rice needed by waterfowl would be available to shorebirds from January through March. Although average water depths are higher during November and December, many rice fields are still being flooded during this period (Figure 4-8). This early season flooding should provide enough shallow water habitat for shorebirds as only a small fraction of rice field habitat must be <10 cm. As a result, flooded rice objectives for wintering waterfowl and wintering shorebirds in the Sacramento Valley Planning Region and its associated basins are assumed to completely overlap in this Plan.

Table 11-12. Integrated riparian habitat objectives for songbirds and waterbirds in the Central Valley.

Basin	*Riparian Songbirds (acres)*	*Waterbirds (acres)*	*Basin Totals (acres)*
American[a]	675	1,000	675
Butte[a]	1,125		1,125
Colusa[a]	1,350		1,350
Sutter[a]	675		675
Yolo[b]	675	1,000	675
Delta[b]	1,500		1,500
Suisun[b]	0		0
San Joaquin	2,500	1,500	2,500
Tulare	200	1,500	1,500
Total	**8,700**	**5,000**	**10,000**

[a] Basins included in the Sacramento Valley planning region for waterbirds
[b] Basins included in the Delta planning region for waterbirds

Table 11-13. Integrated winter-flooded rice objectives for wintering waterfowl and wintering shorebirds in the Central Valley.

Basin	*Wintering Waterfowl (acres)*	*Wintering Shorebirds (acres)*	*Basin Totals[c] (acres)*
American[a]	50,000	18,566	50,000
Butte[a]	62,000		62,000
Colusa[a]	45,000		45,000
Sutter[a]	10,000		10,000
Yolo[b]	3,000	5,142	3,000
Delta[b]	0		0
Suisun	0	NC	0
San Joaquin	0	0	0
Tulare	0	0	0
Total	170,000	23,708	170,000

[a] Basins included in the Sacramento Valley Planning Region for wintering shorebirds.
[b] Basins included in the Delta Planning Region for wintering shorebirds.
[c] Integrated winter-flooded rice objectives for wintering waterfowl and wintering shorebirds.

Flooded rice objectives for wintering shorebirds in the Delta Planning Region actually exceed flooded rice objectives for waterfowl in the Yolo and Delta Basins (5,142 acres vs. 3,000 acres; Table 11-13). However, winter flooding objectives for these two bird groups in the Delta Planning Region basins are still assumed to overlap. Although little rice is grown in the Delta Basin, private landowners flood over 29,000 acres of harvested corn (Table 3-5). The JV assumes that flooded corn and flooded rice are equally capable of meeting shorebird needs. Thus, winter flooding objectives for shorebirds in the Delta Planning Region can be partly or entirely met through shallow flooding of harvested cornfields.

Waterfowl-friendly Rice and Corn

Waterfowl-friendly rice and corn includes rice fields that are intentionally flooded after harvest and rice and corn fields that are not deep plowed following harvest but which remain dry. Most of the acres associated with this objective are rice acres. Acre objectives for waterfowl-friendly rice and corn were only established for wintering waterfowl (Table 11-3). As a result, no integration of this conservation objective is necessary.

Agricultural Easements

The need for Type I and Type II agricultural easements was identified for wintering waterfowl and waterbirds (primarily sandhill cranes). For waterfowl, the need for Type I agricultural easements was identified for American, Butte, and Sutter Basins. For waterbirds, the need for Type I easements was identified for the Delta Basin (Table 11-14). As a result, the need for Type I easements is completely additive for these two bird groups. The need for Type II easements for waterfowl was identified for American, Butte, Sutter, Delta, and San Joaquin Basins, while waterbirds need Type II easements in the Delta Basin (Table 11-15). Thus, wintering waterfowl and waterbirds only overlap in their need for Type II agricultural easements in the Delta Basin.

Table 11-14. Integrated Type I agricultural easements for wintering waterfowl and waterbirds in the Central Valley.

Basin	*Wintering Waterfowl*	*Waterbirds (Sandhill cranes)*	*Integrated Basin Needs*
American	Needed		Needed
Butte	Needed		Needed
Colusa			
Sutter	Needed		Needed
Yolo			
Delta		Needed	Needed
Suisun			
San Joaquin			
Tulare			

Table 11-15. Integrated Type II agricultural easements for wintering waterfowl and waterbirds in the Central Valley.

Basin	*Wintering Waterfowl*	*Waterbirds (Sandhill cranes)*	*Integrated Basin Needs*
American	Needed		Needed
Butte	Needed		Needed
Colusa			
Sutter	Needed		Needed
Yolo			
Delta	Needed	Needed	Needed
Suisun			
San Joaquin	Needed		Needed
Tulare			

Summary of Integrated Conservation Objectives

Integrated Wetland Objectives

Integrated bird conservation objectives for wetland habitats in the Central Valley are presented in Table 11-16.

Table 11-16. Integrated bird conservation objectives for wetland habitats in the Central Valley.

Basin	*Seasonal Wetland Restoration (acres)*	*Seasonal Wetland Enhancement (acres/year)*	*Semi-Permanent Wetland Restoration (acres)*	*Riparian Restoration (acres)*
American	20,396	1,957	425	675
Butte	17,396	3,381	425	1,125
Colusa	2,396	2,057	425	1,350
Sutter	4,396	527	425	675
Yolo	3,170	973	508	675
Delta	19,170	2,118	1,208	1,500
Suisun	0	2,675	333	0
San Joaquin	20,340	6,752	2,815	2,500
Tulare	21,263	3,442	5,935	1,500
Total	108,527	23,884	12,500	10,000

Integrated Agricultural Objectives

Integrated bird conservation objectives for agricultural habitats in the Central Valley are presented in Table 11-17.

Table 11-17. Integrated bird conservation objectives for agricultural habitats in the Central Valley

Basin	*Winter-Flooded Rice (acres)*[a]	*Waterfowl-friendly Agriculture*[b]	*Type I Agricultural Easements*[c]	*Type II Agricultural Easements*[d]
American	50,000	69,000	Needed	Needed
Butte	62,000	104,000	Needed	Needed
Colusa	45,000	85,000		
Sutter	10,000	18,000	Needed	Needed
Yolo	3,000	8,000		
Delta	0	23,000		Needed
Suisun	0	0		
San Joaquin	0	0		Needed
Tulare	0	0		
Total	**170,000**	**307,000**		

[a] *The amount of harvested rice that must be flooded to meet wintering duck and wintering shorebird needs when wetland restoration objectives are met for the Central Valley.*

[b] *Waterfowl-friendly agriculture is defined as the amount of winter flooded rice plus rice and corn acres that are not flooded and are not deep plowed following harvest.*

[c] *Agricultural easements that maintain waterfowl food resources on agricultural lands.*

[d] *Agricultural easements that buffer existing wetlands from urban and residential development.*

Integrated Annual Water Needs

Table 11-18. Total annual water needs for wetland and winter-flooded agricultural habitats in the Central Valley when integrated bird habitat objectives are met.

Basin	*Seasonal Wetland Water Needs (acre-feet)*[a]	*Semi-Permanent Wetland Water Needs (acre-feet)* [b]	*Agricultural Winter FloodingcNeeds (acre-feet)* [c]	*Total Water Needs (acre-feet)* [d]
American	117,915	7,304	125,000	250,219
Butte	228,122	33,626	155,000	416,748
Colusa	123,930	32,382	112,500	268,812
Sutter	31,735	5,691	25,000	62,426
Yolo	58,640	14,948	7,500	81,088
Delta	121,215	17,234	72,500	210,949
Suisun	153,102	44,555	0	197,657
San Joaquin	443,374	70,996	0	514,370
Tulare	217,744	65,440	0	283,184
Total	**1,495,777**	**292,176**	**497,500**	**2,285,453**

[a] *Annual water needs for managed seasonal wetlands (public and private) when seasonal wetland objectives are met for the Central Valley.*
[b] *Annual water needs for managed semi-permanent wetlands (public and private) when semi-permanent wetland objectives are met for the Central Valley.*
[c] *Annual water needs for winter-flooded agriculture (predominantly rice) when seasonal wetland objectives are met for the Central Valley.*
[d] *Sum of seasonal wetland, semi-permanent wetland, and winter-flooded agriculture water needs.*

Table 11-18 presents total annual water needs for seasonal wetlands, semi-permanent wetlands, and winter-flooded agriculture, when integrated bird habitat objectives are met for the Central Valley. Annual water requirements used to estimate total water needs are presented by habitat type and basin in Table 11-19. Total water for seasonal wetlands includes the water needs for existing wetlands, and the water needed when seasonal wetland restoration objectives are met. Total water needs for semi-permanent wetlands also includes water needs of existing wetlands, and the water needed when semi-permanent wetland restoration objectives are met. Finally, water needs for winter-flooded agriculture reflects the amount of winter flooding that must be maintained in the Central Valley even when wetland restoration objectives have been met.

Table 11-19. Annual water requirements (acre-feet per acre) by habitat type and basin.

Basin	*Seasonal Wetlands*[a]	*Semi-Permanent*[a] *Wetlands*	*Winter Flooded*[b] *Agriculture*
American	5.0	7.4	2.5
Butte	5.6	7.4	2.5
Colusa	5.0	7.4	2.5
Sutter	5.0	7.4	2.5
Yolo	5.0	7.4	2.5
Delta	4.75	7.4	2.5
Suisun	4.75	7.4	0
San Joaquin	5.45	7.4	0
Tulare	5.25	8.0	0

[a] *Water requirements from Central Valley Wetlands Water Supply Investigations Final Report 2000.*
[b] *Dale Garrison, USFWS personal communication.*

Securing long-term water supplies for managed wetlands in the valley will be a significant challenge for the JV. The CVPIA statutorily obligates the Secretary of Interior to consult with the JV in matters involving wetland water acquisition and delivery. Considering this obligation, the JV maintains a unique responsibility to consider CVPIA and other water supply issues related to the implementation of this 2006 Plan by participating in various forums where wetland water supplies can be affected.

Estimated Costs of Meeting Integrated Bird Conservation Objectives

The cost of delivering conservation programs in the Central Valley varies widely. As a result, dollar estimates for meeting integrated bird objectives are generalized in this Plan and are subject to change. The purpose in providing these costs is to broadly outline the challenges faced by JV partners in meeting the goals of this plan, and not provide rigorous cost projections.


Kern National Wildlife Refuge
Photo: Dale Garrison, USFWS

Cost estimates used in the 2006 Plan were provided by public and private entities that deliver conservation programs in the Central Valley. Where possible, these costs are comprehensive. For example, costs associated with wetland restoration include the cost of the actual restoration (e.g. costs of levee construction), staff costs associated with a typical project (e.g. design and permitting), and easement costs paid to a landowner.

The costs of meeting wetland and riparian restoration objectives identified in the 2006 Plan are presented in Table 11-20. Seasonal wetland and semi-permanent wetland restoration objectives were combined as restoration costs were assumed to be similar. It is important to note that semi-permanent wetland objectives in this Plan are considered five year objectives that are likely to increase in future JV Plan updates.

The costs associated with wetland enhancement were not estimated in the 2006 Plan, as these expenses vary widely by project. Similarly, the cost of acquiring reliable water supplies to meet wetland and winter-flooded rice needs was not estimated as these costs can vary widely among years. Finally, the JV did not forecast the potential costs of Type I and Type II agricultural easements as acre targets have not been established for these conservation objectives.

Table 11-20. Estimated costs of meeting wetland and riparian restoration objectives for the Central Valley.

Basin	*Wetland Restoration Objectives (acres)*[a]	*Total Wetland Restoration Costs*[b]	*Riparian Restoration Objectives (acres)*	*Total Riparian Restoration Costs*[c]	*Total Costs*[d]
American	20,821	$62,463,000	675	$3,375,000	$65,838,000
Butte	17,821	$53,463,000	1,125	$5,625,000	$59,088,000
Colusa	2,821	$8,463,000	1,350	$6,750,000	$15,213,000
Sutter	4,821	$14,463,000	675	$3,375,000	$17,838,000
Yolo	3,678	$11,034,000	675	$3,375,000	$14,409,000
Delta	20,378	$61,134,000	1,500	$7,500,000	$68,634,000
Suisun	333	$999,000	0	$0	$999,000
San Joaquin	23,155	$69,465,000	2,500	$12,500,000	$81,965,000
Tulare	27,198	$81,594,000	1,500	$7,500,000	$89,094,000
Total	**121,027**	**$363,078,000**	**10,000**	**$50,000,000**	**$413,078,000**

[a] *Includes seasonal and semi-permanent wetland restoration objectives.*
[b] *Wetland restoration costs estimated at $3,000/acre.*
[c] *Riparian restoration costs estimated at $5,000/acre*
[d] *Sum of wetland and riparian restoration costs.*

Conservation Delivery Options

The JV has made great strides towards meeting conservation objectives set forth in the 1990 Plan. This success has been due to the efforts of many partners and a wide range of habitat programs. Some programs, such as California Wildlife Conservation Board's Inland Wetlands Conservation Program and California Department of Fish and Game's California Waterfowl Habitat Program, were developed in response to and for the purpose of implementing the stated objectives of the 1990 Plan. As the 2006 Plan has greatly expanded the JV's objectives to include multiple bird groups and habitat types, a comprehensive assessment of existing programs to deliver these objectives is needed. This assessment will evaluate the capability of current programs to deliver JV objectives, provide recommendations for adjusting existing programs, and identify new programs to deliver the 2006 Plan's objectives over the next 5 years.

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CALIFORNIA
WATERFOWL

February 2, 2012

Delta Stewardship Council
980 Ninth Street, Suite 1500
Sacramento, CA 95814
Attn: Terry Macaulay

RE: Comments on Fifth Draft Delta Plan Environmental Impact Report (EIR)

Dear Chairman Isenberg and Council Members:

The California Waterfowl Association (CWA), a nonprofit organization dedicated to the conservation of California's waterfowl, wetlands and hunting heritage, would like to take this opportunity to provide input on the Delta Stewardship Council's fifth draft Delta Plan EIR.

First, please note that the Delta Plan is statutorily required to address waterfowl habitat needs. Section 85302 (e) (6) of the Water Code mandates, as part of its subgoals and strategies, that the Delta Plan "*Restore habitat necessary to avoid a net loss of migratory bird habitat and, where feasible, increase migratory bird habitat to promote viable populations of migratory birds.*"

In addition, Section 85302 (c) states that "The Delta Plan shall include measures to promote all of the following characteristics of a healthy Delta ecosystem:

(1) Viable populations of native resident and migratory species.
(2) Functional corridors for migratory species.
(3) Diverse and biologically appropriate habitat and processes."

The Sacramento-San Joaquin Delta, along with the adjacent Suisun Marsh, historically provided key habitat for migratory and resident waterfowl. Despite significant changes in land and water use over the last 150 years, conservation efforts by nonprofits like CWA, state and federal resource agencies, farmers and other private landowners have helped protect and even enhance the Delta and Suisun Marsh's overall waterfowl habitat values. In fact, the Delta and Suisun Marsh of today still support millions of migratory birds while also providing important wildlife-dependent recreational opportunities for the public—chiefly hunting and wildlife viewing.

The land use and conservation efforts most responsible for the Delta and Suisun Marsh's contemporary benefit to ducks, geese and other migratory birds are managed wetlands and associated uplands, as well as wildlife-friendly farming practices. Managed wetlands offer critical winter foraging habitat, while also providing important late winter/spring breeding areas for waterfowl. Upland fields adjacent to managed wetlands are also a key component to waterfowl nesting success. Post-harvest corn fields, as well as some rice cultivation, additionally provide critical food resources for migrating waterfowl and shorebirds throughout much of the Delta. The Delta Plan should support these ongoing conservation efforts.

It should also be noted that managed wetlands, due to the ability of wetland managers to precisely control the flooding and manipulation of the land, tend to be amongst the most biologically productive of all wetland types. Recognizing that California has lost over 90 percent of its original wetlands, it is critical that those wetlands which remain are as productive as possible through biologically proven, active manipulation and management activities.

4630 Northgate Blvd. Suite 150, Sacramento, CA 95834
916.648.1406 • www.calwaterfowl.org

Conversely, the tidal wetlands targeted for restoration under the Delta Plan—while used by some diving duck species as wintering habitat—unfortunately offer only limited food resources overall for waterfowl and generally less quality waterfowl breeding habitat than either managed wetlands or pre-harvest, flooded agricultural lands.

With that background, please consider the following comments:

- The draft Delta Plan's legally enforceable Policy ER P2 states "that habitat restoration actions must be consistent with the habitat type locations based on elevations shown on the elevation map in Figure 5-2 page 117, and accompanying text shown in Appendix D."

  This has the potential to severely limit habitat creation and opportunities, particularly as it relates to managed wetlands and associated upland habitat, since most of the habitat type locations specified on the elevation map within the Suisun Marsh and Delta are labeled as "intertidal" or "subtidal". It should also be noted that the Fifth Draft of the Delta Plan defines "habitat restoration" as tidal, riparian and floodplain restoration, and does not specifically include managed wetlands or upland nesting habitat as part of that definition.

- The draft Delta Plan's Policy ER P3 states, "Actions other than habitat restoration, including new or amended local or regional land use plans, shall demonstrate that they have, in consultation with the Department of Fish and Game, avoided or mitigated within the Delta the adverse impacts to the opportunity for habitat restoration at the elevations shown in Figure 5-2."

  Again, this policy places unnecessary restrictions on land uses which may be beneficial to waterfowl and other wildlife, such as the cultivation of corn or rice. Seasonal managed wetland activity or agricultural practices that have the potential to cause oxidation or reduce peat soils, for instance, could be considered inconsistent with ER P3 and deemed as not a covered action.

- All actions that meet the requirements of Section 85057.5(a) of the Water Code are covered actions unless the action: 1) falls with the statutory exclusions found in Section 85057.5(b) of the Water Code or 2) is expressly excluded by the Delta Plan.

  Section 85057.5(b) states that a covered action does not include "Routine maintenance and operation of any facility located, in whole or in part, in the Delta, that is owned or operated by a local public agency." Page 54 of the draft Delta Plan also states that "Routine agricultural practices are unlikely to be considered a covered action unless they have significant impacts on the achievement of the coequal goals."

  Many of the levees which protect and support managed wetlands in the Delta and Suisun Marsh are maintained by local districts, while managed wetlands themselves require routine maintenance and operation activities in order to optimize habitat values. Routine agricultural activities include the flooding of post-harvest rice and corn fields for decomposition purposes, which greatly benefit migratory waterfowl and other birds and are supported by the Department of Fish and Game's policies. Managed wetland activities, as well as post-harvest flooding of rice and corn, should appropriately be considered covered actions because they provide high quality migratory bird habitat, which (as noted above) the Delta Plan is statutorily required to support.

- The impacts implementation of the Delta Plan's current draft policies—particularly on the Suisun Marsh—will have significant direct and indirect physical changes in the environment. The following environmental consequences have not been considered, disclosed, or analyzed in the draft EIR and must be addressed:

1. The loss, conversion, or degradation of existing seasonal managed wetland habitats from the implementation of the Council's Policies on the changes in seasonal managed wetlands operations and maintenance.

2. The loss, conversion, or degradation of existing wildlife species diversity, abundance and presence in the Suisun Marsh from the implementation of the Council's Policies on the changes in seasonal managed wetlands operations and maintenance.

3. Reduction in existing waterfowl species composition, abundance, and distribution wintering food source availability and loss.

4. Reductions of wintering waterfowl carrying capacity within the Suisun Marsh, including impacts and loss of resident breeding and migratory waterfowl populations, raptors, water birds, and terrestrial wildlife species.

5. Impacts and loss of wetland plant communities in the managed wetlands supporting the endangered Salt Marsh Harvest Mouse.

6. The economic and social impact of changes in existing Suisun Marsh habitats and salinity regimes that could change existing waterfowl hunting and the financial viability of continued wetland conservation activities.

- The draft Delta Plan's focus on a "more natural flow regime" threatens to curtail water diversions for managed wetlands and wildlife-friendly agriculture that depend heavily on surface water supplies, such as Sacramento River flows. This includes National Wildlife Refuges and State Wildlife Areas (many of which a part of the Central Valley Project Improvement Act's Refuge Water provisions), duck clubs and other privately owned wetlands, and lands under rice cultivation. As the draft EIR states, "Under the Proposed Project, the SWRCB would be encouraged to modify Delta flow objectives in order to place more emphasis on creating a natural flow regime in the Delta. Such objectives would likely reduce the amount of water available for municipal, agricultural, and industrial water uses within the Delta and outside the Delta…"

  A "more natural flow regime" in the Delta would require reductions in upstream water storage, which, in turn, would affect the availability of critically-needed water supplies for waterfowl habitat. The draft EIR fails to fully analyze and mitigate for this significant effect to the environment.

Thank you for the opportunity to comment. I applaud the Council and its staff's efforts to meet the co-equal goals of a more reliable water supply and protection and enhancement of the Delta ecosystem while balancing the needs of a diverse array of stakeholders. Should you have questions about our input or need additional information, I may be reached at jcarlson@calwaterfowl.org or (916) 648-1406.

Sincerely,

John Carlson, President
California Waterfowl Association

DUCKS
UNLIMITED
1937-2012

Western Regional Office
3074 Gold Canal Drive
Rancho Cordova, CA 95670-6116
(916) 852-2000 fax (916) 852-2200
www.ducks.org

February 2, 2012

VIA ELECTRONIC MAIL: eircomments@deltacouncil.ca.gov

Mr. Phil Isenberg
Chair, Delta Stewardship Council
980 Ninth Street, Suite 1500
Sacramento, California 95814

Re: Draft Delta Plan EIR

Dear Chairman Isenberg and Members of the Council:

Ducks Unlimited has reviewed the 5th Draft of the Delta Plan (the Plan) and the accompanying DEIR. Our comments and concerns are focused on the effect of the Plan and its implementation on the waterfowl that utilize wetland habitats in the Delta/Suisun Marsh, Sacramento Valley and the San Joaquin Valley and the mitigation of adverse impacts, or lack thereof, that is being proposed to offset those impacts.

Generally speaking our concerns can be summarized as follows. First, the Plan indicates that it is not proposing specific projects, but rather, is providing a set of "Policies" and "Recommendations" that will guide the Council in its consideration to approve, for consistency with the Plan, future proposed projects, aka "covered actions." The Plan proposes polices and recommendations that promote the restoration of the wetland habitats, primarily tidal wetlands, needed to fill the deficit of critical fish rearing habitat in the Delta. However, it fails to recognize that much of the land where historic tidal wetlands occurred, after having been "reclaimed" to agriculture for decades, has been restored to seasonal managed wetlands critical to the needs of an entirely different suite of species –birds. Despite the fact that provisions of the Delta Reform Act of 2009 requires that habitat be restored to ensure that there be no net loss of migratory bird habitat, neither the Plan or the DEIR propose measures to avoid such impacts or to mitigate for the likely mass conversion of one habitat (managed seasonal wetlands) to another (tidal wetlands). Second, the policies contained in the Plan to promote the adoption of updated flow requirements by the State Water Resources Control Board could have a significant detrimental impact on water supplies to wetlands and agricultural lands important to migratory birds in various portions of the Sacramento Valley, the Delta and the San Joaquin Valley. While the Plan and DEIS does not describe it, we suspect that updated flow requirements would constitute higher flows through the Delta in the winter months and lower ones in the summer. If so, the increased flow through the Delta would likely result in less water available to, among other purposes, birds both in and outside the Delta. This impact is not described, analyzed or mitigated. Third, the "Delta as a Place" is described and policies and recommendations are proffered to address the economic sustainability of the region. The obvious opportunities to integrate economic values of recreation and agriculture are not discussed or suggested. Fourth, although the Delta Plan does not specifically address conveyance of water, it could and should contain policies that prevent or mitigate for transfer of water supplies from the Sacramento Valley and Delta to other regions of the State to the detriment of valuable private and public wetlands.

Conversion of seasonal managed wetlands to tidal wetlands. In previous correspondence we have stressed the critical nature of the entire Central Valley with respect to supporting breeding, migrating, and wintering waterfowl and other water bird populations. The remaining wetlands –virtually all intensively managed and artificially irrigated- serve as the primary wintering ground for the entire Pacific Flyway. The Delta is one of the Valley's key areas for wintering migratory birds. The Central Valley once contained over four million acres of wetlands and supported 20-40 million wintering waterfowl annually. Today its wetlands have been reduced by close to 95%. Nevertheless, it still constitutes, quite possibly, the most important migratory bird habitat on the entire planet. Every acre that we are able to protect and restore for this purpose is critical.

Ducks Unlimited, our supporters, allies and partners have protected and restored thousands of acres of wetland habitat in the Central Valley, utilizing literally hundreds of millions of public and private dollars. This work has been conducted over many years but accelerated since the enactment of the North American Waterfowl Management Plan and the creation of the Central Valley Joint Venture. Delta wetlands play a pivotal role in the overall effort, and currently serve a large portion of the five to six million birds that live in the Central Valley from August through April. The Central Valley Joint Venture partnership, on which DU and 19 other NGOs and public agencies participate, has adopted a long- term implementation plan that is based on rigorous science and realistic habitat expectations. In the Delta, this partnership has restored over 8,000 acres of wetlands and enhanced approximately 30,000 agricultural acres for migratory birds. We remain focused on completing our goals for the Delta, which will require restoring another 19,000 acres of seasonal wetlands and enhancing 52,000 acres of agricultural lands.

Much of this work can be undone by converting the thousands of acres of managed seasonal wetlands to tidal wetlands. Historically, the Delta and the rest of the Central Valley supported many times the number of migratory birds it does now, enjoying the more "natural flow regime" where rivers overflowed and wetlands were naturally irrigated by flood waters. Due to the massive conversion of natural wetlands to agriculture and urbanization and the manipulation of the region's hydrology, it is impossible for the functions and values of these natural seasonal wetlands to exist independently. Therefore, we have created managed wetlands, where land is "farmed" for the food plants needed by the visiting flocks and irrigated through gates and canals. This effort is rewarded by higher values for migratory birds than possible under unmanaged conditions. Tidal wetlands provide some food and other habitat needs for birds, but are less valuable at a ratio of about 7:1. That means that when seasonal wetlands are converted to tidal wetlands and "natural" processes are left to endure, there is a major decline in habitat value for migratory birds. Focusing on just fish, as the Delta Plan does, may result in a significant decrease in the capacity of the region to serve the biological needs of other wintering and resident wildlife.

With that in mind, Ducks Unlimited and our CVJV allies sought language and amendments to the originally drafted Sacramento-San Joaquin Delta Reform Act of 2009 (the Act) to ensure that, as policies were developed, actions taken and projects were implemented to protect, restore and enhance the Delta ecosystem, they would not favor one species or group of species over the other and would not adversely impact the ecological values already provided by previous conservation work. According to the Act, the implementation of the Delta Plan shall further the restoration of the Delta ecosystem and include measures that promote, among other things, "Viable populations of native resident and migratory species [Section 85302 (c) (1)]." Even more specifically, the Delta Plan was required to contain "the following subgoals and strategies for restoring a healthy ecosystem: (6) Restore habitat necessary to avoid a net loss of migratory bird habitat (emphasis added) and, where feasible, increase migratory bird habitat to promote viable populations of migratory birds [Section 85302 (e) (6)]. We intended that language to result in a Delta Plan that addressed this habitat conversion issue, avoided detrimental impacts to migratory birds and contained policies and recommendations to ensure that there would be "no net loss of functions and values" for these species' habitats. To comply with these legally binding requirements the Plan should contain 1. a policy that habitat projects avoid the conversion of managed seasonal wetlands to another habitat type, and 2. a policy that ensures, when wetland habitat conversion is unavoidable, that an evaluation of the functions and values of the converted habitat be conducted and the project components contain measures to replace the lost functions and values. We were unable to find anything in the Plan or DEIR that contained such provisions.

Impacts of an enhanced flow regime in the Delta on Valley wetlands. Policy ER P1 of the Delta Plan states that development, implementation and enforcement of new and updated flow requirements for the Delta and high priority tributaries is key to the achievement of the coequal goals and that the State Water Resources Control Board should update the Bay-Delta Water Quality Control Plan objectives that are needed to achieve the coequal goals. In Section 2.2.4.1 of the DEIR it discusses the potential of such an update to impact water supplies currently enjoyed by water users both in the Delta and outside the Delta. As indicated above, most of the seasonal wetlands of the Sacramento and San Joaquin Valleys and the Delta are irrigated, not by natural flood flows or other processes, but by deliberate diversion of water from the systems, either in exercise of legal rights or as recipients of tail water flows from agricultural activities. In addition and very importantly, the use of diverted water to flood agricultural fields in the late fall, winter and early spring enables the creation of surrogate habitat (e.g., flooded rice fields) that are critical to providing for the nutritional and caloric needs of migratory birds. In fact, flooded rice and corn fields are known to provide more of the food needed by wintering waterfowl, shorebirds and other groups of birds in the Central Valley than does managed seasonal wetlands (Central Valley joint Venture 2006 Implementation Plan, page 46). Therefore, to the extent that water supplies for seasonal managed wetlands in the Central Valley and agricultural and other users providing wintering habitat are reduced by new and updated Delta flow requirements, the migratory bird components of the ecosystem would likely be harmed. Any change in the flow regime should be carefully considered with respect to how that water is currently used to support other terrestrial and even aquatic components of the ecosystem. We have found no indication in the DEIR that these impacts have been identified, considered or mitigation measures identified.

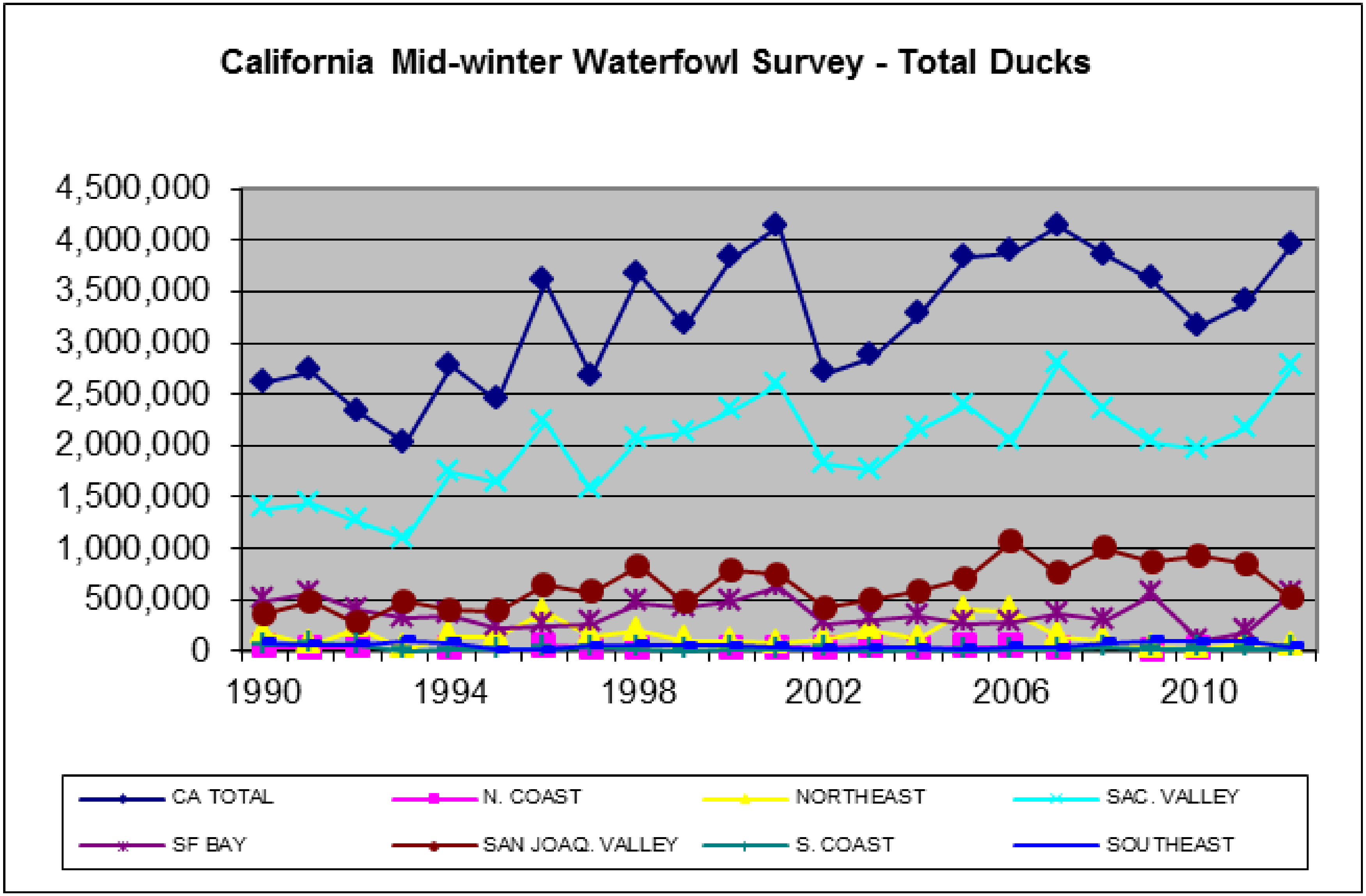
The Plan and DEIR fail to fully discuss the opportunities to integrate recreation, restoration and agriculture into the Delta economy. In Section 2.2.5.1. and Section 2.2.5.2., the DEIS reviews means to encourage economic sustainability in the Delta, including ways to develop economic models that are consistent with and take advantage of the Delta's natural assets, and by making improvements in the physical and institutional environment. The latter section relies on a plan developed by the California Department of Parks and Recreation for concepts pertaining to recreation. However, little is discussed regarding ways of minimizing the economic impacts of habitat restoration and maximizing the possible economic gains that could be realized. For example, the Delta historically has been a concentration area for waterfowl and new seasonal wetlands, and if managed carefully, they could return tremendous economic value to landowners for their recreational hunting. Moreover, a technique developed in the Klamath Basin involving rotational seasonal wetland and agricultural plots (called "walking wetlands") could be combined with tidal restoration on properties with the appropriate physical characteristics. If this were to be accomplished on even a modest scale, the impacts of habitat restoration could be reversed from one that has a net negative effect on property value, regional income and tax revenues, to one that has a net positive effect. In Section 2.2.4.4 Subsidence Reversal, the DEIR should discuss the potential to utilize State lands for subsidence reversal efforts that also include increasing recreational opportunities. Subsidence reversal wetlands can be designed and managed as waterfowl hunting areas. A recent project on Sherman Island at Mayberry Farms was designed specifically for this purpose. The property is currently managed and operated under a private waterfowl hunting lease. Ducks Unlimited designed this project for DWR. This model could be expanded in many other areas on Sherman and Twitchell Islands, as well as other areas of the Delta where subsidence reversal is being pursued. By designing the site appropriately to meet the goals of both subsidence reversal and recreation, these areas could be leased out and thus be managed with little or no cost to the State.

Enhanced water conveyance can adversely impact migratory birds. Section 4.4.1.3 of the DEIR recognizes that operation of facilities to improve water supply reliability, such as tunnels and canals built to shunt water around the Delta to the export pumps, could have an adverse impact on "habitat for fish and wildlife." Section 4.4.3.1.1 describes the impact of water facilities on sensitive habitat in a similar fashion. In both cases the impact considered is the short term, direct impact of locating, constructing and operating the facilities. We would add that the impacts would be proportionate to the amount of water that could be moved, and there may be indirect impacts not being considered in the DEIR. Sacramento Valley managed wetlands depend heavily on agricultural return flows and on the infrastructure that is constructed and maintained for agriculture. For example, the private wetlands in the Butte Sink rely on drain water that is produced from rice lands within the area. One of the most significant, yet subtle, impacts of enhanced water conveyance is the long-term facilitation of water transfers from the Sacramento Valley to areas south of the Delta. This would impact habitat for both migratory birds and for resident and sensitive species as well. We believe that conservatively sized facilities would result in a lower probability of permanently sending water surplus to agriculture –followed by water directly used by agriculture, to regions where there would be little to no habitat benefit for wildlife.

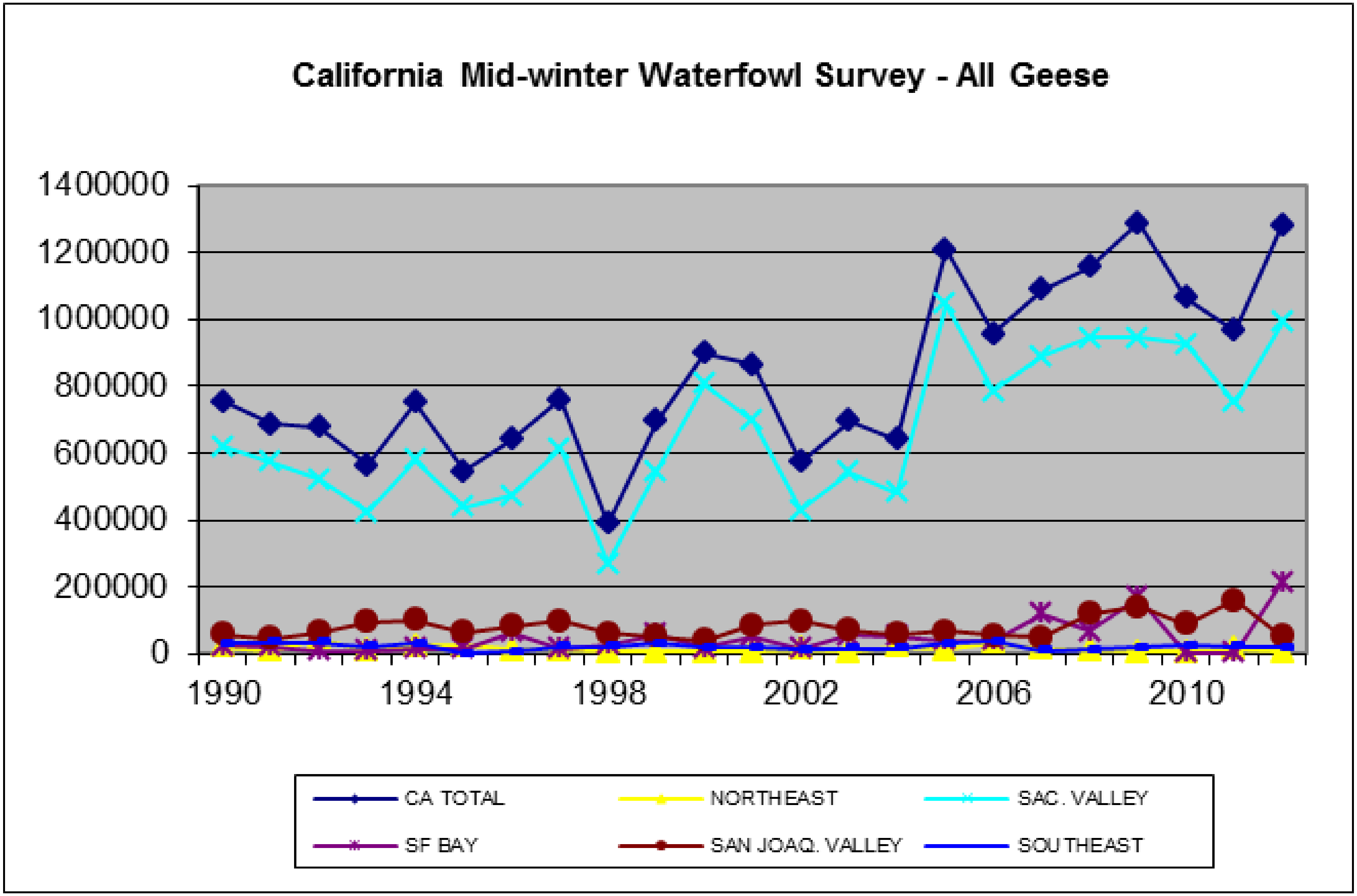
Thank you for the opportunity to review the Delta Plan and Draft Environmental Impact Report and for considering our comments.

Sincerely,

Mark Biddlecomb
Director, Western Region



Mike Wolder, Supervisory Wildlife Biologist
Sacramento National Wildlife Refuge Complex



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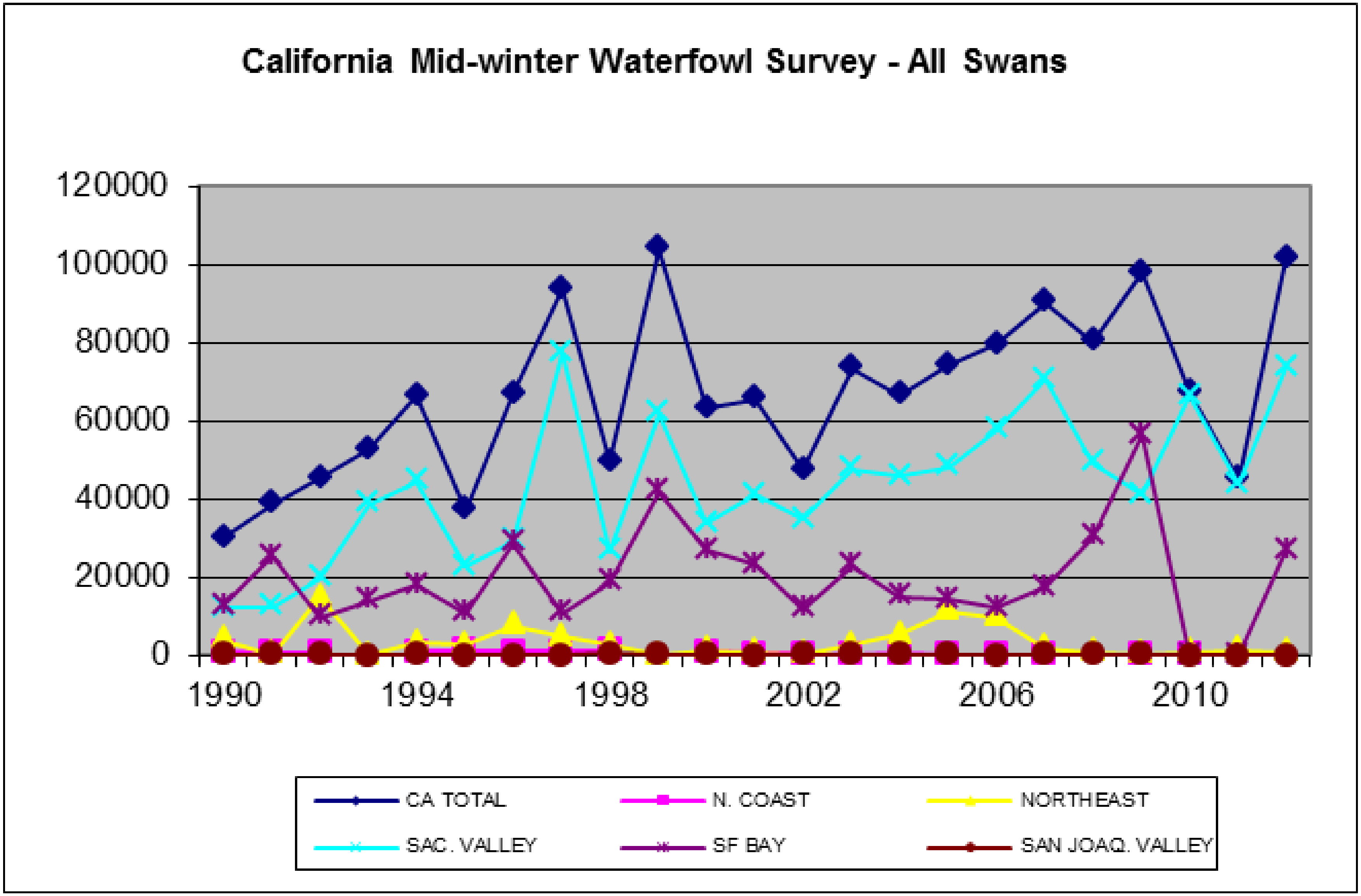

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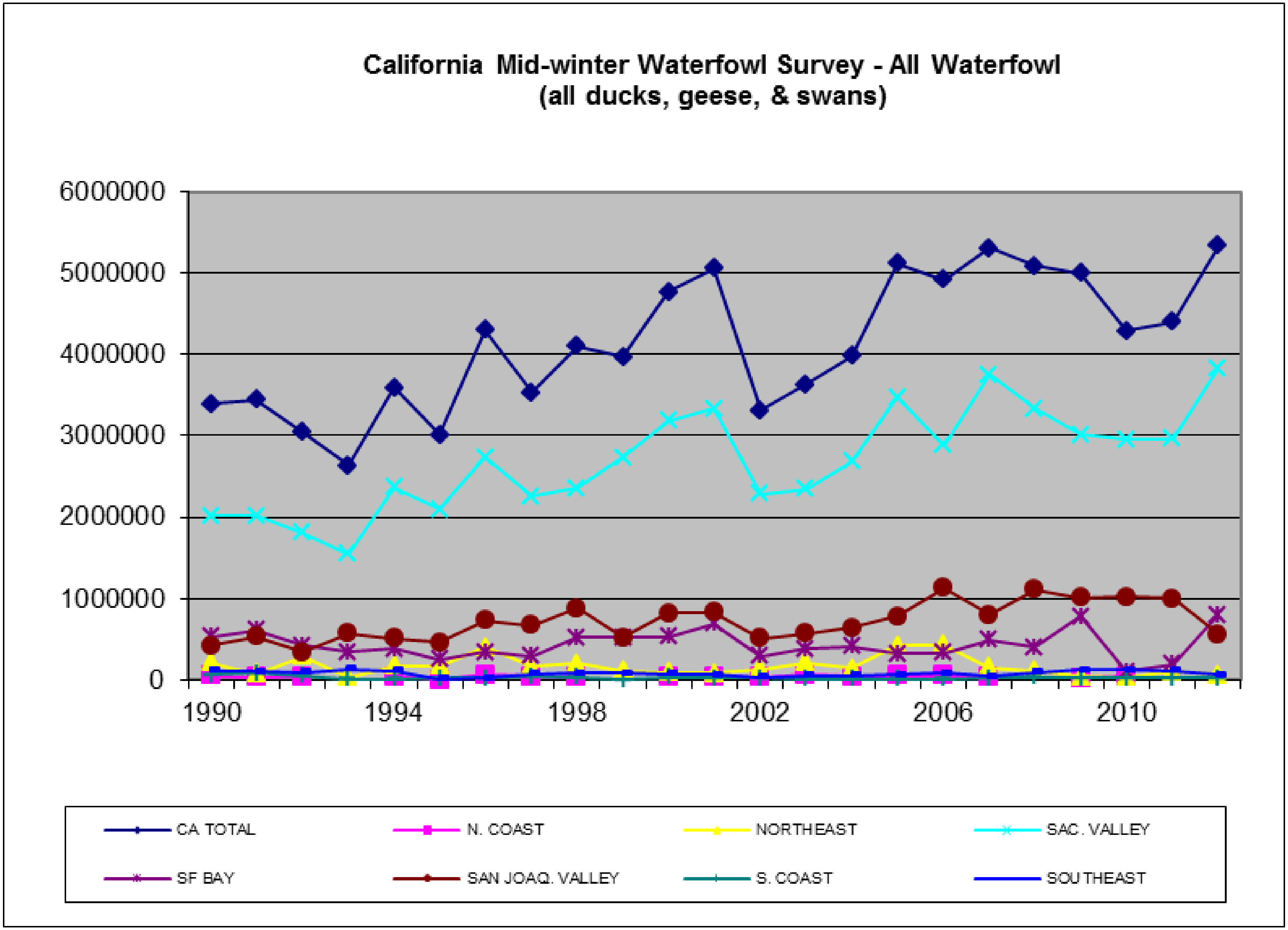
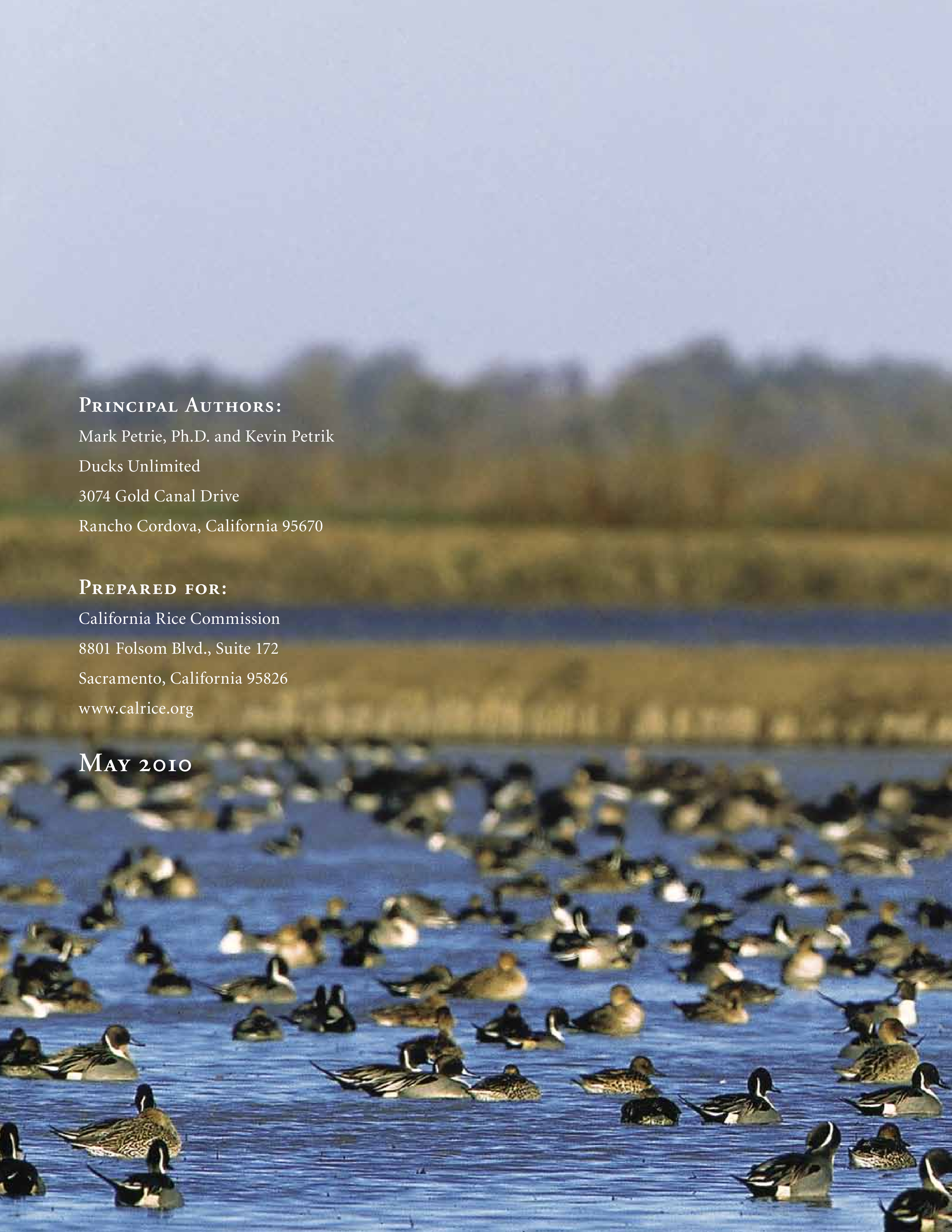


Mike Wolder, Supervisory Wildlife Biologist
Sacramento National Wildlife Refuge Complex

ASSESSING WATERBIRD BENEFITS FROM WATER USE IN
CALIFORNIA RICELANDS

Report Prepared By DUCKS UNLIMITED



Principal Authors:

Mark Petrie, Ph.D. and Kevin Petrik
Ducks Unlimited
3074 Gold Canal Drive
Rancho Cordova, California 95670

Prepared for:

California Rice Commission
8801 Folsom Blvd., Suite 172
Sacramento, California 95826
www.calrice.org

May 2010

INTRODUCTION

Prior to the Gold Rush of the mid 1800s, the Central Valley of California contained more than four million acres of wetlands and supported over 20 million waterfowl during fall and winter. Today less than five percent of the valley's wetlands remain, yet the region still supports one of the highest concentrations of waterfowl on earth. During winter, as many as seven million ducks and geese, or nearly 10 percent of all North America's waterfowl, continue to rely on Central Valley habitats.

The Central Valley continues to be the most important waterfowl wintering area in the Pacific Flyway because of the remarkable partnership between wetland managers and rice producers. While most of the valley's remaining wetlands are managed to the benefit of waterfowl, many of the wildlife values wetlands once provided are served by rice fields. Without these agricultural habitats, the number of birds using the Central Valley would be greatly diminished.

There are several threats to the California rice industry looming on the short and long-term horizons, including urban expansion into agricultural areas. The purpose of this report is to answer certain questions as they relate to the need for a reliable water supply for rice production. It is important to understand that it is not just rice that grows in these fields. California ricelands are used by 230 species of wildlife, including about seven million waterfowl, several hundred thousand shorebirds and wading birds, and endangered Giant Garter Snakes. With every acre of lost production due to inadequate water supplies there is an impact on these species.

California ricelands are used by 230 species of wildlife.

During fall and winter, the Central Valley supports one of the highest densities of waterfowl on earth.

Central Valley Rice Production

Source: DWR Land Use Survey

Most of the Central Valley's rice is grown in four drainage basins. Although these basins account for only 25 percent of the Valley's landmass, half of all waterfowl winter there.

Due to the efforts of the Central Valley Joint Venture partners, there exists good information on the importance of rice fields to waterfowl. This analysis by Ducks Unlimited evaluates how duck populations would be affected if rice water supplies were reduced by 25 and 50 percent, respectively. Please note that this analysis includes just one category of waterbirds – ducks. However, it is logical that shorebird and wading bird populations would also be affected by a decline in rice water supplies.

The Value of Rice Fields to Waterfowl

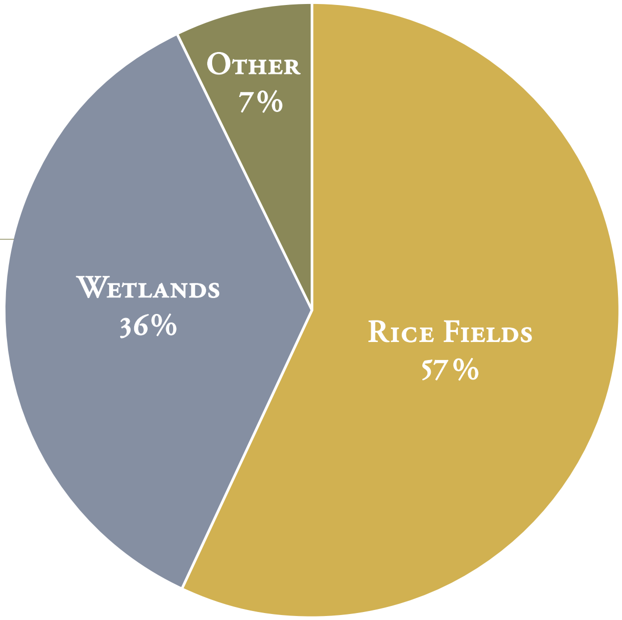
Waterfowl managers have divided up the Central Valley into nine drainage basins that reflect regional differences in drainage patterns. Most of the Central Valley's rice is grown in the Colusa, Butte, Sutter, and American drainage basins. For the most part, these basins make up the Sacramento Valley portion of the Central Valley. Although these four basins account for only 25 percent of the valley's landmass, 50 percent of all waterfowl are found here including 85 percent of all geese.

> *Four drainage basins where rice is grown account for only 25 percent of the valley's landmass, but provide habitat for 50 percent of all waterfowl.*

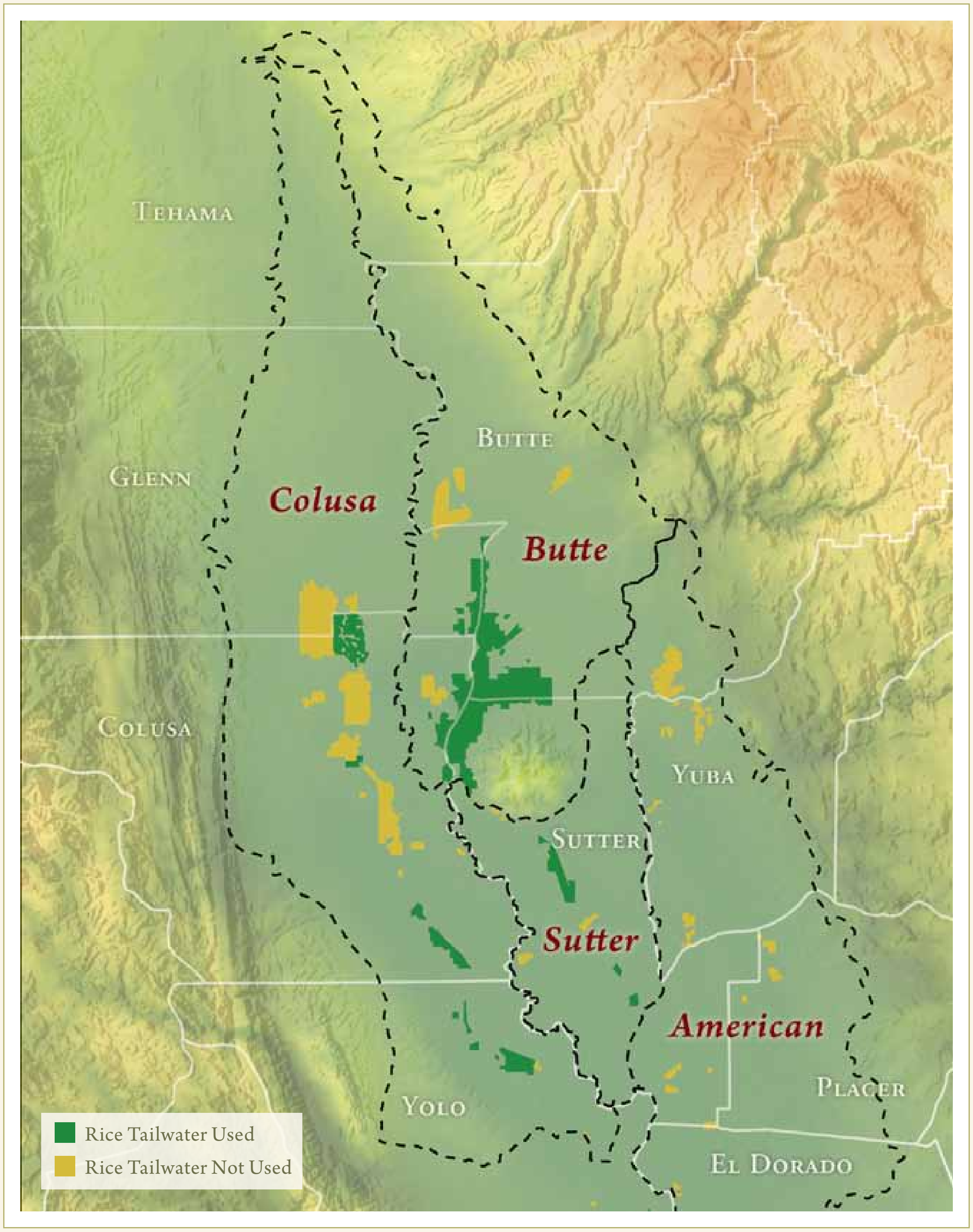
Most waterfowl in the Central Valley obtain their food from managed seasonal wetlands, harvested rice, and corn fields. The relative contribution that each of these habitats makes to the total food resources available for waterfowl is dependent on the number of acres in each habitat, the amount of food in each acre, and the nutritional value of the foods in each habitat. In each of the past five years about 530,000 acres has been planted in rice on average in the valley. Most of these acres provide food for ducks and geese once the rice is harvested in early fall. Managed seasonal wetlands total about 200,000 acres. Most harvested cornfields that are important to waterfowl are found in the Delta Basin and total about 30,000 acres. Based on this breakdown, rice fields provide nearly 60 percent of all waterfowl food resources in the Central Valley.

Percentage of Food Resources for Waterfowl Provided in the Central Valley

Rice fields provide nearly 60 percent of all the food resources available to ducks and geese in the Central Valley, with wetlands and harvested corn fields providing the rest.



WETLAND USE OF RICE TAILWATER



Rice provides an important source of food for waterfowl and an important source of water for many wetlands. It is estimated that 56 percent of all seasonal wetlands in the Sacramento Valley use rice tailwater for fall flooding.

Although rice fields and managed wetlands provide different kinds of food for waterfowl, these two habitat types are often linked by a shared water resource. Rice fields are drained prior to harvest and this drain or "tailwater" can provide an important source of water for nearby wetlands. Private and public wetland managers were recently surveyed to gather information on the use of rice tailwater in flooding managed seasonal wetlands in the Sacramento Valley. Depending on weather conditions and harvesting schedules, the use of tailwater for flooding seasonal wetlands can begin in August and last through September.

Results of the survey indicate that rice tailwater represents an important water source for many private and public owned wetlands in the Sacramento Valley. All told, an estimated 56 percent of seasonal wetlands in the Sacramento Valley use tailwater for fall flooding (nearly 35,000 acres).

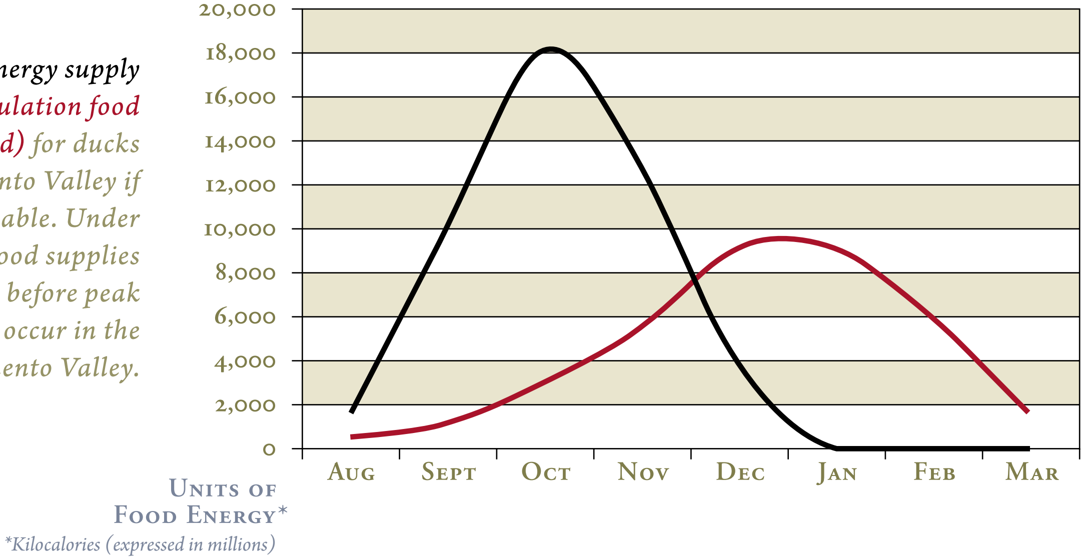
Rice not only provides the majority of food resources available to waterfowl, it also represents an important source of water for many of the Central Valley's wetlands.

One way to appreciate the importance of rice is to ask what would happen if rice were no longer available? Waterfowl managers have established monthly population objectives for ducks and geese in the Sacramento Valley, where most of the state's rice is grown. We can use these population objectives to estimate how much food waterfowl need and what might happen in the absence of rice. In the figure below, we use population objectives and the daily energy need of a single bird to generate a "population food energy demand curve" for ducks between fall and spring. We also generated a "population energy supply curve" that reflects the food resources that are available to ducks in the Sacramento Valley. In this case, it was assumed that no rice was grown and that birds had to rely exclusively on wetland food sources.

Rice not only provides the majority of food resources available to waterfowl, it also represents an important source of water for many of the Central Valley's wetlands.

POPULATION ENERGY SUPPLY CURVE

Population food energy supply (black) vs. population food energy needs (red) for ducks in the Sacramento Valley if no rice is available. Under these conditions, food supplies run out even before peak bird numbers occur in the Sacramento Valley.



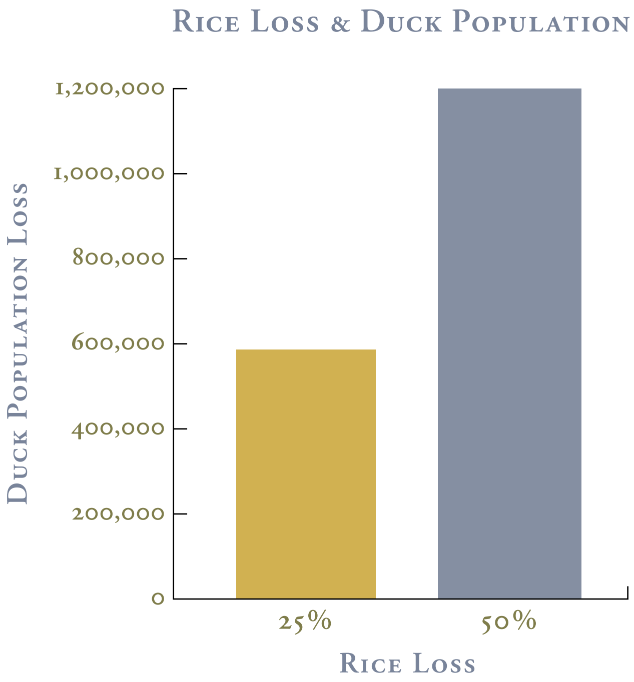
Like ducks, Tundra Swans derive food and habitat from rice fields.

Population energy demand increases from August through January as birds migrate into the Sacramento Valley, and then declines as birds begin their spring migration north. Food supplies increase from August to October as managed wetlands in the Sacramento Valley are flooded up. However, as bird numbers build and population energy demand increases, these wetland food supplies become quickly exhausted. In fact, food supplies are predicted to run out even before peak duck numbers occur in the Sacramento Valley if no rice is grown.

It is unlikely that rice will disappear from the Central Valley, at least in the foreseeable future. However, a possible scenario is that rice production declines from its current level because of limited water supplies that result from drought conditions, lack of additional water supply improvements and/or competition for the water currently used in California ricelands. Considering this possibility, an important question is how many fewer ducks would use the Central Valley if rice production was reduced? What if the reduction was 25 percent or 50 percent? This is difficult to answer because bird numbers in the valley change dramatically from fall through spring. Duck populations can peak at over five million in early January, but can be less than one million in August or early September. This complicates the question of how many fewer ducks will less water used in rice support?

For planning purposes, waterfowl managers assume that migrating and wintering ducks rely on the Central Valley for about 225 days (basically mid-August to late-March). Harvested rice fields now provide about 500 million duck-use-days worth of food. Most of this is in the form of "waste rice" that is left behind after harvest is completed. A duck-use-day's worth of food is the amount of food needed to support one average size bird for one day.

Northern Pintail



A 25 percent loss of rice acreage would reduce the capacity to support duck populations by about 600,000 birds. A 50 percent loss would double that figure to 1.2 million ducks.

Under current conditions, a 50 percent decrease in the numbers of acres in rice production would result in a loss of capacity to support about 1.2 million ducks over this entire 225 day period (1.2 million ducks x 225 days = 50 percent of the duck use days now provided by rice). Accordingly, a 25 percent reduction in the number of acres in rice production would result in a loss of capacity to support about 600,000 ducks over the same period.

One acre of rice provides about two-thirds of the waterfowl food that is provided by one acre of managed wetland. There are about 350,000 acres of winter-flooded rice in the Central Valley. In terms of waterfowl food, this equates to about 235,000 wetland acres (350,000 x 2/3). Wetland restoration costs in the Central Valley, including the costs of land purchase, average about $6,500 per acre. Replacing the food now provided by rice with wetland based foods would total over $1.5 billion.

While the value of harvested rice fields to wintering and migrating waterfowl is widely recognized, rice also provides important waterfowl habitat during the growing season. Rice fields provide important habitat for breeding mallard pairs and ducklings from April through August when most seasonal wetlands in the Central Valley are dry. Mallards that breed and are raised in the Central Valley now make up to 20 percent of the total duck harvest in California and this local production has become increasingly important to hunter success. Most private wetland owners in the Central Valley manage their lands for the dual purpose of providing habitat for wintering waterfowl and opportunity for hunting of waterfowl. These private wetland owners supply and manage nearly 70 percent of all wetland habitats available to waterfowl and incur substantial costs in doing so. Providing a reasonable level of hunter success is critical to this continued private investment in maintaining wetlands for waterfowl. Rice fields that support breeding waterfowl in the Central Valley ultimately contribute to hunter success and thus encourage future investments in wetlands.

> *Replacing the food now provided by rice with wetland based foods would total over $1.5 billion.*

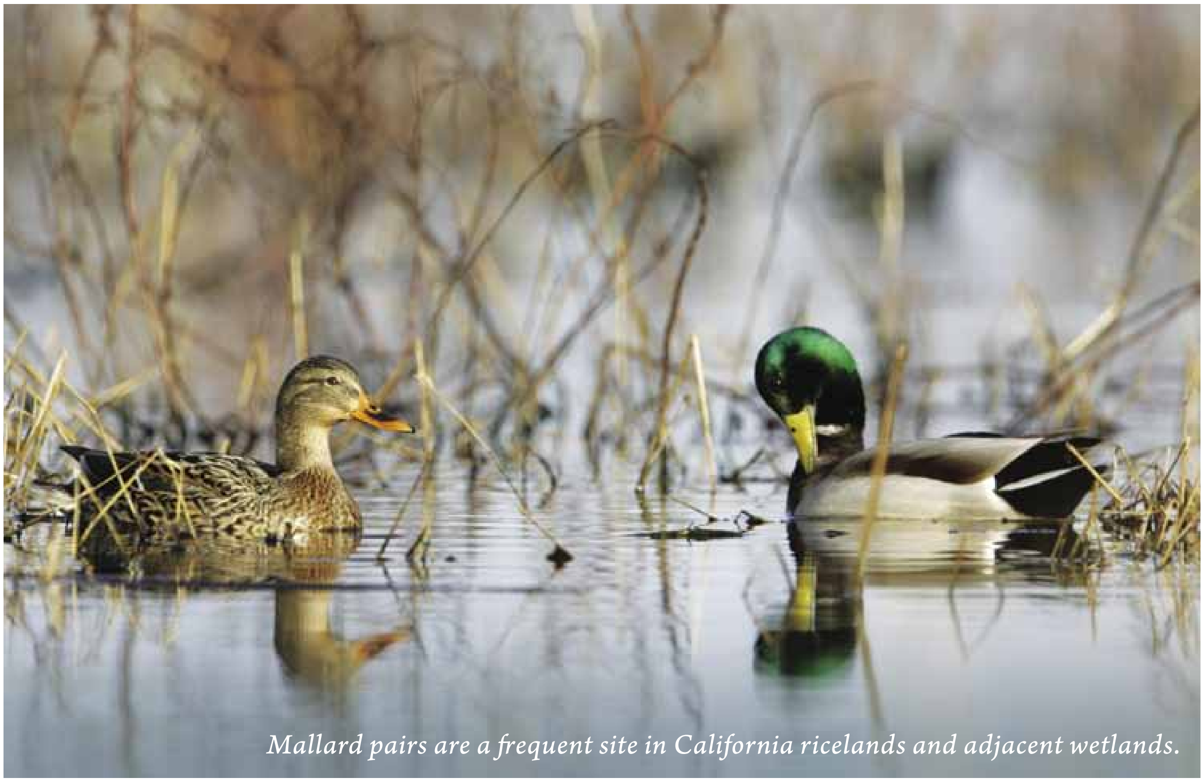
Conclusions

This report describes a clear link between working ricelands, managed in a wildlife-friendly manner, and the wildlife that use them. Millions of waterfowl and scores of species of other wildlife in California lose critical habitat if fewer acres of rice are planted. In this report the effect of loss of rice agriculture on just one group of waterbirds has been evaluated. The results demonstrate that if the rice industry shrinks by half, the capacity to support over a million ducks simply disappears. If a similar analysis was done for other waterbirds, an even greater impact on total waterbird numbers would be demonstrated.

> *The results demonstrate that if the rice industry shrinks by half, the capacity to support over a million ducks simply disappears.*

Shorebirds such as the Long-billed Curlew thrive in California ricelands.

The economic value of the "ecosystem services" provided by winter flooded rice is also well described. The cost of offsetting the loss of California ricelands by restoring wetlands would exceed $1.5 billion. This does not include the benefits provided to nearly 35,000 acres of managed wetlands that rely on rice tailwater for early flood up. As long as water continues to flow through California rice fields and these family farms remain viable, these ecosystem services will continue to be provided to the benefit of wildlife and California's citizens.



Mallard pairs are a frequent site in California ricelands and adjacent wetlands.

Grassland Water District
Ducks Unlimited
Conservation Today, Wetlands for Tomorrow.
NCWA
Northern California Water Association
California Waterfowl Association
California Rice Commission
San Joaquin River Exchange Contractors Water Authority
CCID • CCC
FCWD • SLCC

January 26, 2011

The Honorable Edmund G. Brown, Jr.
Governor
State of California
State Capitol Building
Sacramento, CA 95814

The Honorable Ken Salazar
Secretary, Department of the Interior
1849 C Street, NW
Washington, DC 20240

RE: Delta Solutions and the Pacific Flyway

Dear Governor Brown and Secretary Salazar:

Considerable effort is underway in California to address ecological and water supply and quality problems in the Sacramento and San Joaquin Rivers Delta (Delta) and throughout the Central Valley. While we recognize the importance of the Delta and the need to address these problems, we are worried that the singular focus on improving the Delta fails to consider the impacts of the proposed actions on migratory bird habitat throughout the state and potential impacts on the entire Pacific Flyway.

Our concern is largely based upon recent flow studies prepared by the State Water Resources Control Board (SWRCB) and the Department of Fish and Game (DFG), as well as proposals contemplated by the Delta Stewardship Council and the parties developing the Bay Delta Conservation Plan (BDCP). These efforts are largely one-dimensional, focusing solely on facilitating change to improve conditions for fish in the Delta, while either discounting or ignoring potential negative impacts on Central Valley terrestrial, wetland and aquatic habitats. Particularly troubling is the potential impact of proposed stream flow increases on the upstream habitat throughout the Central Valley that is dependent upon reliable water supplies.

When examining the flow proposals, the potential to destroy considerable habitat both north and south of the Delta is readily apparent. The SWRCB and DFG flow proposals both call for increases in targeted pulse flows from Delta tributaries as well as increased unimpaired flows. This would result in the reallocation of millions of acre-feet of water to increase flows through the Delta and out into the Pacific Ocean. In the Sacramento Valley, this would come at a cost of approximately four million acre-feet of water that previously was used to irrigate farm lands, managed wetlands and provide water supplies for the six National Wildlife Refuges and more than 50 state wildlife areas, which are all significant parts of the Pacific Flyway. If these proposals were implemented, the impact on waterfowl and shorebird habitat along the Pacific Flyway would be immediate and potentially catastrophic. In the San Joaquin Valley, wetland habitats have yet to receive their full water supply allocations and the ability to identify new sources of affordable water supplies has become markedly more difficult. This proposal would only make that situation more severe.

As we all move forward on efforts to address water supply issues both north and south of the Delta, it is our hope that we do so in a way that will also enhance the Pacific Flyway. Any effort to “fix” the Delta that destroys habitat in other areas of the state is neither acceptable nor sustainable. It is inappropriate and indefensible to redirect resources to save one category of species (fish) in one location (the Delta) to the detriment of other species (waterfowl and shorebirds) and habitat in other regions of the state (wetlands and wildlife-friendly agriculture of the Sacramento and San Joaquin Valleys). It is our hope that the State of California and the Department of the Interior, working with many others, will elevate the importance of sustainable water supplies for the Pacific Flyway in these various processes and make sure we avoid conflict in these efforts to improve the Delta. We welcome any efforts towards our mutual desire to sustain migratory birds in this critically important region.

Sincerely,

Paul Buttner

Paul Buttner, Manager, Environmental Affairs
California Rice Commission

John Carlson, President
California Waterfowl Association

Mark E. Biddlecomb

Mark Biddlecomb, Director, Western Regional Office
Ducks Unlimited

David Widell, General Manager
Grasslands Water District

David Guy, President
Northern California Water Association

Steve Chedester, Executive Director
San Joaquin River Exchange
Contractors Water Authority

California Rice

California Rice Commission
www.calrice.org
First Edition, 2011

RAPTORS & RICE

IN CALIFORNIA'S SACRAMENTO VALLEY

2011 EDITION

ABOUT THE AUTHOR

ZACH SMITH

Zach grew up in San Diego and spent much of his youth honing his soccer skills. A move to Davis for college eventually introduced him to the world of science, particularly raptors. After graduation, he worked as a freelance field biologist that has led him to many wild parts of California, the Gulf Coast of Texas, the southern New Jersey shore, Chile's Atacama Desert, the humid lowlands of Veracruz and the Canary Islands, among other locales. Zach teamed with conservationist Ed Pandolfino from 2007–2010 to coauthor the Central Valley Raptor Study. Currently, Zach works at the Montezuma Hills Wind Resource Area and lives in Davis with his wife, Elizabeth.

PEREGRINE FALCON
Falco peregrinus

INTRODUCTION

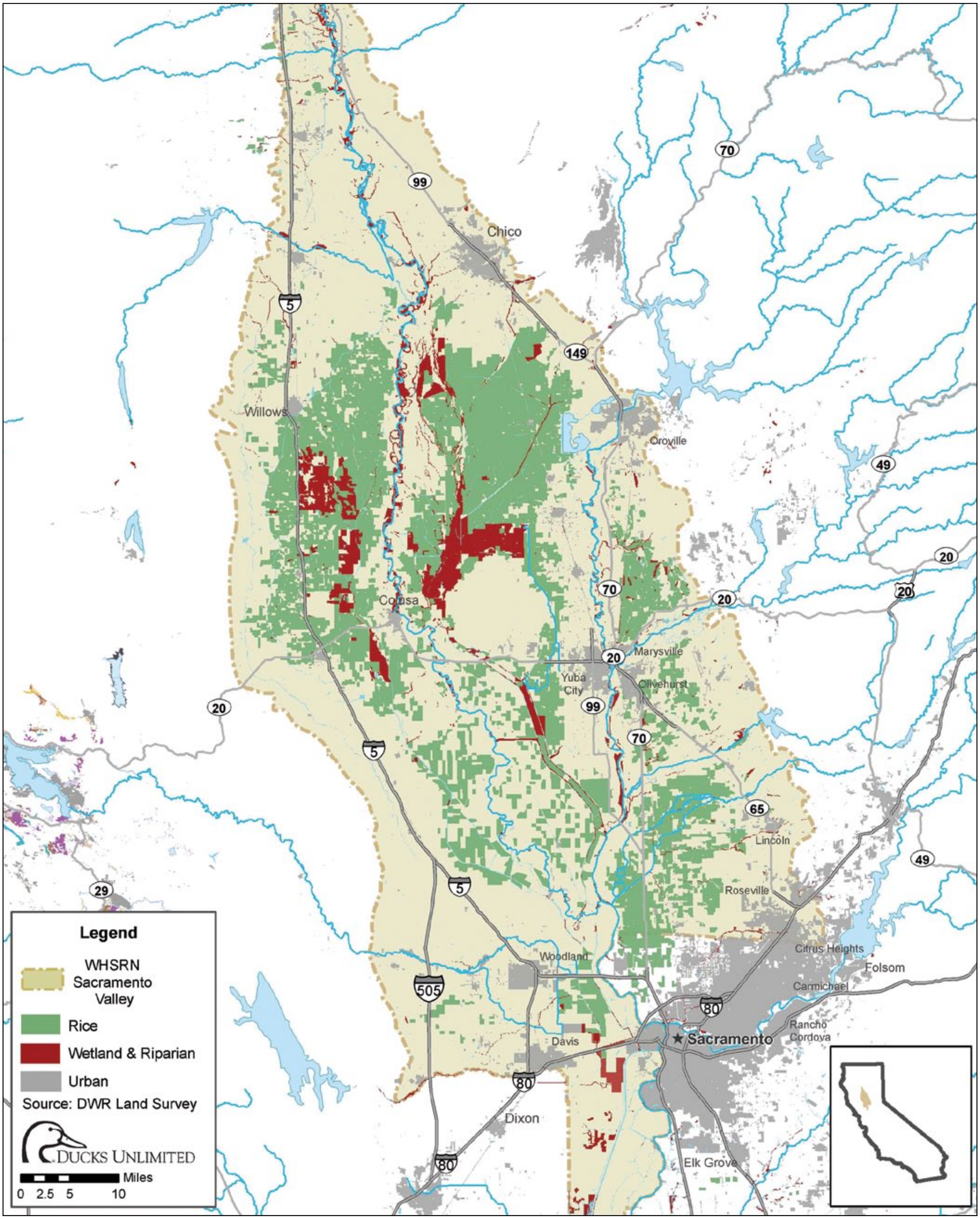
The Central Valley of California is one of the most important regions in North America for wintering raptors. Also known as birds of prey, this general category includes eagles, kites, harriers, hawks, falcons and owls. These birds can be observed with relative ease throughout this large valley as they seek out enough food to survive the winter. The combination of a mild climate and thousands of square miles of open country makes the region an attractive winter destination for thousands of raptors from all over western North America. The mix of pasture, grassland, forage and row crops, in addition to stream and wetland habitats, provides enough prey to support a diverse raptor population.

Since the early 1900s, volunteers have participated in the Christmas Bird Count, a yearly volunteer effort to count birds across the continent. Both historic Christmas Bird Count results and data from the recently completed Central Valley Winter Raptor Survey ("Raptor Survey," Pandolfino et al. 2011) strongly suggest that no other area in North America supports such a high density and diversity of wintering raptors.

> *Fourteen different raptor species were observed in rice over the course of the Raptor Survey.*

Rice cultivation in California is most prominent in the Sacramento Valley, the northern part of the Central Valley containing the Sacramento River. More than 500,000 acres are utilized for rice production, which is the vast majority of the state's rice acreage (California Rice Commission 2010). The importance of rice to wildlife has

FIGURE 1: *Special Shorebird Habitat Area*



Source: DWR Land Survey

been highlighted by past research (Elphick 2000, Elphick 2004, Elphick and Oring, 2003, Shuford et al. 1998). In addition to rice acreage, there are approximately 75,000 acres of managed wetlands sprinkled throughout the rice areas (Figure 1). The presence and proximity of these wetlands to the rice fields are believed to enhance the habitat quality of the adjacent ricelands. In fact, the Western Hemisphere Shorebird Reserve Network (WHSRN) has designated the Sacramento Valley as Shorebird Habitat of International Significance. This 620,000 acre area is one of the largest specially-designated sites of its kind in North America.

The presence of raptors in ricelands is well known, but quantitative information on species diversity and densities is scarce. The Raptor Survey was initiated in 2007 to quantify wintering habitats used by raptors, their densities and species richness in the Central Valley. Surveys were conducted each winter through 2010 along 19 driving routes throughout the Central Valley. More than half of these surveys were located in the Sacramento Valley, which provided an opportunity to create a sizable dataset on raptors observed in rice.

A variety of shorebirds are found in the Central Valley, including Killdeer which nest extensively in rice growing areas.

WHITE-TAILED KITE
Elanus leucurus

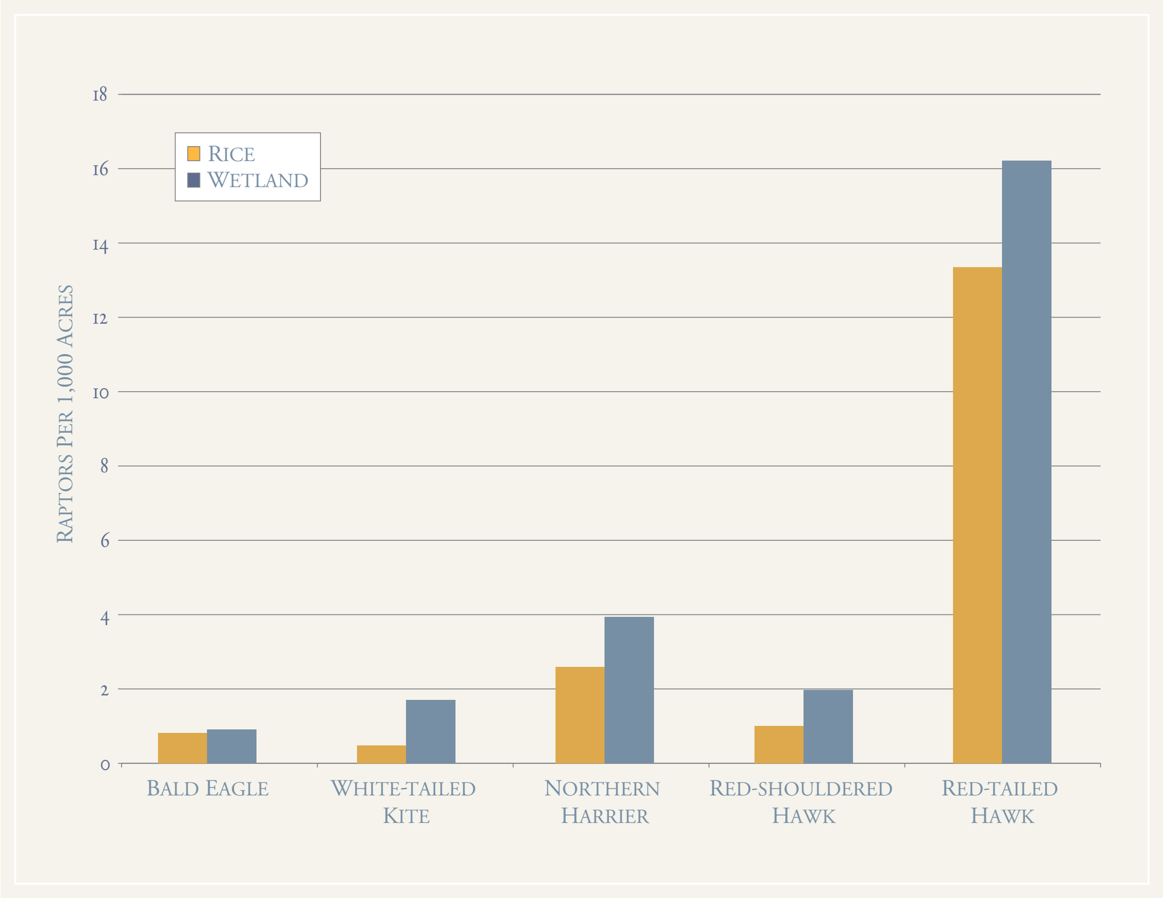
TABLE 1:

14 Raptor Species associated with ricelands in the Sacramento Valley

1. BALD EAGLE – *Haliaeetus leucocephalus*
2. WHITE-TAILED KITE – *Elanus leucurus*
3. NORTHERN HARRIER – *Circus cyaneus*
4. SHARP-SHINNED HAWK – *Accipiter striatus*
5. COOPER'S HAWK – *Accipiter cooperii*
6. RED-SHOULDERED HAWK – *Buteo lineatus*
7. RED-TAILED HAWK – *Buteo jamaicensis*
8. ROUGH-LEGGED HAWK – *Buteo lagopus*
9. GOLDEN EAGLE – *Aquila chrysaetos*
10. AMERICAN KESTREL – *Falco sparverius*
11. MERLIN – *Falco columbarius*
12. PEREGRINE FALCON – *Falco peregrinus*
13. PRAIRIE FALCON – *Falco mexicanus*
14. GREAT HORNED OWL – *Bubo virginianus*

FIGURE 2:

Species density in rice and wetland in the Sacramento Valley



The Raptor Survey documented 14 raptor species associated with ricelands in the Sacramento Valley (Table 1). Species commonly observed in rice included Bald Eagle, Northern Harrier, Red-shouldered Hawk, and Red-tailed Hawk. All of these showed a significant affinity for rice. Rice fields are often termed "surrogate wetlands" for their role in supporting wildlife known to use natural wetlands (Elphick and Oring 1998).

Depending on the species in question, rice cultivation benefits wintering raptors in the Sacramento Valley by providing a reliable supply of prey. This is especially helpful because it can be a stressful time of the year, as younger birds are challenged with potentially inconsistent food supplies during their first time away from the nest. Of all 12 habitats sampled during the Raptor Survey, rice supported the third-highest species richness with 14 different species observed in rice over the course of the survey. Species richness was higher only in wetlands, irrigated pasture and grasslands. Raptor density in rice was the fourth highest, trailing only wetlands, pasture, and alfalfa.

> *Fourteen different raptor species were observed in rice over the course of the Raptor Survey.*

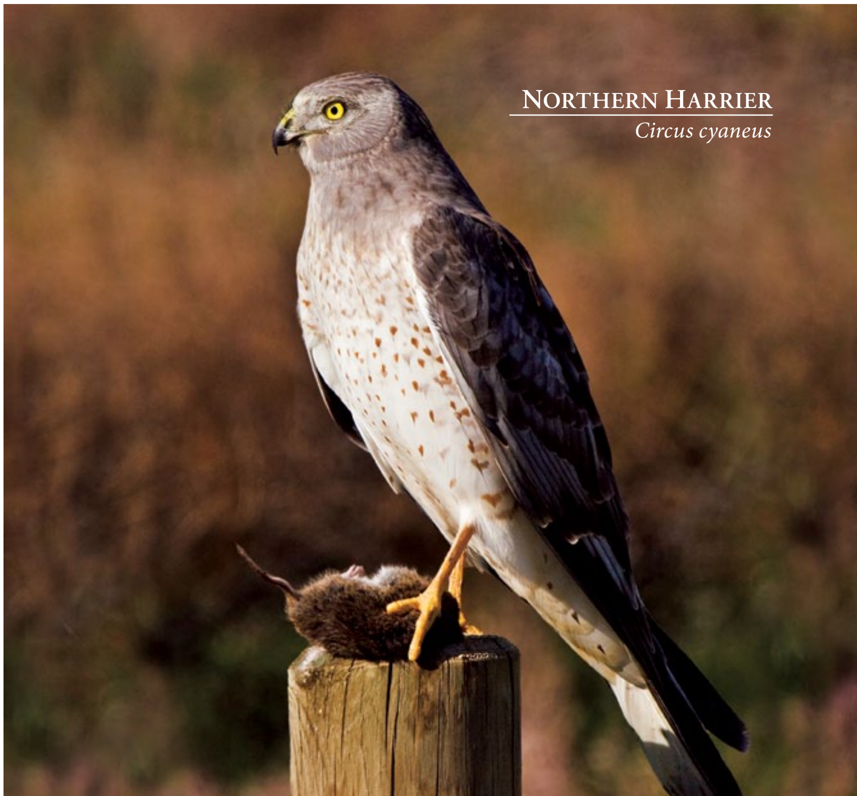
PRIMARY RAPTOR SPECIES USING RICELANDS

Among the 14 raptor species documented during the Raptor Survey in Sacramento Valley rice fields, four in particular showed a significant affinity for this habitat type – Bald Eagle, Northern Harrier, Red-shouldered Hawk, and Red-tailed Hawk. See Table 2 for information on habitat associations of the following species with different habitats in the Sacramento Valley.

BALD EAGLE
Haliaeetus leucocephalus

RED-SHOULDERED HAWK
Buteo lineatus

RED-TAILED HAWK
Buteo jamaicensis



NORTHERN HARRIER
Circus cyaneus

BALD EAGLE

This species was never considered common anywhere during the Raptor Survey. However, rice fields consistently supported a large percentage of Bald Eagles observed each winter. This species is known to concentrate at locations where its preferred prey is abundant, such as salmon runs or where waterfowl form large flocks (Griffin et al. 1982, McWilliams et al. 1994). Large concentrations of waterfowl in the Sacramento Valley attract Bald Eagles to the region during winter. The species is primarily a fish-eater, but broadens its diet during winter when fish can be scarce and waterfowl are plentiful in rice fields and wildlife refuges throughout the region. The Raptor Survey results indicate that Bald Eagles are found in rice and adjacent wetlands more than would be expected based on relative availability of the habitat type.

NORTHERN HARRIER

Throughout its range Northern Harriers are known to use wetland habitats, which tend to be rich in prey. Flying low over cattails and the edges of ponds and fields, Harriers look and listen for birds and rodents hiding in vegetation. Many rice fields, both flooded and dry, are bordered by waste rice stubble that harbors small rodents and birds. Harriers can be seen diligently working these edges in their slow, buoyant flight hoping to startle prey into the open for a quick chase. Harrier density was higher only in wetlands and forage crops during the Raptor Survey, pointing to the importance of rice for this species in winter. Harriers were also common in alfalfa, another crop that is important to bird life in the region (Shuford et al. 2009).

RED-SHOULDERED HAWK

Well known for their affinity for wooded areas, Red-shouldered Hawks often utilize edge habitat (forest or streamside margins) during winter and can be seen hunting from utility wires along roadside ditches, orchards and rice fields. As expected, they are quite common where streamside vegetation is prominent. These hawks are known as generalists, hunting a variety of prey including rodents, birds, reptiles and amphibians (Crocoll 1994). During the Raptor Survey, more observations of Red-shouldered Hawks were recorded in rice than any other habitat sampled. The combination of foraging, perching, and roosting opportunities provided by rice field margins in proximity to streamside habitat (both natural and planted) likely draw this raptor to utilize ricelands in the Sacramento Valley.

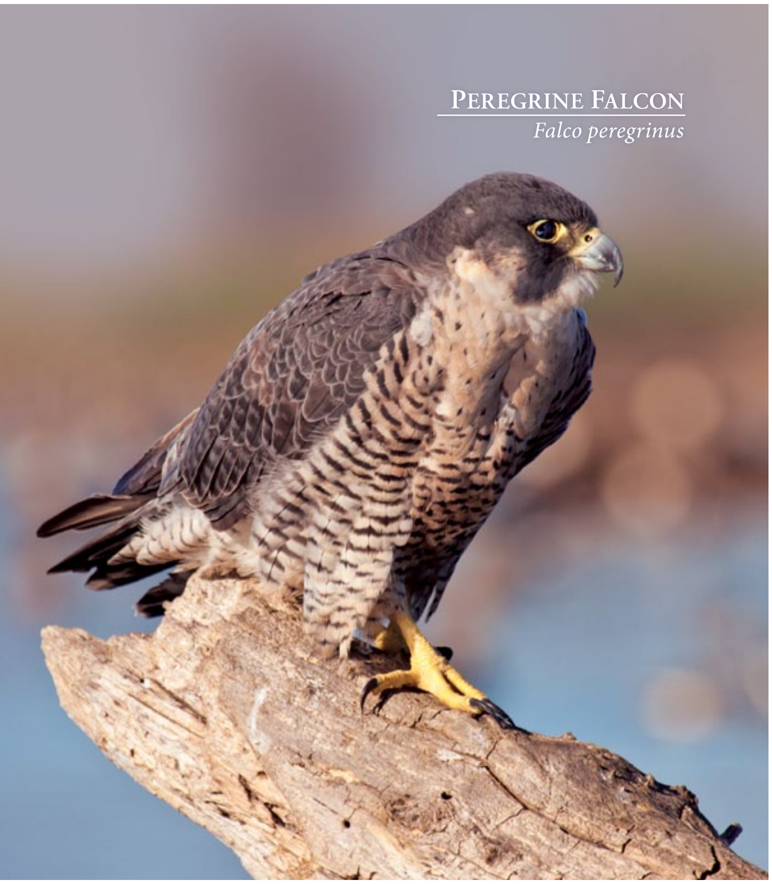
> *Rice fields consistently supported a large percentage of Bald Eagles observed each winter.*

RED-TAILED HAWK

Accounting for over 40 percent of all birds recorded on the Raptor Survey, Red-tailed Hawks are abundant throughout the Sacramento Valley. This species' ability to exploit a variety of habitats is well-documented (Preston and Beane 1993). These birds occur in high densities during the winter where rice farming is a prominent land-use. Rice supported the second-highest density of Red-tailed Hawks of any habitat type sampled during the Raptor Survey (second only to wetlands), attesting to the potential high quality of ricelands as raptor habitat. Red-tailed Hawks are year-round residents in the Sacramento Valley and most likely utilize ricelands throughout that time.

SECONDARY RAPTOR SPECIES USING RICELANDS

Two other raptor species, White-tailed Kite and Peregrine Falcon, showed a lesser affinity for ricelands but still at levels meriting special recognition in this report.



PEREGRINE FALCON
Falco peregrinus

> *Data from the Raptor Survey suggest that rice may be important locally for kites.*

WHITE-TAILED KITE

White-tailed Kites tend to prefer other habitat types such as alfalfa, grassland, forage crops, fallow fields and wetlands in the Central Valley (Dunk 1993, Erichsen 1995), but they were observed frequently in rice fields. This species can exploit prey that is otherwise inaccessible due to its unmatched skill at hover-hunting (staying in one spot in the air like a helicopter) over open areas where perch-hunting species are limited. Data from the Raptor Survey suggest that rice may be important locally for kites.

PEREGRINE FALCON

While not present in high densities anywhere in the Central Valley, Peregrine Falcons are drawn to the large concentrations of shorebirds (sandpipers, plovers) and waterfowl found in both ricelands and wetlands during winter. Thus, the highest Peregrine densities were in these two habitats during the Raptor Survey. These groups of birds provide Peregrines with an abundant source of food during the winter.

WHITE-TAILED KITE
Elanus leucurus

In Addition to raptor species, Great Egrets frequent California ricelands and adjacent wetlands.

ADJACENT WETLANDS

Habitat variety plays a role in the distribution, abundance, and diversity of raptors found in a given area. Different species have varying needs when it comes to foraging and roosting habitat and when an area can provide a diversity of options, the raptor diversity will likely increase.

Many of the rice fields in the Sacramento Valley, while expansive in places, are often interspersed with wetlands and other agricultural land uses (see Figure 1). Adjacent managed wetlands often contain streamside habitat, either planted or native, which provides roosting cover and foraging opportunities. These areas have low levels of human activity (i.e. car traffic) which not only disturbs birds, but can be a direct source of mortality (Moore and Mangel 1996, Jacobson 2005). Of the approximately 75,000 acres of wetlands in the Sacramento Valley, about 40,000 of these acres rely upon rice tailwater for their flood-up. Of the water used in rice cultivation, only about two-thirds is actually consumed by the rice plants, leaving about one-third to released (tailwater) be reused for flooding of wetlands, other agriculture uses or simply be returned to the Sacramento River.

Results from the Raptor Survey indicate that wetlands throughout the Central Valley support a higher density and diversity of wintering raptors than any other habitat type in the region. A mixture of managed wetlands and rice fields in flooded and dry states provides vital hunting and roosting habitat for wintering raptors in the Sacramento Valley.

Stilts are among the nearly 230 wildlife species that use California ricelands.

CURRENT POPULATIONS

Studies on raptor densities and habitat associations have not previously been attempted on the scale of the Raptor Survey, so historical population data for wintering raptors are not readily available. The California Department of Fish and Game conducted raptor surveys in the Central Valley twice each year sporadically from the late-1960s through the early-1980s but differences in study design make comparisons unreliable (Mallette 1970, Schlorff 1984). Other studies have been done over shorter time spans and limited geographic focus (Wilkinson and Debban 1980, Smallwood et al. 1996, Reeves and Smith 2004). Data from the Raptor Survey indicate that the Central Valley supports roughly 90,000 wintering raptors comprising 19 species (Pandolfino and Smith, manuscript in preparation). Density data from the Raptor Survey and from Christmas Bird Counts both suggest that raptor densities in the Valley are among the highest of any region in North America (Root 1988, Berry et al. 1998, Pandolfino 2006, Pearlstine et al. 2006).


BALD EAGLE
Haliaeetus leucocephalus

> *Raptor densities in the Central Valley are among the highest of any region in North America.*


NORTHERN HARRIER
Circus cyaneus

IMPORTANCE OF RICE FIELDS TO RAPTORS

The Raptor Survey results indicate that for a few species rice fields are important in helping to support a healthy wintering raptor population in the Sacramento Valley. One way to gauge the value of ricelands to raptor populations is to calculate the potential impact of reductions in rice acreage. Raptor density in wetland habitat (4.3 birds/km^2) was higher than in any other habitat type. The corresponding density figure for rice was 2.6 birds/km^2.

The difference in raptor diversity and density between rice and wetlands was consistent over the three years of the Raptor Survey. Based on this difference, we can estimate that, for every 1,000 acres of rice lost, one would need to create 600 acres of wetland to compensate for the raptor habitat lost. Therefore, the 500,000 acres of ricelands in the Sacramento Valley potentially support raptors at a level equivalent to approximately 300,000 acres of wetlands. Wetlands support large numbers of waterfowl, shorebirds, and rodents which in turn support the raptors. Creating more of this habitat to make up for lost rice would be difficult and very expensive. Since various land uses can support raptors at some level, estimating the cost for creating raptor habitat equivalent to what is currently provided by ricelands is challenging. However, a project to acquire and restore 300,000 acres of new wetlands could potentially cost $2 billion. In addition, operation and maintenance cost for this amount of wetlands would be approximately $35 million per year.

> *The 500,000 acres of ricelands in the Sacramento Valley potentially support raptors at a level equivalent to approximately 300,000 acres of wetlands.*

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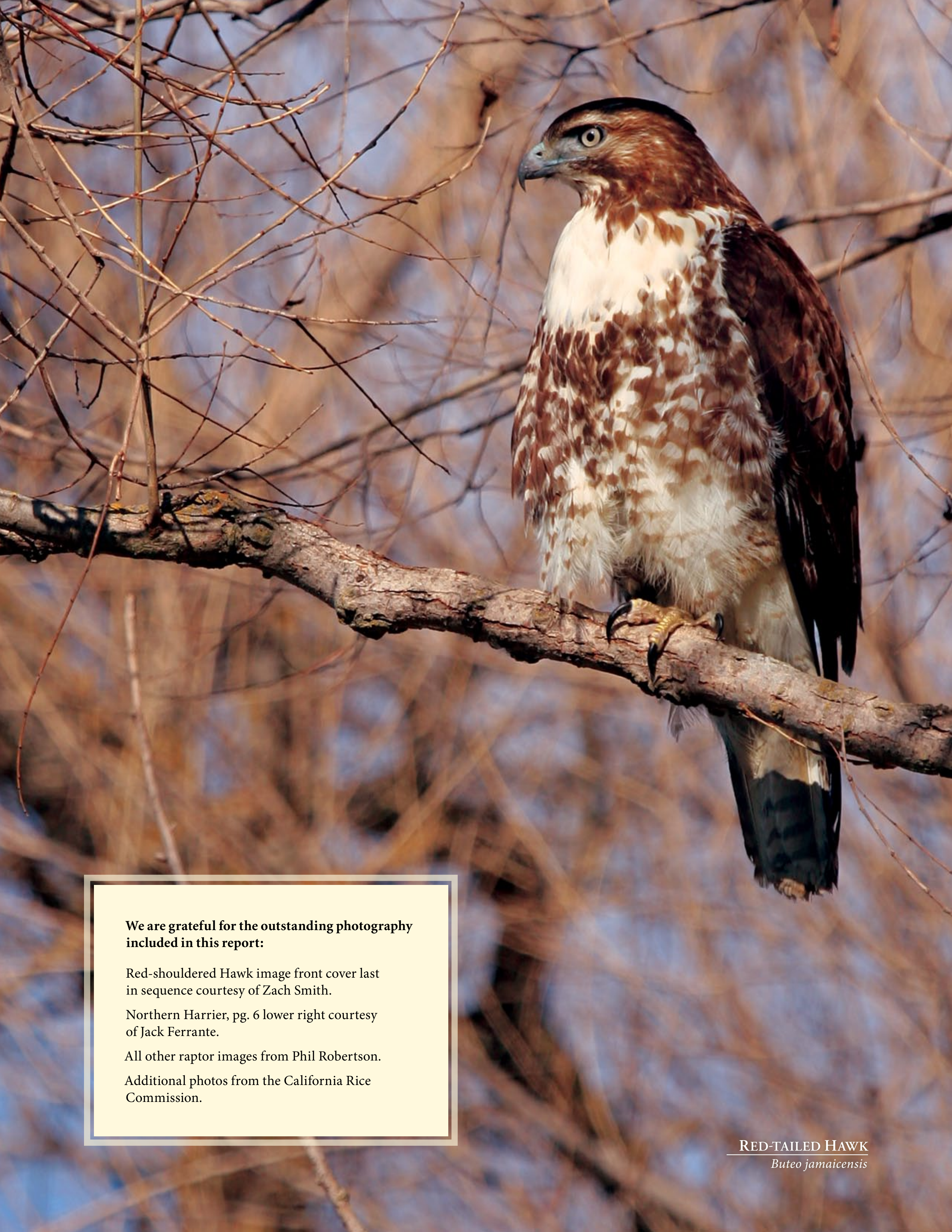
RED-SHOULDERED HAWK
Buteo lineatus



We are grateful for the outstanding photography included in this report:

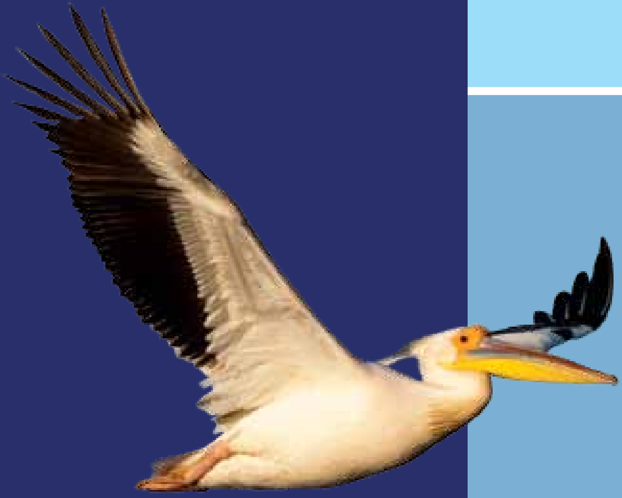
Red-shouldered Hawk image front cover last in sequence courtesy of Zach Smith.

Northern Harrier, pg. 6 lower right courtesy of Jack Ferrante.

All other raptor images from Phil Robertson.

Additional photos from the California Rice Commission.

RED-TAILED HAWK
Buteo jamaicensis



Wildlife

KNOWN TO USE CALIFORNIA RICELANDS

Prepared for:

California Rice Commission
www.calrice.org

Prepared by:

ICF Jones & Stokes
630 K Street Suite 400
Sacramento, CA 95814
916.737.3000

Principal Authors:

John Sterling
President
Central Valley Bird Club
and Sterling Wildlife Biology

Paul Buttner
Environmental Affairs Manager
California Rice Commission

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Introduction

California ricelands have become important "surrogate" wetland habitats for many wildlife species. In fact, nearly 230 species are known to use California ricelands.

With the extensive loss of about 95 percent of the native wetland habitats in the Central Valley, riceland habitats have become essential to the management of certain wildlife, such as waterfowl and shorebirds. Moreover, many special-status species have also successfully adapted to cultivated ricelands. For some wetland-dependent species, ricelands provide essential wetland-like habitat that has contributed to the stability of populations. In some cases, habitat provided by ricelands has helped to support population increases.

This report discusses the general values that California ricelands provide for wildlife. It also examines, in greater detail, the use of ricelands by special-status wildlife species and several other species that depend on the specially-designated shorebird habitat provided by ricelands.

WILDLIFE USE OF CULTIVATED RICELANDS

Early in the nineteenth century, the Central Valley was characterized by large numbers of small creeks, sloughs, oxbows and major rivers that were subject to periodic flooding. The scouring associated with seasonal flooding created a mosaic of channels, depressions, lowland swamps, marshes, and hummocks across wide expanses of the Central Valley (Scott and Marquiss 1984). An estimated four million acres of wetlands, together with extensive grasslands, riparian forests, and valley oak woodlands, formed a complex mosaic of habitats that supported enormous flocks of ducks, geese, swans, cranes, shorebirds, various wading birds and other species.

In the mid-nineteenth century, the landscape of the Central Valley began to undergo a gradual conversion to one dominated by intensively managed agricultural lands, finally becoming one of the most productive agricultural regions in the world. This loss of habitat resulted in substantial declines in the estimated 40 million waterfowl, and other waterbird populations that historically used the Central Valley (Elphick and Oring 2003). Despite this enormous habitat loss, three million to six million ducks, geese, and swans continue to winter in California. During their annual cycles, large numbers of shorebirds, pelicans, egrets, herons, ibises, songbirds, and raptors use the Central Valley wetlands. The total annual waterbird count (including migrants) in the region has been estimated as high as 10 to 12 million (Gilmer et al. 1982).

With the gradual loss of wetlands in the Central Valley, wildlife has become increasingly dependent on suitable agricultural lands for food and cover. Certain types of agriculture—chiefly rice cultivation—help to sustain remaining populations by creating valuable habitat that provides functions similar to native valley habitats. Rice cultivation has provided surrogate wetland habitats that serve as essential breeding and wintering habitat for waterfowl, shorebirds, wading birds, and other wildlife (Elphick and Oring 1998). These habitats also provide food and cover for some reptiles, amphibians, and mammals.

Each year, approximately 500,000 acres of land, mainly in the Sacramento Valley, are planted in rice (Buttner 2004, personal communication). Rice fields are flooded during the summer growing season, and as a result of straw burning legislation to improve air quality (Rice Straw Burning Act, 1991), many rice fields are also flooded following harvest in an effort to decompose rice straw (Brouder and Hill 1995). In total, many of these fields are flooded for up to eight months of the year, during which time the rice fields become temporary wetlands with enormous significance to bird populations wintering and breeding in the Central Valley. In addition to the surrogate wetland values they offer, rice fields also provide a high-value food source from the 75,000 tons of waste grain estimated to remain on the ground following the annual rice harvest in the Central Valley. It is this waste rice grain, as well as other valuable food in rice fields, that enables wintering waterfowl in the Sacramento Valley to gather more than 50 percent of their nourishment from rice farms (Central Valley Joint Venture 2006).

These flooded rice fields are dynamic in their attraction to wildlife and in the habitat values they provide. Habitat quality varies with rainfall, site-specific flooding cycles, management practices, and the particular habitat requirements of each species.

"The rice fields become temporary wetlands with enormous significance to bird populations wintering and breeding in the Central Valley."

While specific management practices can influence the value of ricelands (Elphick and Oring 1998), the mere presence of summer and winter-flooded habitat has provided more than 500,000 acres of wetland-like habitat in the Central Valley. This habitat, in conjunction with the abundant food source remaining in rice fields after harvest, has contributed to population increases of many wetland-dependent species. During the winter months, large flocks of water birds forage in flooded rice fields. These shorebird and waterfowl concentrations attract raptors, especially Northern Harrier, Peregrine Falcon and Bald Eagle. Unflooded rice fields also support large rodent populations which in turn attract hundreds of raptors, such as White-tailed Kites, Northern Harriers, Red-tailed Hawks, American Kestrels and Short-eared Owls.

The Central Valley is an essential habitat area for waterfowl (ducks, geese, and swans). It serves as part of an annual bird migration corridor known as the Pacific Flyway. During the 1880s, an estimated four million acres of wetland habitat was available to waterfowl during the winter. Today, just over 205,000 acres of wetlands remain (Central Valley Joint Venture, 2006), supplemented by approximately 500,000 acres of ricelands. This additional surrogate wetland acreage plays an enormous role in sustaining the populations of the 3 to 6 million waterfowl that continue to use the Central Valley during winter. Together, both rice and wetland habitats help establish the Central Valley as the most important waterfowl wintering area in the Pacific Flyway, supporting up to 60 percent of the total flyway population in some years (Central Valley Joint Venture 2006).

Rice farmers also enjoy a healthy symbiotic relationship with the 75,000 acres of managed wetlands in the Sacramento Valley. Rice fields and the adjacent wetlands share the many of the same wildlife species as they move back and forth between the two habitats at various times of the year. In addition, the water released from rice fields is reused to flood about half of the Sacramento Valley's wetlands (Smith, personal communication).

For a variety of reasons—including loss of wetlands, extended periods of drought on the breeding grounds, and loss of nesting habitat—populations of wintering waterfowl in California have declined dramatically since the late 1970s. Through the efforts of waterfowl conservation groups and the proactive management of both breeding and wintering waterfowl habitats by state and federal agencies, the decline in California's waterfowl population slowed, and then started to reverse in the late 1980s. The winter flooding of rice fields in the Central Valley has been an important factor in this recovery. This winter flooding has resulted in an apparent dependence of some waterfowl species on flooded rice fields. For example, more than one million Northern Pintails have been counted in recent years during January waterfowl surveys in the Central Valley. Heitmeyer and Raveling (1988) demonstrated this species' dependence on flooded rice fields during their study of foraging behavior and habitat preferences in the Central Valley.

Overall, ricelands are known to be used by 187 species of birds, 27 species of mammals, and 15 species of reptiles (Appendix A). Of these nearly 230 species, 30 are currently considered special-status species. In addition, 17 of the bird species are part of a specially-designated habitat area that includes rice fields and adjacent wetlands of the Sacramento Valley (See Section 3).

Special-Status Wildlife Species Use Of Ricelands

This discussion of special-status species use of ricelands addresses both wetland-dependent species and other species that use ricelands incidentally.

Special-status species are those assigned an official designation by a state or federal resource agency that indicates population declines or other reason for particular concern. For purposes of this report, special-status species are defined as:

- Species listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (ESA) (50 CFR 17.11, and various notices in the Federal Register [FR] [proposed species])
- Species that are included on the federal bird species of conservation concern list for Bird Conservation Region 32 that includes the Central Valley (USFWS 2008)
- Species listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (CESA) (14 California code of Regulations [CCR] 670.5)
- Animal species of special concern to the California Department of Fish and Game (DFG) (Shuford and Gardali 2008 [birds], Williams 1986 [mammals], Jennings and Hayes 1994 [reptiles and amphibians])
- Animals fully protected in California (California Fish and Game Code, Section 3511 [birds], 4700 [mammals], and 5050 [reptiles and amphibians])
- Bald and Golden Eagles specifically listed by the Bald and Golden Eagle Protection Act (16 U.S.C. 668).

SPECIAL-STATUS WILDLIFE KNOWN TO USE CALIFORNIA RICELANDS DURING THEIR ANNUAL CYCLE

Species	Scientific Name	Status*
REPTILES		
Western Pond Turtle	*Actinemys marmorata*	**CSC**
Giant Garter Snake	*Thamnophis gigas*	**CE, FE**
BIRDS		
Fulvous Whistling-Duck	*Dendrocygna bicolor*	**CSC**
Tule Greater White-fronted Goose	*Anser albifrons elgasi*	**CSC**
Redhead	*Aythya americana*	**CSC**
American White Pelican	*Pelecanus erythrorhynchos*	**CSC**
Least Bittern	*Ixobrychus exilis*	**CSC**
White-tailed Kite	*Elanus leucurus*	**CFP**
Bald Eagle	*Haliaeetus leucocephalus*	**BGE, CE, CFP**
Northern Harrier	*Circus cyaneus*	**CSC**
Swainson's Hawk	*Buteo swainsoni*	**CT, FSCC**
Golden Eagle	*Aquila chrysaetos*	**CFP, BGE**
Prairie Falcon	*Falco mexicanus*	**FSCC**
Peregrine Falcon	*Falco peregrinus*	**FSCC**
Lesser Sandhill Crane	*Grus canadensis canadensis*	**CSC**
Greater Sandhill Crane	*Grus canadensis tabida*	**CT**
Snowy Plover	*Charadrius alexandrinus*	**CSC**
Mountain Plover	*Charadrius montanus*	**CSC, FSCC**
Whimbrel	*Numenius phaeopus hudsonicus*	**FSCC**
Long-billed Curlew	*Numenius americanus*	**FSCC**
Marbled Godwit	*Limosa fedoa*	**FSCC**
Short-billed Dowitcher	*Limnodromus griseus*	**FSCC**
Black Tern	*Chlidonias niger*	**CSC**
Burrowing Owl	*Athene cunicularia hypugaea*	**CSC, FSCC**
Long-eared Owl	*Asio otus*	**CSC**
Short-eared Owl	*Asio flammeus*	**CSC**
Bank Swallow	*Riparia riparia*	**CT**
Loggerhead Shrike	*Lanius ludovicianus*	**CSC, FSCC**
Tricolored Blackbird	*Agelaius tricolor*	**CSC, FSCC**
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	**CSC**

** CSC (California Species of Special Concern); FSCC (Federal Bird Species of Conservation Concern); CFP (California Fully Protected); CT (California Threatened); CE (California Endangered); FE (Federally Endangered); BGE (Bald and Golden Eagle Protection Act)*

REPTILES

Western Pond Turtle *(Actinemys marmorata)*

The Western Pond Turtle is usually found along the quiet waters of marshes, streams, ponds, and other permanent and ephemeral aquatic habitats from sea level to approximately 4,500 feet. Pond turtles use aquatic habitat for activities such as foraging and temperature regulation. They use upland terrestrial habitats for overwintering, nesting, and dispersal. Within the aquatic habitat, pond turtles require emergent basking sites, such as rocks, logs, emergent vegetation, or undercut areas along a bank to maintain proper temperature regulation. The size of the aquatic habitat can vary considerably. Western Pond Turtles have been found in ephemeral pools of only a few square meters and in water bodies that cover several dozen square kilometers. They are also found in ponds that vary up to 50 percent or more in size during the course of a year and in areas where water is present for only a small portion of the year (Holland 1994). Western Pond Turtles are typically found in aquatic habitat during their active period, from approximately March through September. By October, they usually disappear to overwintering sites, often grasslands adjacent to the aquatic habitat.

Western Pond Turtles consume a variety of foods. The majority of their diet consists of crustaceans, midges, dragonflies, beetles, stoneflies, and caddisflies. They also feed on mammal, bird, reptile, amphibian, and fish carrion. They rarely eat plant matter but have been observed foraging on willow and alder catkins and on ditch grass inflorescences (Holland 1991). Nekton (free-swimming pelagic animals) are important food for hatchlings and juveniles (Holland 1985, Holland 1991).

Western Pond Turtles inhabit streams and canals adjacent to rice fields throughout the northern Sacramento Valley. They may benefit from the abundant invertebrate prey found in flooded rice fields.

The Western Pond Turtle is a California species of special concern.

Giant Garter Snake *(Thamnophis gigas)*

The Giant Garter Snake is a large, aquatic garter snake historically found throughout the Central Valley from Butte County south to Kern County (U.S. Fish and Wildlife Service 1999). Since the 1940s, the species has been eliminated from the southern portion of its range. The current range extends from near Gridley in Butte County to the Mendota Wildlife Area in Fresno County (U.S. Fish and Wildlife Service 1999). Populations of Giant Garter Snake are limited to ponds, sloughs, marshes, and rice fields of Sacramento, Sutter, Butte, Colusa, and Glenn Counties. Remnant populations also exist along the western border of the Yolo Bypass in Yolo County and along the eastern fringes of the San Joaquin–Sacramento River Delta from the Laguna Creek–Elk Grove region of Sacramento County south to Stockton in San Joaquin County (Hansen 1986, 58 FR 54053, October 20, 1993). Giant Garter Snakes also occur in rice fields in Merced and Fresno Counties (U.S. Fish and Wildlife Service 1999).

The Giant Garter Snake is endemic to emergent wetlands in the Central Valley. The species occurs in marshes, sloughs, ponds, small lakes, and low-gradient waterways such as small streams, irrigation and drainage canals, and rice fields. Giant Garter Snakes require permanent water during the active season (early spring through mid-fall) to maintain dense populations of food organisms. These snakes also require herbaceous emergent vegetation for protective cover and foraging habitat, as well as open areas and grassy banks for basking. Small mammal burrows and other small crevices in upland habitat are required for winter hibernation sites and refuge from floodwaters (58 FR 54053, October 20, 1993). All three habitat components (cover and foraging habitat, basking areas, and protected hibernation sites) are needed for the species to persist in an area.

The diet of Giant Garter Snakes consists mainly of aquatic prey such as fish and amphibians. Giant Garter Snakes may concentrate feeding efforts at pooled areas that trap and concentrate prey. Native prey species include Sacramento blackfish (Orthodox microlepidotus) and Pacific treefrog (Pseudacris [Hyla] regilla). Nonnative species preyed upon include carp (Cyprinus carpio), mosquitofish (Gambusia affinis), other small fish, and bullfrog (Rana catesbeiana) (U.S. Fish and Wildlife Service 1999).

Loss of wetlands in the Central Valley has resulted in significant population declines of Giant Garter Snake resulting in its current listing as endangered under both the federal and state Endangered Species Acts. The development of ricelands has created an important alternative habitat for Giant Garter Snakes. Some of the most important remaining populations of this species in the American and Butte Basins have been found to depend on flooded rice fields as a primary habitat component.

> *"The development of ricelands has created an important alternative habitat for Giant Garter Snakes."*

BIRDS

Fulvous Whistling-Duck *(Dendrocygna bicolor)*

The Fulvous Whistling-Duck is a long-legged duck with brown and cinnamon-colored plumage. Natural habitat includes shallow freshwater marsh, but this species has become closely linked with ricelands throughout much of its range, particularly along the Gulf Coast (Hohman and Lee 2001). Their diet consists of weed seeds, water-seeded rice, and earthworms (Hohman and Lee 2001). In the United States, its breeding population migrates to winter in Mexico. Historically it was an irruptive species that in some years ranged into the Sacramento Valley and southern San Francisco Bay (Hamilton 2008). Although seen in large numbers in the Delta region in 1876, the first nest for the state was not found until 1896 after irrigation took hold in the San Joaquin Valley and their population increased dramatically within a few years to take advantage of an increase in man-made habitat (Barnhart 1901, Hamilton 2008).

Fulvous Whistling-Ducks are rapidly disappearing from California and are primarily confined to the Imperial Valley (Hohman and Lee 2001, Hamilton 2008), where during the 1990s fewer than five pairs were thought to remain (Patten et al. 2003). In the Central Valley, they bred at the Mendota Pool and Wildlife Area, the Woodland Sugar Ponds, and the Kern National Wildlife Refuge as recently as the 1970s to early 1980s. Unexpectedly, one-two breeding pairs with young were discovered in the Tulare Basin area in 2006 (Sterling 2007) when a large influx occurred in the southwest indicated that a population can potentially become re-established in California. Fulvous Whistling-Ducks are known to nest in rice fields. Their range expansion into the United States during the latter half of the nineteenth century was greatly facilitated by rice cultivation that increased the quality and acreage of available habitat (Hohman and Lee 2001). Because large numbers of Fulvous Whistling-Ducks from Mexico had historically wandered to California during wet years, they may potentially recolonize their former range in California. Rice cultivation had played an important role in the historical spread of these ducks in the Central Valley and may play a role in the future, if a large-scale irruption of migrants from Mexico occurs, and summer water is available for their wetland and rice field habitats.

The Fulvous Whistling-Duck is on the California Bird Species of Special Concern Priority 1 list primarily due to loss of nesting habitat and the severe decline in the species range and population in the state (Hamilton 2008).

Tule Greater White-fronted Goose *(Anser albifrons elgasi)*

The Tule Greater White-fronted Goose is the larger of two North American subspecies of Greater White-fronted Goose (A. albifons). Tule Greater White-fronted Geese breed exclusively in the upper Cook Inlet region of Alaska (Deuel and Takekawa 2008) and winter in the Colusa Basin and Butte Sink region of the Sacramento Valley as well as the Suisun and Napa marshes (Wege 1984, Deuel and Takekawa 2008). Their population is currently estimated at 7,000 to 10,000, but there is no solid evidence of population trends given the lack of accurate historical estimates (Deuel and Takekawa 2008). In contrast with the more common subspecies, Pacific White-fronted Goose (A.a. frontalis), tule geese rarely form flocks larger than 25 individuals (Bauer 1979 in Deuel and Takekawa 2008). During the winter, they forage primarily in harvested rice fields and corn fields along with Pacific White-fronted Geese (Deuel and Takekawa 2008). As is true of most migrating and wintering waterfowl in the Central Valley, ricelands provide a viable surrogate wetland habitat for this species.

The Tule Greater White-fronted Goose is on the California Bird Species of Special Concern Priority 3 list due to the small population size that winters entirely in a small geographic area of California (Deuel and Takekawa 2008).

Redhead *(Aythya americana)*

The Redhead is a diving duck identified by its darker coloration and rounder head profile from the similar Canvasback. A small population breeds in the remnant marshlands in the Central Valley. Population trends from several periods and different techniques documented steady declines throughout the state (Beedy and Deuel 2008). This species is a nest parasite, in that many females do not build nests and incubate eggs. They simply lay their eggs in other waterbirds' nests. The few that do build nests make them in the vegetation of marshes, usually with water depths exceeding two feet. Redheads frequent flooded rice fields where they feed on excess grain, vegetation, and insects, snails and other aquatic invertebrates.

The Redhead is on the California Bird Species of Special Concern Priority 3 list primarily due to extensive loss and degradation of breeding habitat and vulnerability to hunting, contaminants, and disease (Beedy and Deuel 2008).

American White Pelican *(Pelecanus erythrorhynchos)*

The American White Pelican is a large white bird with black flight feathers and long, massive bill. Pelicans eat fish and crawfish that they scoop up in their bills in deep marshes, lakes and ponds. They frequent flooded rice fields for resting and are often found in large flocks. This colonially-nesting species no longer breeds in the Central Valley, but non-breeding or possibly breeding visitors from nesting colonies in northeastern California are common sights during the spring and summer. In winter a larger influx of pelicans visits the Central Valley.

The American White Pelican is on the California Bird Species of Special Concern Priority 3 list primarily due to loss, degradation, and human disturbance of breeding habitat and colonies as well as vulnerability to contaminants and disease (Shuford 2008a).

Least Bittern *(Ixobrychus exilis)*

The Least Bittern is a small heron that is rarely seen due to its cryptic (light brown) coloration and its tendency to hide in dense cattail marshes. Consistent with other members of the heron family, Least Bitterns prey upon fish, frogs, and large invertebrates such as crawfish. Small populations breed in the Central Valley primarily in the Sacramento Valley wildlife refuges and some have been documented to remain throughout the winter. They are sometimes found in cattail-lined rice irrigation ditches, but occurrences within rice fields are not well documented. Their population numbers and trends are not well-documented due to the lack of appropriate, species specific surveys in the region (Sterling 2008).

The Least Bittern is on the California Bird Species of Special Concern Priority 2 list primarily due to loss or degradation of breeding habitat (Sterling 2008).

White-tailed Kite *(Elanus leucurus)*

The White-tailed Kite is a medium-sized hawk identified by its long white tail and distinctive black scapulars (shoulder patches). It is also identified by its habit of hovering (or kiting) while hunting. White-tailed kites breed in riparian corridors and in valley oak savanna in the Central Valley (Moore 2000). They forage in grass-

lands, ricelands and other agricultural fields that support concentrations of small rodent prey (Dunk 1995). Obervers counted 133 White-tailed Kites in rice fields and grasslands during the 2002 Lincoln Christmas Bird Count, with as many as eight individuals seen in a single rice field. This count was the second highest of more than 1,900 counts conducted throughout the continent and highlights the importance of rice fields as winter foraging habitat.

The White-tailed Kite is a California fully protected species. Its population in California has fluctuated dramatically during the past 100 years. In the 1930s, the population declined precipitously, but from the 1950s to the 1970s it rebounded in both numbers and distribution (Eisenmann 1971).

Bald Eagle *(Haliaeetus leucocephalus)*

The Bald Eagle is a large bird of prey belonging to the group of "fish eagles." Adult Bald Eagles are characterized by their distinctive white head and tail and heavy yellow bill. Bald Eagles in California generally nest in ponderosa pine and mixed conifer forests in mountainous regions (Lehman 1979, Detrich 1985, Jurek 1990). Nest sites are always associated with bodies of water, usually lakes and rivers that support abundant fish, waterfowl, or other waterbird prey. During winter, Bald Eagles migrate locally or long distances to sites that are also associated with lakes and rivers. Because of the large wintering waterfowl populations, Bald Eagles are occasionally observed hunting or roosting in the Central Valley during the winter.

Bald Eagles are becoming more regular winter visitors and breeders in the Sacramento Valley. Their populations declined drastically due to the eggshell thinning effects of DDT, but since the ban on the use of that pesticide in the 1970s, populations have rebounded across the continent. In the Central Valley, these eagles are most often found during winter hunting waterfowl concentrated in flooded rice fields. In the spring and summer, eagles are primarily found along the Sacramento, Feather and other rivers where they nest in large riparian trees and prey upon fish.

The Bald Eagle is a California fully protected species, is listed as endangered under California Endangered Species Act and is also federally protected under the Bald and Golden Eagle Protection Act. It is currently considered to be increasing in California (California Department of Fish and Game 2000a).

Northern Harrier *(Circus cyaneus)*

The Northern Harrier is a slender, medium-sized raptor recognized by its distinctive white rump and its low, coursing flight behavior. Closely associated with grasslands and fresh- and salt-water marshes, Northern Harriers are common during the winter and spring/fall migration periods, but are relatively uncommon in the Central Valley during the breeding season. However, the Central Valley supports the largest breeding population in California (Davis and Niemela 2008). They nest on the ground and require adequate cover to conceal their nests from predators (MacWhirter and Bildstein 1996). Ricelands in the Central Valley provide an important wetland substitute for this species. Harriers often hunt for small shorebirds, songbirds, and rodents concentrated in flooded and disked rice fields, as well as in fallow fields that support high densities of voles and other prey (Wilkison and Debban 1980). One hundred seventy-five Northern Harriers were observed in rice fields and grasslands during the 2002 Lincoln Christmas Bird Count. This count was tied for the seventh highest of more than 1,900 counts conducted throughout the continent and, as such, highlights the importance of rice fields as winter foraging habitat.

The Northern Harrier is on the California Bird Species of Special Concern Priority 3 list, primarily due to loss or degradation of breeding habitat (Davis and Niemela 2008).

Swainson's Hawk *(Buteo swainsoni)*

The Swainson's Hawk is a medium-sized bird of prey that inhabits open country grasslands, shrub-steppes, deserts, and agricultural areas of western North America during the breeding season and winters in grassland and agricultural regions extending from Central Mexico to southern South America (England et al. 1997, Bradbury et al. in preparation). Early accounts described the Swainson's Hawk as one of the most common raptors in California, occurring throughout much of the lowland areas of the state (Sharpe 1902).

With the conversion of native grassland foraging habitat and the loss of riparian forest and oak woodland nesting habitat, the statewide population was reduced substantially. Currently, there are an estimated 700 to 1,000 breeding pairs in the state (Swainson's Hawk Technical Advisory Committee file data), representing less than 10 percent of the historic population (Bloom 1979).

The Central Valley population (between 600 and 900 breeding pairs) extends from Tehama County southward to Tulare and Kings Counties. Despite the loss of native habitats in the Central Valley, the Swainson's Hawk appears to have adapted relatively well to certain types of agricultural patterns in areas where suitable nesting habitat remains. The optimal foraging and nesting habitat conditions in Yolo and portions of Sacramento and San Joaquin counties support the bulk of the Central Valley Swainson's Hawk population (Estep 1989, Estep in preparation).

In the Central Valley, Swainson's Hawks typically forage in agricultural fields that provide accessibility to prey. Flooded rice fields are not suitable for foraging by Swainson's Hawks. However, where rice fields occur within a mosaic of other crop types, disked or fallow rice fields may be used by foraging hawks, and rice field berms are occasionally used for resting and foraging.

The Swainson's Hawk is listed as threatened under California Endangered Species Act and is a federal species of conservation concern (USFWS 2008).

Golden Eagle *(Aquila chrysaetos)*

The Golden Eagle is a large bird of prey characterized by its dark brown body and golden mantle. Golden Eagles nest throughout much of the state, including the Great Basin, Coast Ranges, and southern California deserts. They also nest around the perimeter of the Central Valley, and a few pairs nest in the valley, including at the Sutter Buttes. Nests are constructed on cliff ledges and in trees. Golden Eagles forage over large open upland habitats, primarily grassland, oak savanna, and shrub-steppe habitats, for ground squirrels, rabbits, and other mammalian prey. They are occasionally observed on the valley floor in agricultural areas and are sometimes seen hunting in fallow or disked rice fields.

The Golden Eagle is a California fully protected species and is also federally protected under the Bald and Golden Eagle Protection Act.

Prairie Falcon *(Falco mexicanus)*

The Prairie Falcon is a large cliff-nesting falcon. Unlike Peregrine Falcons, Prairie Falcons are not associated with wetland foraging habitat but with open plains and shrub-steppe deserts, where they range widely in search of mammalian and avian prey (Steenhof 1998). Prairie Falcons are primarily found in the Central Valley during winter, although a few may breed in the surrounding foothills (Hunting 2008). They hunt medium-sized birds, ground squirrels and other small mammals, and reptiles in grasslands and croplands (Steenhof 1998). Prairie Falcons often hunt over fallow and flooded rice fields, where there are concentrations of prey (Steenhof 1998). Nine Prairie Falcons were observed in rice fields and grasslands during the 2002 Lincoln Christmas Bird Count. This count tied for the second highest of more than 1,900 counts conducted throughout the continent and, as such, highlights the importance of rice fields as winter foraging habitat.

The Prairie Falcon is a federal species of conservation concern (USFWS 2008), due primarily to its small statewide breeding population, estimated at 300 to 500 pairs in 1977, (Boyce et al. 1986). Threats to this population include loss of breeding and foraging habitat, human disturbance at nest sites, shooting, and collision with humanmade objects (Hunting 2008).

Peregrine Falcon *(Falco peregrinus)*

The Peregrine Falcon is a large falcon that nests on cliff ledges, typically near fresh- or saltwater marshes or other habitats that support waterfowl, shorebirds, or other waterbird prey. Prior to World War II, Peregrine Falcons nested throughout much of California from sea level to over 7,000 feet, with the densest populations along the coast, in the Cascades, and in the Sierra Nevada (Jurek 1989). Beginning in the 1940s, the widespread use of chlorinated hydrocarbon pesticides, such as DDT, triggered a precipitous decline in Peregrine populations throughout North America and in much of the rest of the world. These pesticides concentrated in the tissues of prey populations and were subsequently passed to the Peregrines themselves, resulting in the inability of the females to form normal eggs. By the late 1960s, the species was seriously threatened over much of its range. Recovery efforts over the past 25 years have brought the estimated breeding population in California from less than 10 active sites in 1975 to more than 2000 in 2006 (California Dept. of Fish & Game). Nationwide recovery efforts were so successful that the species, formerly listed as endangered under the Endangered Species Act, was delisted in 1999 by the U.S. Fish and Wildlife Service. Pesticides still plague nesting Peregrines in California, despite the ban on DDT since 1972 (Risebrough and Monk 1989), but the recovery of this species in California and across North America is encouraging. Peregrine Falcons winter in the Central Valley, where they make long foraging flights over the surrounding wetlands and flooded rice fields, hunting for ducks and shorebirds.

The statewide population of Peregrine Falcons is currently estimated at 215-246 breeding pairs (Comrack and Logsdon 2008).

Although no longer listed under the federal Endangered Species Act, the Peregrine Falcon remains listed as endangered under California Endangered Species Act and a federal species of conservation concern (USFWS 2008).

Lesser Sandhill Crane *(Grus canadensis canadensis)* **and Greater Sandhill Crane** *(Grus canadensis tabida)*

Sandhill Cranes are elegant, long-necked, long-legged birds of open grasslands and freshwater marshes. Only Greater Sandhill Cranes breed in California, nesting in high mountain meadows of the northern Sierra Nevada and Cascade Ranges and large high-desert meadows of northeastern California.

On their wintering grounds in the Central Valley, Sandhill Cranes forage primarily on waste grain in corn, rice, and wheat fields. They gather in large wintering flocks at traditional sites in Merced County, the Delta region, and the northern Sacramento Valley. Many of California's winter population of 5,000 to 6,000 Greater Sandhill Cranes winter in the Butte Sink, where they forage primarily on rice (California Department of Fish and Game 2000b). The coastal segment of the Pacific Flyway population of Lesser Sandhill Crane (approximately 3,800 birds) leaves southeastern Alaska in the fall to winter in the rice fields and refuge systems in the northern Sacramento Valley from Red Bluff to southern Butte County. The eastern segment of this population (approximately 25,000 birds) winters in corn stubble fields near Lodi and a variety of other habitats south to the Carrizo Plains in San Luis Obispo County (Littlefield 2008). Both subspecies wintering in the Sacramento Valley are entirely dependent on state and federal refuge lands and private agricultural lands for winter roosting and foraging habitat. Ricelands provide essential habitat for both subspecies of Sandhill Cranes. Waste grain provides an important food resource, and flooded rice fields are used as roosting sites (Pogsdon 1990).

> *"Ricelands provide essential habitat for both subspecies of Sandhill Cranes. Waste grain provides an important food resource, and flooded rice fields are used as roosting sites."*

The Greater Sandhill Crane is listed as threatened under California Endangered Species Act, primarily because of the loss of suitable breeding habitat, human disturbance, predation on the local breeding population in northeastern California, and the continued loss of winter foraging habitat (California Department of Fish and Game 2000b).

The Lesser Sandhill Crane is on the California Bird Species of Special Concern Priority 3 list, primarily because its foraging and loafing habitat in the Central Valley is rapidly being converted from grain crops to orchards, vineyards, and housing developments.

Snowy Plover *(Charadrius alexandrinus)*

The Snowy Plover is a small, pale shorebird with distinctive black markings on the head and neck. Breeding locations in California include the Pacific Coast, eastern California, and the Salton Sea (Page et al. 1995). One Central Valley population exists year-round in agricultural evaporation ponds in the southern San Joaquin Valley (Shuford et al. 1995, Shuford et al. 2008). Snowy Plovers nest on the ground in the open and are consequently subject to predation and a variety of human disturbances. Coastal populations nest in the sand on beaches or in dry salt flats in lagoons. Inland populations use flats at salt evaporation ponds and river bars. Snowy Plovers feed primarily on terrestrial and aquatic invertebrates.

Snowy Plovers are occasionally found during migration and winter at sewage treatment ponds in the Central Valley (Sterling 2003a) and have been observed occasionally in flooded rice fields (Shuford et al. 1995, Sterling 2003).

The species' inland population is on the California Bird Species of Special Concern Priority 3 list, primarily because of changes in water levels, especially those caused by humans, in addition to nest predation and disturbance.

Mountain Plover *(Charadrius montanus)*

The Mountain Plover is a medium-sized, long-legged, drab-colored shorebird that breeds in the Rocky Mountain region from New Mexico to the Canadian border and winters primarily in California's Central Valley. Mountain Plovers nest primarily in shortgrass prairie but are also found in semi-desert and agricultural landscapes (Knopf 1996).

Mountain Plovers winter in grasslands and disked or burned agricultural fields in the Central Valley from Yolo County south to Kern County, as well as in the Imperial Valley and along the lower Colorado River Valley (Rosenberg et al. 1991, Knopf and Rupert 1995, Patten et al. 2003, Hunting and Edson 2008). Mountain Plovers are not commonly found in rice-cultivated habitats. However, they have been reported to forage occasionally in recently disked rice fields incidentally during migration (Knopf 1996, Edson and Hunting 1999, Hunting and Edson 2008).

The Mountain Plover is a California species of special concern and a federal species of conservation concern (USFWS 2008). It is on the California Bird Species of Special Concern Priority 2 list, primarily because of wintering habitat loss and degradation in California (Hunting and Edson 2008).

Whimbrel *(Numenius phaeopus)*

The Whimbrel is a large brown shorebird that is similar in size and shape to the Long-billed Curlew. Both of these birds tend to forage in upland pastures and tilled cropland as well as in flooded rice fields and other wetlands. Whimbrels nest in the high arctic and winter along the coasts of southern United States south to southern South America (Skeel and Mallory 1996). They migrate through the Central Valley in large flocks during the spring but are rare during fall migration and winter (Shuford et al. 1998). Agricultural fields, including rice are important habitats for Whimbrels in the Central Valley and constitute 50 percent of the habitat use (Shuford et al. 1998). When foraging in rice fields, Whimbrels prey upon crayfish and other invertebrates (Skeel and Mallory 1996).

The Whimbrel is a federal species of conservation concern (USFWS 2008) and is considered a species of moderate to high conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001). The Whimbrel was considered to be of primary conservation importance in the Central Valley, because of its large spring migrant population (up to 45 percent of the Alaskan subspecies population) (Page and Shuford 2000).

Long-billed Curlew *(Numenius americanus)*

The Long-billed Curlew is a large, light brown shorebird with long legs and a very long decurved bill. This is an inland-breeding bird, with only a small number of individuals nesting in extreme northeastern California. However, Long-billed Curlews winter throughout much of the state, including the Central Valley, where the species is a relatively common winter visitor and migrant. Typical winter habitat includes pastures and agricultural fields where curlews probe for invertebrates. While ricelands are not important to the overall wintering population, groups of curlews are regularly observed foraging in flooded and disked rice fields (Shuford et al. 1998).

The Long-billed Curlew is a federal species of conservation concern (USFWS 2008). It is considered highly imperiled in the U.S. Shorebird Conservation Plan (Brown et al. 2001) due to population declines outside of California. However, the small breeding population in northeast California is considered stable and there is no evidence of a decline in the wintering population in California.

Marbled Godwit *(Limosa fedoa)*

The Marbled Godwit is a large, long-legged, cinnamon-plumaged shorebird readily distinguished by its long, straight, bicolored bill (pink at base, black near tip) that is used to probe deeply into mud in search of invertebrate prey. One small population nests in western Alaska, while the majority nests in the upper Great Plains in southern Canada, Montana and the Dakotas (Gratto-Trevor 2000). Most migrate to spend the winter in coastal California, with some wintering in the lower San Joaquin Valley in the Tulare Lake Basin. A few Marbled Godwits can be found in the Sacramento Valley rice country during spring (April-May) and fall (July-September) migration. Their migration pathway is unusual in that they cross the Sierra Nevada and pass over the Central Valley to reach the coast. The high count for Sacramento Valley rice country was 37 in August 2003 near Davis (Sterling 2003b), whereas 37,000 have been estimated to winter along the coast (Hickey et al. 2003).

Due to population declines and habitat loss on its breeding grounds, the Marbled Godwit is a federal species of conservation concern (USFWS 2008).

Short-billed Dowitcher *(Limnodromus griseus)*

The Short-billed Dowitcher is a medium-sized, plump shorebird similar to its cousin, the Long-billed Dowitcher. Both species have relatively long bills that they use to probe into deep mud for invertebrate prey. The Short-billed Dowitcher is identified by its different call (a mellow “tu tu tu”), its tail pattern and by its juvenile plumage. It nests further south than its cousin, in boreal wetlands of southern Alaska and central Canada, and winters further south as well to central Peru and Brazil (Jehl, Jr. et al. 2001). As many as 150,000 migrate along the California coast, where some remain to winter (Hickey et al. 2003). However, some migrate through the Central Valley where they feed in rice fields and evaporation ponds. Large-scale shorebird surveys have not distinguished the two species of dowitchers (Shuford et al. 1998). Therefore, the relative abundance of Short-billed Dowitchers in the Sacramento Valley rice country is not well documented. Most of the sightings are of easily-identified juveniles in late August and September, but some vocalizing adults are found during spring as well.

Due to population declines, the Short-billed Dowitcher is a federal species of conservation concern (USFWS 2008).

Black Tern *(Chlidonias niger)*

The Black Tern is unique among terns in that breeders have a distinctive black head and sooty-colored body. This small tern nests in freshwater habitats and eats insects as well as fish, the principal diet of most terns (Dunn and Agro 1995).

Black Terns nest semicolonially and forage for aerial insects and aquatic invertebrates in freshwater marshes in northeastern California and in rice fields in the Sacramento and in upper San Joaquin Valleys (Dunn and Agro 1995, Shuford et al. 2001, Shuford 2008b). Surveys conducted during the 1998 El Niño year found 2,213 breeding pairs in the Central Valley, of which 90 percent were in rice fields in the Sacramento Valley, and another three percent were in rice fields in the San Joaquin Valley (Shuford et al. 2001, Shuford 2008b). During the early nineteenth century, natural marshes in the San Joaquin Valley sustained large populations of Black Terns. With the loss of these breeding areas, the rice fields of the Sacramento Valley have become this species’ stronghold in the Central Valley. The state’s only other stronghold is in the natural marshes of northeastern California (Shuford et al. 2001, Shuford 2008b).

The Black Tern is on the California Bird Species of Special Concern Priority 2 list, primarily due to loss and degradation of breeding habitats.

Burrowing Owl *(Athene cunicularia)*

The Burrowing Owl is a small, ground-dwelling owl found throughout most of the western United States. Active both day and night, Burrowing Owls use ground burrows or other cavities for nesting, cover and forage in grasslands and agricultural fields. In California, most nesting burrows are abandoned California ground squirrel burrows.

The species was widespread in California prior to 1945 (Grinnell and Miller 1944), but urbanization and agricultural conversion of nesting areas have reduced the population significantly since then. Existing populations have been reduced to small fragmented groups frequently surrounded by urban development. It's estimated that a decrease of nearly 60 percent in California populations has occurred since the 1980s (DeSante and Ruhlen 1995). Burrow destruction, the effects of grazing, shooting, secondary poisoning from ground squirrel eradication programs, and collisions with automobiles have historically been the most frequently cited factors for this decline (Remsen 1978). However, in the past 20 to 30 years, the increase in commercial and residential development has produced the largest single impact on populations.

In the Sacramento Valley, Burrowing Owls are found in remnant patches of grassland habitat, in ruderal areas, along levees and roadsides, and in agricultural fields. Their territories tend to be very localized, with most owls hunting within 600 meters of their burrows during the breeding season (Gervais and Rosenberg 2008). They forage primarily in grasslands and agricultural fields, where they prey upon large insects, rodents, small birds, reptiles, and frogs at night and sometimes during the day (Haug et al. 1993). Burrowing Owls have been known to nest along rice field berms in the Sacramento Valley and to use fallow and disked rice fields for foraging.

The Burrowing Owl is on the California Bird Species of Special Concern Priority 2 list and is a federal species of conservation concern (USFWS 2008), primarily because of habitat loss and degradation from rapid urbanization and conversion of agricultural lands to orchards and vineyards.

Long-eared Owl *(Asio otus)*

Long-eared Owls are medium-sized owls that nest in dense riparian vegetation and forage primarily in grasslands and agricultural fields, where they prey upon small rodents (Marks et al. 1994). Historically, Long-eared Owls were considered common breeders in large bottomland forests of cottonwood and willows in the Central Valley (Grinnell and Miller 1944). Due largely to loss of habitat, there are no reports of breeding and only a few reports of wintering Long-eared Owls in recent years. Because of their cryptic diurnal and active nocturnal behaviors, these owls are easily overlooked and may be more common than recent records indicate. Long-eared Owls are not currently known to breed in the rice-growing regions of the Central Valley (Hunting 2008). However, they still occasionally occur during winter in the Sacramento Valley, and are known to hunt over grasslands and rice fields at night or roosting in thickets of trees adjacent to their foraging habitat.

The Long-eared Owl is on the California Bird Species of Special Concern Priority 3 list, primarily because of loss and degradation of breeding and foraging habitat.

Short-eared Owl *(Asio flammeus)*

The Short-eared Owl is a medium-sized ground-nesting owl that inhabits marshlands and grasslands throughout North America. In California, Short-eared Owls nest in grasslands and marsh or seasonal wetland habitats throughout the state, including the Central Valley. They forage in agricultural fields, freshwater marshes, fallow fields, and tall grasslands, where they prey almost exclusively on small rodents (Holt and Leasure 1993, Roberson 2008). Populations in California have declined due to loss of wetland habitats. The rice-growing regions of California are not part of the species' core breeding area, although a few may occasionally breed there, especially during years with high populations of voles (Roberson 2008). During winter, Short-eared Owls may be found flying over disked, fallow, or flooded rice fields at dawn and dusk. They roost in patches of tall grass, sometimes mixed with shrubs that provide concealment from predators.

The Short-eared Owl is on the California Bird Species of Special Concern Priority 3 list, primarily because of habitat loss and degradation.

Bank Swallow *(Riparia riparia)*

Bank Swallows often join other species of swallows that form large flocks in August and early September. These swallows congregate over rice fields and other wetlands, where they prey on concentrations of flying insects. Bank Swallows nest in small burrows that they dig into riverbanks, primarily along the Sacramento and Feather Rivers (Garrison 1999). At nesting colonies, they forage mostly within 200 meters (650 feet) of their nesting burrows, but this range can vary with distances to good foraging areas. With their concentrations of aerial insects, flooded rice fields that are near existing or potential colony sites may play an important role in the success of those colonies.

The Bank Swallow is listed as threatened under the California Endangered Species Act (California Department of Fish and Game 2000c), primarily because of loss of breeding habitat through human activities that alter the flow of rivers and prevent the creation of new nesting sites.

Loggerhead Shrike *(Lanius ludovicianus)*

Loggerhead Shrikes are common in California's rice-growing regions, where resident populations are augmented by wintering birds from migratory populations farther north and east (Humple 2008). They nest in small isolated trees, hedgerows, and shrubs (Yosef 1996), but are most often seen perched on electrical wires and fences in open country. Shrikes eat large insects, small birds, lizards, and rodents they capture in grasslands, ricelands and other agricultural fields (Yosef 1996).

Loggerhead Shrike is on the California Bird Species of Special Concern Priority 2 list, and is a federal species of conservation concern (USFWS 2008), primarily because of habitat loss of breeding and wintering grounds.

Tricolored Blackbird *(Agelaius tricolor)*

Tricolored Blackbird is a blackbird distinguished from the more common red-winged blackbird by white rather than yellow median wing coverts, which form a red and white shoulder patch. The species is largely restricted to California, with the majority of the breeding populations occurring in the Central Valley (Beedy and Hamilton 1999). Tricolored Blackbirds breed in large colonies, primarily in cattail marshes and Himalayan blackberry brambles (Beedy and Hamilton 1999). During the breeding season, they tend to forage within three miles of their breeding colonies (Beedy and Hamilton 1999). Their preferred foraging habitats include ricelands, alfalfa fields, irrigated pastures, grain fields, annual grasslands, and cattle feedlots and dairies (Beedy 2008). Large flocks of hundreds or thousands are not uncommon during winter in rice fields, where they forage on waste grain, insects (especially grasshoppers), clams, snails, and weed seeds such as water grass (Beedy and Hamilton 1999).

The Tricolored Blackbird is on the California Bird Species of Special Concern Priority 1 list, and is a federal species of conservation concern (USFWS 2008), primarily because of the loss and degradation of habitat from human activities.

Yellow-headed Blackbird

(Xanthocephalus xanthocephalus)

Yellow-headed Blackbird is identified by its very distinct bright yellow head and breast. The species occurs in prairie wetlands and emergent wetlands throughout much of the western United States and Mexico. Yellow-headed Blackbirds nest and roost locally in deep-water tule or cattail marshes in the Central Valley. They form large flocks and forage in agricultural fields where they feed on rice and weed seeds during fall and winter and on a variety of insects during summer (Twedt and Crawford 1995). A few join large flocks of other blackbird species in flooded and disked rice fields (Jones and Stokes file data). While ricelands do not provide nesting habitat for this species, they do provide important summer and winter foraging habitat, particularly in the Sacramento Valley.

> *"Ricelands provide an important summer and winter foraging habitat for the Yellow-headed Blackbird, particularly in the Sacramento Valley."*

Yellow-headed Blackbird is on the California Bird Species of Special Concern Priority 3 list (Jaramillo 2008), primarily because of habitat loss through draining of wetlands.

Shorebird Use Of Ricelands

Like waterfowl, shorebirds have benefited from ricelands in the Central Valley. The northern Central Valley is a site of international stature within the Western Hemisphere Shorebird Reserve Network (WHSRN) because of its importance to large numbers of wintering and migrating shorebirds (WHSRN 2003). Based upon endorsements from scientific reviewers, the highly respected Manomet Center for Conservation Sciences recommended that the ricelands and wetlands of the Sacramento Valley be designated as a "Shorebird Site of International Significance." With this action, the Sacramento Valley's rice fields (which comprise nearly 90 percent of the designated 620,000-acre area) are included within the Western Hemisphere Shorebird Reserve Network. The Sacramento Valley is one of the largest North American sites within this network to be formally recognized for providing this beneficial ecological environment. Figure 1, on page 22, provides a detailed map of this special shorebird habitat area.

Disked rice fields in this shorebird habitat area provide foraging habitat for Killdeer, Black-bellied Plovers, Long-billed Curlews, and a variety of other shorebirds during fall, winter and spring seasons. Whimbrels benefit from rice field use during spring migration. In fact, the vast majority of California shorebird species are attracted to flooded fields (Elphick and Oring 1998, Day and Colwell 1998, Shuford et al. 1998, Elphick 2000). Highlighting the importance of flooded rice fields, extensive surveys conducted from 1992 to 1995 found that those fields held 23 to 30 percent of all shorebirds in the Central Valley (Shuford et al. 1998). Particularly high concentrations were noted in the rice-dominated Colusa, Butte, Sutter, Yolo, and American basins in the Sacramento Valley (Shuford et al. 1998).

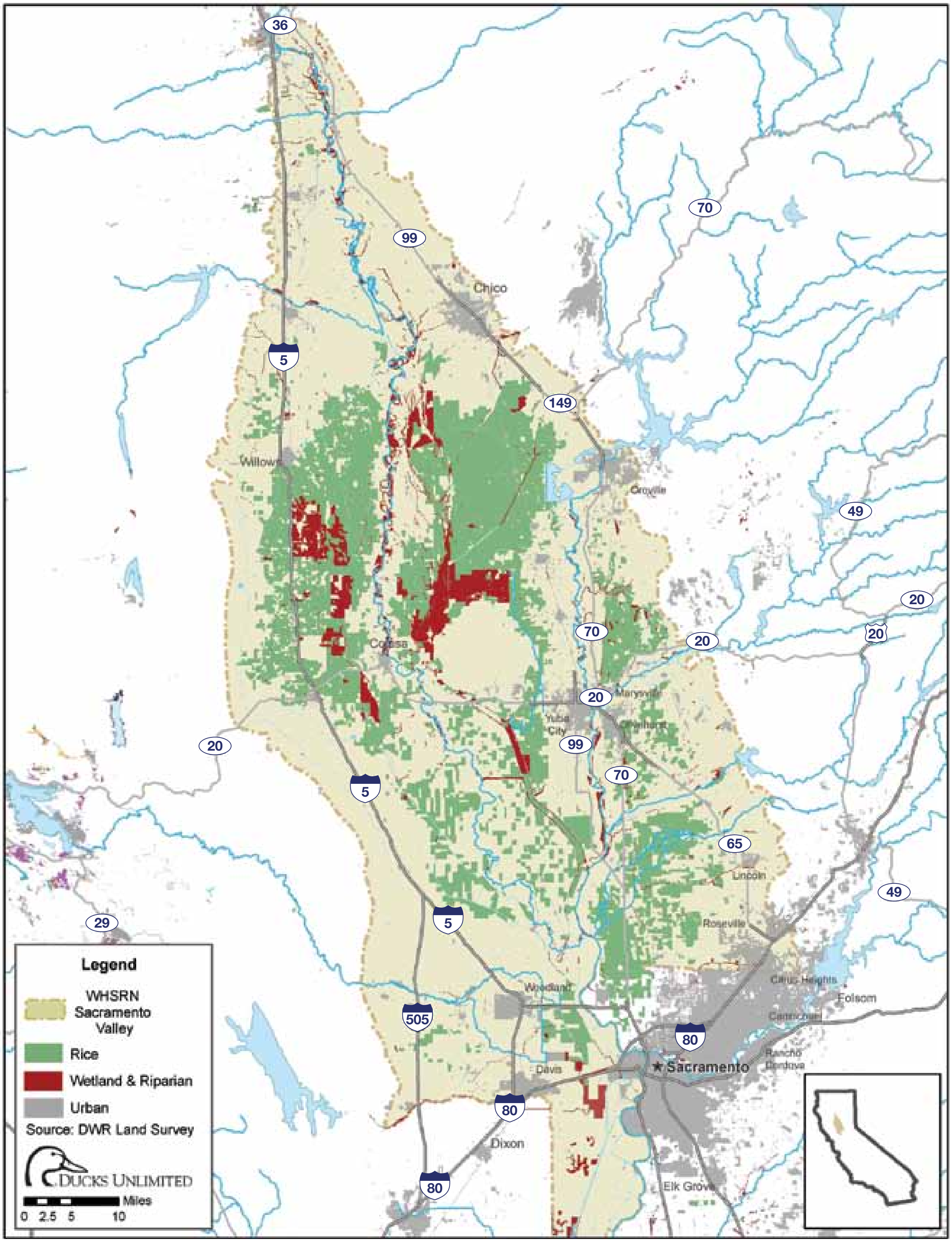
During winter and spring migration in the Sacramento Valley, rice fields, wildlife refuges, and managed wetlands in hunting clubs provide extensive habitat for shorebirds (Page and Shuford 2000). Of the key habitats surveyed from 1992 to 1995, flooded rice fields constituted more than 143,000 acres (21 percent) of the total available shorebird habitat (Shuford et al. 1998). In addition to providing key wetland habitats for shorebirds, rice fields also play a key role in connecting available habitat between the coast, the Sacramento Valley, and the San Joaquin Valley. Maintaining a large-scale mosaic of wetland habitats in a region as large as the Central Valley is vital to the conservation of waterbirds (Haig et al. 1998). This connectivity is especially important during migration when shorebirds require habitat for refueling and resting, and during winter when some species, such as Dunlin and Long-billed Dowitcher populations, move inland from the coast and San Francisco Bay to flooded rice fields in the Sacramento Valley (Shuford et al. 1998).

"During winter and spring migration in the Sacramento Valley, rice fields, wildlife refuges, and managed wetlands in hunting clubs provide extensive habitat for shorebirds."

The importance of flooded, disked (or fallow) rice fields is most pronounced during fall migration (July–October) when there is a scarcity of available shorebird habitat in the Sacramento Valley. August is the low point for shorebird numbers during fall migration because managed wetlands are not usually flooded until September or October. Much of the rice crop is mature at this time, making use by shorebirds limited due to the dense canopy of rice plants (Shuford et al. 1998). However, most fields are flooded immediately following harvest (September through early November), providing quality habitat at this time.

Christmas Bird Count data also illustrates the importance of flooded rice fields to shorebirds, particularly

FIGURE 1: SPECIAL SHOREBIRD HABITAT AREA



Source: DWR Land Survey

wintering Greater Yellowlegs, Dunlin and Long-billed Dowitchers. Only four of 118 Christmas Bird Counts in California are situated within the rice-growing region of the Sacramento Valley. However, these four Christmas Bird Counts rank high for all three of these species with 5 to 22 percent of the total count for all of the 118 California Christmas Bird Counts. The Lincoln Christmas Bird Count in 2004 was an informative addition as it ranked second in the state for Greater Yellowlegs and Dunlin, and had 6 and 16 percent, respectively, of the totals counted in California.

Because of the concern for shorebird populations across the continent, a nationwide conservation plan was developed in an effort to maintain and restore habitats that support adequate shorebird populations in the Western Hemisphere (Brown et al. 2001). This plan is divided into regions. The Southern Pacific Coast Regional Shorebird Conservation Plan covers coastal California and the Central Valley region (Page and Shuford 2000, Hickey et al. 2003) and components of that plan have been incorporated into the Central Valley Joint Venture Implementation Plan (2006) which has set habitat conservation objectives based upon prescribed acreages of flooded rice, semi-permanent and permanent wetlands. These plans encourage harvesting of rice fields by conventional methods (not stripping), maintaining suitable water depths at appropriate levels for a variety of shorebirds and waterbirds, increasing acreage of seasonally-flooded rice fields and other wetlands, and conservation and agricultural easements. The regional plan also ranks species by their national conservation importance (Page and Shuford 2000). In addition to the six special-status shorebirds described in Section 2 (Snowy Plover, Mountain Plover, Marbled Godwit, Whimbrel, Long-billed Curlew and Short-billed Dowitcher), flooded rice fields are of particular importance to the eleven species that are described in this section.

> *"During late winter and spring, Black-bellied Plovers are found in increasing abundance in managed wetlands and agricultural fields, including flooded rice fields."*

Black-bellied Plover *(Pluvialis squatarola)*

The Black-bellied Plover is a medium-sized shorebird. These plovers breed in the arctic tundra of Alaska, Canada and Eurasia and migrate south to winter along the coasts of the United States and Latin America as well as in the Central Valley (Paulson 1995). They have black bellies only during their spring/summer breeding plumage, and during winter they are uniformly gray. During late summer and early winter, most Black-bellied Plovers in the Central Valley are at evaporation and sewage ponds. During late winter and spring, Black-bellied Plovers are found in increasing abundance in managed wetlands and agricultural fields, including flooded rice fields (Shuford et al. 1998). They are also found on upland pastures and dry, tilled fields, sometimes in association with flocks of Killdeer. Black-bellied Plovers forage on earthworms, large insects and crustaceans by plucking them off the surface of mud or dry soil (Paulson 1995).

Although there has been a measurable population decline, the Black-bellied Plover lacks major threats, and has a wide distribution and large population. Therefore, it is considered a species of low conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001).

Killdeer *(Charadrius vociferus)*

The Killdeer is a medium-sized shorebird, about the size of a robin, with two distinct black bands across its chest. Killdeer breed throughout North America and is a familiar bird in the Central Valley. Killdeer nest extensively in this rice-growing region. Eggs are placed in rudimentary nests on scrapes on gravel, bare soil or short grass, edges of roads, parking lots, gravel bars along rivers and even on gravel roofs (Jackson and Jackson 2000). This shorebird species is one of the few that frequents upland pastures, tilled fields, and grasslands more often than traditional shorebird habitat such as managed and natural wetlands.

Although common during the summer in the Central Valley, Killdeer populations increase during the winter to as many as 17,000 with the arrival of migrants from Canada and elsewhere. This large population was the primary reason that Killdeer are considered of primary conservation importance in the Central Valley (Page and Shuford 2000). Within the Central Valley region, the Sacramento Valley harbors the highest populations of Killdeer during the winter with approximately 50 percent of the population concentrated in agricultural fields, and during the late summer with approximately 70 percent in agricultural fields and managed wetlands (Shuford et al. 1998). Ricelands provide important foraging habitat during these seasons.

Black-necked Stilt *(Himantopus mexicanus)*

The Black-necked Stilt is a large, slender black and white shorebird with bright red legs. Stilts breed in wetlands and playa lakes in the western United States, along the eastern coast and throughout much of Latin America (Robinson et al. 1999). Stilts are common breeding and wintering birds throughout the wetlands of the Central Valley. They are one of the few birds that breed in rice fields and place eggs in rudimentary nests (scrapes on bare ground) on dikes, levees, and islets (Robinson et al. 1999). Stilts forage exclusively in shallow wetlands, including flooded rice fields, where they prey upon aquatic insects (Robinson et al. 1999).

Compared to the San Joaquin and Tulare basins, relatively few stilts are found throughout much of the year in the rice-growing region (Shuford et al. 1999). However, during spring breeding season there is a population shift with an influx of stilts into newly flooded rice fields (Shuford et al. 1999). Because of its stable population size and large distribution, the Black-necked Stilt is considered a species of low conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001).

American Avocet *(Recurvirostra americana)*

The American Avocet is a tall, striking shorebird with black and white plumage augmented in the spring by cinnamon color on the head and neck. Avocets breed throughout the interior western United States and winter along the coasts of the southern United States and Mexico (Robinson et al. 1997). They are year-round residents of the Central Valley, although the majority leave the Sacramento Valley during the winter (Shuford et al. 1998). Avocets are most often found in wetlands including flooded rice fields where they forage on aquatic insects in the water. They use their recurved bill in feeding by sweeping it back and forth through water, snatching prey (Robinson et al. 1997). They also forage by plucking, probing and pecking at prey in water and mud. In the Central Valley, most avocets are in the evaporation ponds and managed wetlands in the Tulare Basin and San Joaquin Valley, and to a lesser extent in the rice fields of the Sacramento Valley (Shuford et al. 1998).

The coast and the Central Valley harbor the largest wintering populations of American Avocet. Therefore, both the coast and the Central Valley are considered of primary conservation importance to the species (Page and Shuford 2000). Because there are threats to its wintering grounds, the American Avocet is considered a species of moderate conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001).

Greater Yellowlegs *(Tringa melanoleuca)*

The Greater Yellowlegs is a medium-sized shorebird, with slender proportions and gray plumage contrasting with its long, bright yellow legs. They breed in the boreal forest region of Canada and Alaska and winter from southern United States south to southern South America (Elphick and Tibbitts 1998). Greater Yellowlegs migrate and winter throughout the Central Valley, where many are found in the flooded rice fields of the Sacramento Valley. Unlike many other shorebird species that probe mud, Yellowlegs prey upon invertebrates in the water and therefore, are closely tied to shallow wetlands, including flooded rice fields (Elphick and Tibbitts 1998). They do not form large flocks as many other shorebird species, but sometimes congregate in large mixed-species concentrations of foraging shorebirds.

> *"The rice-growing region becomes even more important to Yellowlegs during spring migration as greater than 60 percent of the Central Valley population is found there."*

The wintering population in rice fields was estimated at 12,300 birds (Elphick and Tibbitts 1998). This large population was the primary reason why Greater Yellowlegs was considered of primary conservation importance in the Central Valley (Page and Shuford 2000). Christmas bird count data demonstrates the relative importance of ricelands as 20 percent of all Yellowlegs counted throughout California were found on the four counts conducted in the rice-growing region. The rice-growing region becomes even more important to Yellowlegs during spring migration as greater than 60 percent of the Central Valley population is found there (Shuford et al. 1998). This influx of birds is likely due to the spring flooding of rice fields that provides excellent habitat for foraging Yellowlegs.

Western Sandpiper *(Calidris mauri)*

The Western Sandpiper is a small shorebird that breeds in the arctic tundra of Alaska and migrates to winter along the coasts of the United States and Latin America (Wilson 1994). Western Sandpipers forage on insects in mud and shallow water, often in large flocks and in association with other small shorebirds. They migrate through the Central Valley in large numbers with counts up to 146,000 during spring migration (Shuford et al. 1998). During the winter, fewer than 9,000 have been counted in the Central Valley, with most found in the San Joaquin Valley (Shuford et al. 1998). Only a few remain in the rice-growing region of the Sacramento Valley during the winter.

Because over one million Western Sandpipers migrate along the coast and through the Central Valley of California, both the coast and the Central Valley are considered of primary conservation importance to the Western Sandpiper (Page and Shuford 2000). Because of a measurable population decline, threats to the non-breeding habitats and its limited breeding range (Alaska), the Western Sandpiper is considered a species of high conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001).

Least Sandpiper *(Calidris minutilla)*

The Least Sandpiper is a small, brown shorebird that breeds in the arctic tundra of Alaska and Canada and migrates to winter in the southern United States and northern Latin America (Cooper 1994). Least Sandpipers forage on insects in mud and shallow water, often in association with Dunlin and Western Sandpipers, but they tend to prefer shallower water depths than those species.

Evenly distributed throughout the Central Valley, they are common during migration and winter in the rice-growing region of the Sacramento Valley (Shuford et al. 1998).

Although there has been a measurable population decline, the Least Sandpiper lacks major threats, and has a wide distribution and large population. Therefore, it is considered a species of low conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001).

Dunlin *(Calidris alpina)*

The Dunlin is a small shorebird that breeds in the arctic tundra of Alaska and Canada and migrates to winter in the southern United States and northern Mexico (Warnock and Gill 1996). Dunlin forage in large flocks in shallow wetlands and sometimes in muddy, tilled fields on insects, worms and other invertebrates (Warnock and Gill 1996). Their spring migration through the Central Valley occurs during April, when most other shorebirds are passing through. However, during fall migration, most arrive in October, nearly two to three months later than other shorebirds. Dunlin populations in the Central Valley are largest during wet winters when there is a movement of coastal populations to the Central Valley (Warnock et al. 1995 and Shuford et al. 1998). Approximately 60 percent of all of the Dunlin in the Central Valley in January have been documented in the rice fields in the Sacramento Valley (Shuford et al. 1998). Christmas bird count data demonstrates the relative importance of the ricelands as up to 22 percent of all Dunlin counted throughout California were found on the four counts conducted in the rice-growing region.

Because over 250,000 (50 percent of the pacifica subspecies) Dunlin winter or migrate along the coast and through the Central Valley of California, both the coast and the Central Valley are considered of primary conservation importance to the pacifica subspecies of Dunlin (Page and Shuford 2000). There has been a measurable population decline of the pacifica subspecies of Dunlin. Therefore, it is considered a subspecies of high conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001).

Long-billed Dowitcher *(Limnodromus scolopaceus)*

The Long-billed Dowitcher is a plump, medium-sized shorebird with a relatively long bill that it uses to probe for worms in mud. Long-billed Dowitchers breed primarily in Alaska and easternmost Siberia and migrate to winter along the coastal United States, the Central Valley, and throughout Mexico (Takekawa and Warnock 2000). They commonly migrate and winter throughout wetland habitats in the Central Valley where they often forage on insects, worms and other invertebrates in flooded rice fields (Elphick and Oring 1998). Peak counts in the Central Valley are over 100,000, with more dowitchers in the Sacramento Valley than elsewhere in the Central Valley (Shuford et al. 1998). Many move inland in winter from the coast and the San Francisco Bay Estuary to the flooded rice fields of the Sacramento Valley (Shuford et al. 1998).

Christmas Bird Count data demonstrates the relative importance of the ricelands as up to 16 percent of all Long-billed Dowitchers counted throughout California were found on the four counts conducted in the rice-growing region. This large population was the primary reason why the Central Valley was considered of primary conservation importance to the Long-billed Dowitcher (Page and Shuford 2000). Because of its large and stable population and lack of threats, the Long-billed Dowitcher is considered a species of low conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001).

Wilson's Snipe *(Gallinago delicata)*

The Wilson's Snipe is a medium-sized plump shorebird, similar in size and shape to the Dowitcher. This species was recently thought to be a subspecies of the Common Snipe that is found in Eurasia. It breeds throughout much of the interior western United States, Canada and Alaska and winters throughout most of the United States, Mexico and Central America (Mueller 1999). Snipe forage on aquatic insects, crustaceans, worms and other invertebrates in shallow wetlands, ricelands, and muddy fields (Mueller 1999). They form small flocks during migration, but in winter they are primarily solitary. However, they will sometimes congregate at prime foraging areas.

Although there are no direct counts of this species, its regional population is thought to be large and was the primary reason why the Central Valley was considered of primary conservation importance to the Wilson's Snipe (Page and Shuford 2000). Because its large global population has had measurable declines, the Wilson's Snipe is considered a species of moderate conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001).

Wilson's Phalarope *(Steganopus tricolor)*

Wilson's Phalarope is a medium-sized, colorful shorebird. It is one of few species where the female is larger and more brightly colored and where the male provides all of the care of the young, including incubation of eggs (Colwell and Jehl 1994). Wilson's Phalaropes breed throughout the interior western United States and Canada and the Great Lakes region (Colwell and Jehl 1994). They do not breed in the Central Valley, but arrive in late summer when they prepare for migration to southern South America by foraging in evaporation ponds, sewage ponds and sometimes in wetlands, including flooded rice fields (Shuford et al. 1998). About 90 percent of the Wilson's Phalaropes in the Central Valley occur in the evaporation ponds of the Tulare Basin in late summer, and only about seven percent are found in the Sacramento Valley during this period (Shuford et al. 1998).

Because there has been a measurable population decline, and threats to a limited wintering range, the Wilson's Phalarope is considered a species of high conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001).

Wading Bird Use Of Ricelands

Wading birds have greatly benefited from ricelands in the Central Valley (e.g. Elphick and Oring 1998, Elphick 2008, Eadie et al. 2008). In the rice-growing regions of the world, flooded rice fields and irrigation canals provide important habitat for waders (herons, egrets, bitterns and ibis), waterfowl (swans, geese and ducks), rails (including coots and moorhens), small grebes, and marsh terns (e.g. Fasola 1978, Fasola et al. 1996, Shuford et al. 1996, Elphick 1998, Lane and Fujioka 1998, Shuford et al. 2001, Tourenq et al. 2004, Eadie et al. 2008). Additionally, unflooded and fallow rice fields provide important habitat for geese, cranes, large herons and egrets (Elphick 1998, Fasola et al. 1996, Eadie et al. 2008).

Flooded rice fields not only provide a surrogate wetland value for many waterbirds during years of normal rainfall (Elphick 2000), they also alleviate the effects of drought on these species when seasonal wetlands are dry. Waders and other birds may respond to drought conditions by assessing available habitat at larger scales than normal (Tourenq et al. 2004), thereby changing the number and distribution of their nesting colonies in the region. During the breeding season, the most important rice fields are within the waders' commuting distance from wildlife refuges, natural wetlands and riparian areas where they nest. In the Central Valley, proximity to wildlife refuges is a key to predicting occurrences of many species in rice fields during winter as well (Elphick 2008). Consequently, the geographic placement of the many federal, state and private wetlands is an important factor for these birds within a larger landscape of rice fields that provide connections between those wetlands. This is important because connectivity of fragmented wetlands is a vital component to waterbird conservation on a large landscape scale (Haig et al. 1998).

Studies of waders from the Central Valley and beyond provide insight into their ecology and how it relates to their conservation. Great Blue Herons nest colonially near areas of rice fields, wetlands and other foraging habitats in order to reduce their energetic costs of commuting (Gibbs 1991, Elphick 2008). In a study in Maine, the number of breeding pairs in a colony was directly proportional to the amount of available foraging habitat (Gibbs 1991). In Northern Italy, nesting colonies of waders were spaced apart so that each colony had a similar acreage of rice fields within a seven-mile commuting distance (Fasola 1978). In Southern France, most species of waders selected areas surrounded by rice fields for nesting colonies (Tourenq et al. 2004). And throughout much of the Mediterranean, local populations of herons and egrets obtain 50 to 100 percent of their prey in rice fields (Fasola et al. 1996). These studies demonstrate that the rice fields play a key role in the conservation of waders in the Central Valley.

> *"Flooded rice fields not only provide a surrogate wetland value for many waterbirds during years of normal rainfall (Elphick 2000), they also alleviate the effects of drought on these species when seasonal wetlands are dry."*

Fallow fields, irrigation canals and unflooded rice fields also play a role in waterbird ecology and conservation.

Fallow fields are important for foraging habitat for upland birds, but can also serve as breeding habitat for American Bittern and ducks such as Mallard and Gadwall (Central Valley Joint Venture 2006). Vegetated irrigation canals also serve as breeding and/or foraging habitat for Pied-billed Grebes, American Bitterns, American Coots, Common Moorhens, Virginia Rails and Soras. Sandhill Cranes, Great Egrets, Black-crowned Night-Herons and Great Blue Herons often hunt for voles, pocket gophers and macro-invertebrates in dry fields. Great Blue Herons and Sandhill Cranes were found significantly more often in unflooded fields during a study in the Central Valley (Elphick and Oring 1998). Likewise, nearly all Greater White-fronted, Snow and Ross Geese were found in unflooded fields (Elphick and Oring 1998). In contrast, flooded rice fields are vital to ducks such as Mallard, Northern Pintail, Northern Shoveler, American Green-winged Teal, Gadwall and American Wigeon (Elphick and Oring 1998). These abundant ducks enhance the benefits of winter flooding by increasing the decomposition of rice straw, so flooding is a mutual benefit for ducks and rice farmers (Bird et al. 2000). By increasing the proportion of flooded rice fields within a three-mile area, farmers would expect an increased number of ducks in any given field (Elphick 2008), thereby accelerating straw decomposition. Winter flooding of rice fields not only greatly increases waterbird density and the number of species, it also greatly enhances their conservation value (Elphick and Oring 2003). So although fallow and unflooded rice fields are important for several species, the overall value of winter flooding should not be underestimated.

Although comprehensive data is lacking on overall populations of waders and their nesting colonies in the Central Valley, the region undoubtedly supports one of the largest populations in the western United States. Most species are very common, characteristic birds of rice fields. Regardless, the conservation of waterbirds and their habitats is a conservation concern. As such, the North American Waterbird Conservation Plan created an overarching framework for the conservation of 210 species of waterbirds and their habitats in North and Central America and the Caribbean (Kushlan et al. 2002). There is currently a plan in development specifically for California, of which the Central Valley is a primary targeted region. In lieu of this plan, the 2006 Central Valley Joint Venture's Implementation Plan currently addresses waterbird conservation through the protection or enhancement of existing wetlands established for waterfowl. Currently, the acreages of flooded rice fields have already met the plan's objectives in providing essential foraging and nesting rice field habitat for a variety of waterbirds (Central Valley Joint Venture 2006). However, the large geographic scales of these plans may overshadow the importance of small wetland complexes (Haig et al. 1998), so it is critical for conservation planning to recognize the connectivity of small wetlands and the rice fields surrounding them as a single mosaic of waterbird habitat. At any scale, the protection of ricelands will continue to play an integral role in bird conservation within the Central Valley.

In addition to the special-status wading bird species described in Section 2 (American White Pelican and Least Bittern), ricelands are also of particular importance to several more species of waders which are described below.

American Bittern *(Botaurus lentiginosus)*

The American Bittern is a solitary, long-necked wader found year-round in emergent marsh habitats throughout much of the Central Valley, Modoc Plateau and isolated wetlands in coastal and southern California. Cryptically colored, this species is typically found in cattail/bulrush–dominated emergent marshes, where its coloration and slow-moving behavior help to conceal it from both prey and potential predators (Gibbs et al. 1992). Its diet consists mainly of small fish, amphibians, and invertebrates. American Bittern populations have declined primarily as a result of the loss of marshlands in California (Peterjohn and Sauer 1993). While American Bitterns prefer to remain concealed in dense marsh vegetation, they are often found feeding in rice fields and rice irrigation ditches in the Central Valley.

The American Bittern was a California species of special concern (Remsen 1978) but is not on the current list (Shuford and Gardali 2008). The wildlife refuge and rice-growing regions of the Sacramento Valley represent this species' population stronghold in California.

Great Blue Heron *(Ardea herodius)*

The Great Blue Heron is a large wader with dark blue-gray plumage and a distinctive presence. Found throughout California, it hunts alone or in congregations of waders in flooded or dry rice fields where it feeds on voles, frogs, fish, snakes, crayfish and other prey (Butler 1992). Great Blue Herons nest in colonies, often in large trees near marshes and rice fields, and often in colonies of Great Egrets (Butler 1992). A characteristic bird of wetlands throughout California, it is commonly seen in flooded rice fields, agricultural ditches, pastures and wetlands in the rice-growing region of the Central Valley.

Great Egret *(Ardea alba)*

The Great Egret is a large, long-necked white wader with long, black legs and a yellow bill that it uses for stabbing and eating voles, frogs, fish, crayfish, insects and other prey (McCrimmon et al. 2001). A commonly-seen bird in rice fields, Great Egrets often congregate in large flocks with other wading birds where food sources are abundant. They nest in colonies, often building large stick nests in trees near marshes and rice fields. Although primarily considered a wetland bird, Great Egrets are often seen hunting in dry rice fields and grasslands, especially during periods when rice fields are not flooded. Once the primary species used in the feather (plume) trade in the 19th and early 20th centuries, it was hunted to near extinction in California and elsewhere in the United States, but Migratory Bird Treaty Act protections enacted in 1913 enabled its populations to rebound to where it is now common throughout the wetlands of its historic range (McCrimmon et al. 2001).

Snowy Egret *(Egretta thula)*

The Snowy Egret is a medium-sized wader, smaller than its cousin, the Great Egret, but similar in having all white plumage. Its yellow feet and black bill further distinguish this species from other white waders. Snowy Egrets congregate in flooded rice fields where they prey upon small fish and aquatic invertebrates—a more selective diet than other waders (Parsons and Master 2000). Their foraging success increases with the number of congregating waders (Erwin 1983, Master et al. 1993). They are also not as likely to be found in dry rice fields or upland areas as are larger waders. Snowy Egrets breed in colonies in densely vegetated cattail and bulrush marshes. As with the Great Egret, it was nearly hunted to extinction for its plumes, but its populations have rebounded to where it is now common throughout the wetlands of its historic range (Parsons and Master 2000).

Green Heron *(Butorides virescens)*

One of the smallest waders, the Green Heron is dark, olive-green with a rufous-brown neck and head, crowned by a black cap. The least gregarious of herons and egrets, it is often found alone in flooded rice fields, especially near riparian areas where it nests in trees. In the Central Valley, it is also the only non-colonial nesting species of the group. Green Herons prey primary upon fish, but will also eat frogs, other small vertebrates, crayfish and a variety of snails and insects (Davis and Kushlan 1994). When hunting, they are the least active of all herons (Kushlan 1976), and often stand motionless at the edge of rice fields, agricultural ditches and marshes. They are not as easily observed as other herons and egrets due to their small stature, dark, cryptic coloration, solitary nature, and hunting technique.

Black-crowned Night-Heron
(Nycticorax nycticorax)

The Black-crowned Night-Heron is a stocky, short-necked, medium-sized wader that nests colonially in densely-vegetated cattail and bulrush marshes, but also sometimes in trees (Davis 1993). Found throughout the world, it is common in the rice-growing region of the Central Valley. It has distinctive differences in immature and adult plumages, with immature birds sporting brown and white plumages similar to the American Bittern, and adults with black backs and caps, and gray underparts and wings. Black-crowned Night-Herons also differ from other waders, having relatively shorter, thicker, non-stabbing bills that they use to grasp frogs, nestling birds and eggs, voles, fish, earthworms, freshwater clams, snails, crawfish and insects (Davis 1993). During the breeding season, they hunt throughout the day and night due to the demands of feeding their young, but otherwise they are primarily nocturnal hunters at least in part to avoid competition for food and foraging areas with other waders (Davis 1993, Watmough 1978). In the non-breeding season, they communally roost during the day in trees in riparian areas, parks, and even in suburban neighborhoods.

White-faced Ibis *(Plegadis chihi)*

The White-faced Ibis is a dark, long-legged wader with a long decurved bill and metallic bronze and brown plumage. White-faced Ibis populations are local throughout the western United States, with principal breeding concentrations in the Great Basin, along the gulf coast, and in California's Central Valley. White-faced Ibis inhabit freshwater wetlands, such as shallow grassy marshes, flooded rice fields and cattail/bulrush marshes. They also feed in flooded meadows and agricultural fields, especially flood-irrigated or cut alfalfa in the Central Valley (Ryder and Manry 1994, Sterling pers. obs.). Ibis nest in large colonies in dense tule and cattail marshes which also serve as nighttime roosts throughout the year. They do not eat rice or other plant material, but prey upon crayfish, insect larvae, and earthworms (Ryder and Manry 1994).

Population declines were already apparent in the 1940s (Grinnell and Miller 1944). This decline continued through the mid 1980s with the continuing loss of wetland habitats, particularly in the Central Valley. However, with the increase of ricelands, ibis populations have begun to rebound. Down to only 200 individuals wintering in the state due to habitat loss and pesticides (Remsen 1978, Henny and Herron 1989), White-faced Ibis populations have increased dramatically in California since the 1980s during both winter (Shuford et al. 1996) and the spring-summer breeding seasons and are now considered yearlong residents (Ryder and Manry 1994). This increase parallels that in the Great Basin, where populations nearly tripled from 1985 to 1997 (Earnst et al. 1998). Displaced birds from flooded colonies the Great Salt Lake Basin during 1980s were thought to drive the tremendous population growth in Oregon during this time (Ivey et al. 1988). The expansion in Oregon, as well as the flood or drought-induced displacement of birds from Great Basin breeding sites, very likely played a direct role in the colonization of the Central Valley, the Klamath Basin and the Modoc Plateau during the late 1980s (Shuford et al. 1996). Unprecedented numbers of ibis were found throughout much of California in spring of those years. These displaced birds arrived in those areas at a time when summer water was becoming available for breeding waterfowl in refuges and rice was established as an important crop in much of the Klamath, Modoc Plateau, Sacramento Valley landscapes. This situation created both excellent breeding habitat in the newly-created summer wetlands as well as excellent foraging habitat in the rice fields. Although systematic breeding censuses have not been conducted in the Central

Valley, it is clear that the ibis breeding population increased dramatically in the past twenty years as several colonies with thousands of nesting pairs are now thriving from Glenn to Kern County where none appeared in the past.

The wintering ibis population also increased dramatically in the Central Valley. Rice fields north of Marysville (in an area called “District 10”) harbor important concentrations of wintering ibis. This area had some of the highest counts of ibis in California during the 2000–2002 Christmas Bird Counts with 3,460, 498, and 857 birds counted, respectively. During the 2000 counts, 27 percent of all ibis recorded in California were in the District 10 rice fields. The magnitude of the species’ increase in the Sacramento Valley is illustrated by comparison with counts in earlier years. Only 110 and 75 ibis were counted at the same location during January surveys in 1994 and 1995 respectively, and none were counted in 1993 (Shuford et al. 1996).

The importance of rice as foraging habitat for ibis in the Sacramento Valley cannot be overstated, they forage extensively in flooded rice fields. During the winter of 1994–95, 53 percent of all Sacramento Valley White-faced Ibis were found in rice stubble fields within three miles of managed wetlands (Shuford et al. 1996). Ibis can also be found foraging in large numbers in rice fields during the summer. They depend heavily on ricelands, especially during the late summer and fall when many wildlife refuges and other managed wetlands are dry.

The White-faced Ibis was a California species of special concern (Remsen 1978) but is not on the current list (Shuford and Gardali 2008). However, because of the species’ population increase, it is a tremendous conservation success story. By providing large expanses of prime foraging habitat in spring, summer and winter, rice cultivation plays an important role in the population and range expansion of this species in California.

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Appendix:

Wildlife Known to Use California Ricelands

Common Name	Scientific Name
BIRDS	
Pied-billed Grebe	*Podilymbus podiceps*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmophorus occidentalis*
Clark's Grebe	*Aechmophorus clarkii*
American White Pelican	*Pelecanus erythrorhynchos*
Double-crested Cormorant	*Phalacrocorax auritus*
American Bittern	*Botaurus lentiginosus*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Little Blue Heron	*Egretta caerulea*
Cattle Egret	*Bubulcus ibis*
Green Heron	*Butorides virescens*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Glossy Ibis	*Plegadis falcinellus*
White-faced Ibis	*Plegadis chihi*
Fulvous Whistling-Duck	*Dendrocygna bicolor*
Tundra Swan	*Cygnus columbianus*
Whooper Swan	*Cygnus cygnus*
Trumpeter Swan	*Cygnus buccinator*
Greater White-fronted Goose	*Anser albifrons*
Snow Goose	*Anser caerulescens*
Ross' Goose	*Anser rossii*
Brant	*Branta bernicla*
Canada Goose	*Branta canadensis*
Cackling Goose	*Branta hutchinsii*
Wood Duck	*Aix sponsa*
Green-winged Teal	*Anas (c.) carolinensis*
Mallard	*Anas platyrhynchos*
Northern Pintail	*Anas acuta*
Garganey	*Anas querquedula*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Gadwall	*Anas strepera*
Eurasian Wigeon	*Anas penelope*
American Wigeon	*Anas americana*
Canvasback	*Aythya valisineria*
Redhead	*Aythya americana*
Tufted Duck	*Aythya fuligula*

Common Name	Scientific Name
Ring-necked Duck	*Aythya collaris*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Common Goldeneye	*Bucephala clangula*
Bufflehead	*Bucephala albeola*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Ruddy Duck	*Oxyura jamaicensis*
Turkey Vulture	*Cathartes aura*
White-tailed Kite	*Elanus leucurus*
Bald Eagle	*Haliaeetus leucocephalus*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*
Swainson's Hawk	*Buteo swainsoni*
Red-tailed Hawk	*Buteo jamaicensis*
Ferruginous Hawk	*Buteo regalis*
Rough-legged Hawk	*Buteo lagopus*
Golden Eagle	*Aquila chrysaetos*
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Gyrfalcon	*Falco rusticolus*
Prairie Falcon	*Falco mexicanus*

Common Name	Scientific Name
Ring-necked Pheasant	*Phasianus colchicus*
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
Common Moorhen	*Gallinula chloropus*
American Coot	*Fulica americana*
Sandhill Crane	*Grus canadensis*
Black-bellied Plover	*Pluvialis squatarola*
Pacific Golden-Plover	*Pluvialis fulva*
American Golden-Plover	*Pluvialis dominicus*
Snowy Plover	*Charadrius (a.) nivosus*
Semipalmated Plover	*Charadrius semipalmatus*
Killdeer	*Charadrius vociferus*
Black-necked Stilt	*Himantopus mexicanus*
American Avocet	*Recurvirostra americana*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Solitary Sandpiper	*Tringa solitaria*
Willet	*Catoptrophorus semipalmatus*
Spotted Sandpiper	*Tringa macularia*
Whimbrel	*Numenius phaeopus*
Long-billed Curlew	*Numenius americanus*
Marbled Godwit	*Limosa fedoa*
Ruddy Turnstone	*Arenaria interpres*
Black Turnstone	*Arenaria melanocephala*
Red Knot	*Calidris canutus*
Sanderling	*Calidris alba*
Semipalmated Sandpiper	*Calidris pusilla*
Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
Baird’s Sandpiper	*Calidris bairdii*
Pectoral Sandpiper	*Calidris melanotos*
Sharp-tailed Sandpiper	*Calidris acuminata*
Dunlin	*Calidris alpina*
Curlew Sandpiper	*Calidris ferruginea*
Stilt Sandpiper	*Micropalama himantopus*
Ruff	*Philomachus pugnax*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Jack Snipe	*Lymnocryptes minimus*
Wilson’s Snipe	*Gallinago delicata*
Wilson’s Phalarope	*Steganopus tricolor*
Red-necked Phalarope	*Phalaropus lobatus*
Long-tailed Jaeger	*Stercorarius longicaudus*
Franklin’s Gull	*Larus pipixcan*
Mew Gull	*Larus canus*

Common Name	Scientific Name
Ring-billed Gull	*Larus delawarensis*
California Gull	*Larus californicus*
Herring Gull	*Larus argentatus*
Thayer’s Gull	*Larus thayeri*
Glaucous Gull	*Larus hyperboreus*
Glaucous-winged Gull	*Larus glaucescens*
Caspian Tern	*Sterna caspia*
Forster’s Tern	*Sterna forsteri*
Black Tern	*Chlidonias niger*
Mourning Dove	*Zenaida macroura*
Barn Owl	*Tyto alba*
Great Horned Owl	*Bubo virginianus*
Burrowing Owl	*Speotyto cunicularia*
Long-eared Owl	*Asio otus*
Short-eared Owl	*Asio flammeus*
Lesser Nighthawk	*Chordeiles acutipennis*
Vaux’s Swift	*Chaetura vauxi*
Belted Kingfisher	*Megaceryle alcyon*
Northern Flicker	*Colaptes auratus*
Black Phoebe	*Sayornis nigricans*
Say’s Phoebe	*Sayornis saya*
Western Kingbird	*Tyrannus verticalis*
Horned Lark	*Eremophila alpestris*
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Cliff Swallow	*Hirundo pyrrhonota*
Barn Swallow	*Hirundo rustica*
Western Scrub-Jay	*Aphelocoma californica*
Yellow-billed Magpie	*Pica nuttalli*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Bewick’s Wren	*Thryomanes bewickii*
Marsh Wren	*Cistothorus palustris*
Western Bluebird	*Sialia mexicana*
Mountain Bluebird	*Sialia currucoides*
Hermit Thrush	*Catharus guttatus*
American Robin	*Turdus migratorius*
Northern Mockingbird	*Mimus polyglottos*
American Pipit	*Anthus rubescens*
Northern Shrike	*Lanius excubitor*
Loggerhead Shrike	*Lanius ludovicianus*
European Starling	*Sturnus vulgaris*
Yellow-rumped Warbler	*Dendroica coronata*

Common Name	Scientific Name
Common Yellowthroat	*Geothlypis trichas*
Blue Grosbeak	*Guiraca caerulea*
Lazuli Bunting	*Passerina amoena*
Spotted Towhee	*Pipilo maculatus*
California Towhee	*Pipilo crissalis*
Vesper Sparrow	*Pooecetes gramineus*
Lark Sparrow	*Chondestes grammacus*
Savannah Sparrow	*Passerculus sandwichensis*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*
White-throated Sparrow	*Zonotrichia albicollis*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
White-crowned Sparrow	*Zonotrichia leucophrys*
Harris' Sparrow	*Zonotrichia querula*
Dark-eyed Junco	*Junco hyemalis*
McCown's Longspur	*Calcarius mccownii*
Lapland Longspur	*Calcarius lapponicus*
Chestnut-collared Longspur	*Calcarius ornatus*
Bobolink	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Tricolored Blackbird	*Agelaius tricolor*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Rusty Blackbird	*Euphagus carolinus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Great-tailed Grackle	*Quiscalus mexicanus*
Brown-headed Cowbird	*Molothrus ater*
House Finch	*Carpodacus mexicanus*
Lesser Goldfinch	*Spinus psaltria*
American Goldfinch	*Spinus tristis*
House Sparrow	*Passer domesticus*

Common Name	Scientific Name
MAMMALS	
Virginia opossum	*Didelphis virginiana*
Ornate shrew	*Sorex ornatus*
California myotis	*Myotis californicus*
Red bat	*Lasiurus borealis*
Hoary bat	*Lasiurus cinereus*
Pallid bat	*Anthrozous pallidus*
Brazilian free-tailed bat	*Tadarida brasiliensis*
Desert cottontail	*Sylvilagus audubonii*
Black-tailed jackrabbit	*Lepus californicus*
California ground squirrel	*Spermophilus beecheyi*
Botta's pocket gopher	*Thomomys bottae*
Western harvest mouse	*Reithrodontomys megalotis*
Deer mouse	*Peromyscus maniculatus*
California vole	*Microtus californicus*
Muskrat	*Ondatra zibethicus*
Black rat	*Rattus rattus*
Norway rat	*Rattus norvegicus*
House mouse	*Mus musculus*
Coyote	*Canis latrans*
Red fox	*Vulpes fulva*
Gray fox	*Urocyon cinereoargenteus*
Mink	*Mustela vison*
Western spotted skunk	*Spilogale putorius*
Striped skunk	*Mephitis mephitis*
River otter	*Lutra canadensis*
Black-tailed deer	*Odocolieus hemionus*
Beaver	*Castor canadensis*
REPTILES	
Western toad	*Bufo boreas*
Pacific treefrog	*Pseudacris regilla*
Bullfrog	*Rana catesbeiana*
Western pond turtle	*Actinemys marmorata*
Western fence lizard	*Sceloporus occidentalis*
Coast horned lizard	*Phrynosoma coronatum*
Western skink	*Eumeces skiltonianus*
Coachwhip	*Masticophis flagellum*
Racer	*Coluber constrictor*
Gopher snake	*Pituophis melanoleucus*
Common king snake	*Lampropeltis getulus*
Common garter snake	*Thamnophis sirtalis*
Western garter snake	*Thamnophis elegans*
Giant garter snake	*Thamnophis gigas*
Western rattlesnake	*Crotalus viridis*

California Rice

Wildlife Known To Use California Ricelands

California Rice Commission
www.calrice.org
Third Edition, 2011

NCWA
Northern California Water Association

CALIFORNIA RICE COMMISSION

April 9, 2010

Mr. Charles Hoppin, Chair
Ms. Frances Spivy-Weber, Vice Chair
Mr. Arthur Baggett, Jr.
Ms. Tam Doduc
Mr. Walter Pettit
State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95812-0100

Dear Chairman Hoppin and Members of the Board:

The Northern California Water Association and the California Rice Commission appreciate the deliberate approach the State Water Resources Control Board is taking to the Delta Flow Criteria Informational Proceeding. As you continue this process, we request that your analysis of criteria for the Delta include the recognition that changes in Delta flows could significantly impact upstream public trust values, including the considerable habitat investments that have been made upstream from the Delta in the Sacramento Valley.

Water users, conservation groups, individual landowners and state and federal agencies have all made substantial investments (totaling in the hundreds of millions of dollars) in habitat improvements for terrestrial species in the Sacramento Valley. These investments have also included substantial improvements to enhance fish passage and fisheries habitat in the Sacramento River and its tributaries.

The Sacramento Valley is home to several million acres of family farms that provide the economic engine for the region, serving as working landscape while contributing valuable habitat for waterfowl along the Pacific Flyway as well as resident terrestrial species such as the giant garter snake. This region contains six National Wildlife Refuges, more than 50 state wildlife areas and other privately managed wetlands that support the annual migration of waterfowl, geese and water birds in the Pacific Flyway. All of this habitat is reliant upon dependable water supplies in the Sacramento Valley as shown in the Central Joint Habitat Venture “Implementation Plan” developed by federal, state and non profit organizations committed to bird habitat conservation.

In light of this, we ask that as you continue the evaluation of Delta outflows that the State Water Resources Control Board consider the substantial environmental benefits and public trust values that are made possible in the Sacramento Valley through the diversion and responsible use of water upstream of the Delta. It is our concern that these benefits could be diminished or lost if changes in flows are made that affect the timing and availability of water upstream.

Thank you for your consideration of our comments.

Sincerely,

Todd Manley
Todd Manley, NCWA

Paul Buttner
Paul Buttner, CRC

Waterfowl Impacts of the Proposed Conservation Measure 2 for the Yolo Bypass – An effects analysis tool

July 16, 2012

Prepared by:
Kevin Petrik, Mark Petrie, Aaron Will and Jeff McCreary
Ducks Unlimited,
Western Regional Office,
3074 Gold Canal Drive, Rancho Cordova, CA 95670

Prepared for:
Bay Delta Conservation Plan - Yolo Bypass Fisheries Enhancement Planning Team

Support from:
Metropolitan Water District of Southern California
Westlands Irrigation District

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1 Executive Summary

This project is the result of initial Bay Delta Conservation Plan's Conservation Measure 2 Yolo Bypass Fishery Enhancement Planning Team meetings held during the summer and fall of 2011 to discuss the biological needs of fish species and how alteration of flood duration and frequency could affect current land uses within the Bypass. From these meetings it became clear that there was a gap in information to determine the effects from Conservation Measure 2 on other key species and habitats that benefit from the current operation of the Yolo Bypass, waterfowl in particular. Many of land uses in the Bypass provide habitat for waterfowl, notably the Yolo Bypass Wildlife Area and many private hunt clubs. These stakeholders requested that any changes to flood management in the Yolo Bypass be examined with consideration for the effects on waterfowl, among other effects. This study is an effort to describe the main drivers of waterfowl and associated recreational use in the Yolo Bypass and report on the successful development of a tool that can evaluate effects on these resources and uses due to implementation of future flood management scenarios as part of Conservation Measure 2.

2 Background

Conservation Measure 2 proposes to increase fish habitat functions and values within the Yolo Bypass through the activation of floodplain processes by increasing the frequency, duration, and amount of flooding over the Fremont Weir between November and April. In order to refine what operational scenario the Measure might operate and how the effects of that scenario on waterfowl may either be minimized or off-set, this project designed a tool that can model the effects on waterfowl and their habitat resulting from a change in Yolo Bypass flood management. Waterfowl habitat for the purpose of this project is defined as managed seasonal wetlands and winter flooded rice fields. Potential flood flows through the future operation of a gate or passive notch in the Weir have yet to be determined; however, current estimates are for allowing flows of up to an additional 6,000 cubic feet per second (cfs) in certain situations. This is the boundary condition that was used in developing the evaluation tool and is integral to the proof of concept examples as described in this report. Future scenario runs may vary the magnitude, duration and frequency of new flooding in the Bypass and their effects can nonetheless be quantified with this tool.

Wetlands and their management at Yolo Bypass Wildlife Area was the focus for the development of this tool considering that the majority of wetlands located within the Bypass are situated within its borders. Additional waterfowl habitat is also present on private hunt clubs and on winter flooded rice fields on both the Wildlife Area and private farmland throughout the Bypass.

3 Main Drivers

The four main drivers of effects on waterfowl from increased flooding in the Yolo Bypass include the changes to recreational use, loss of farming and hunting income, reductions in foraging habitat and the loss of wetland seed production due to later spring draw down. Each of these drivers is described in detail in the following sections.

3.1 Recreation/Hunt Use

The Yolo Bypass Wildlife Area (YBWA) is a popular waterfowl hunting and bird watching area with bird numbers peaking in February. It is open to the public most days except during certain Bypass flooding instances. Current procedure regulating public access at the YBWA during floods is to close the entire area soon after water overtops the Fremont Weir. Even relatively small overtoppings can inundate public access infrastructure in certain portions of the YBWA. This infrastructure is not currently capable of limiting access to only non-flooded areas, hence closing the entire area for the duration of the flood. In order to understand the relationship between the magnitude of a flood and the number of days of closure, this study used the record of Fremont Weir overtopping events and matched it chronologically with the record of YBWA closures as a metric for effects on recreation. Since there is not a direct tally of YBWA closures, the last 13 years of hunt records were examined to record the days that hunting was closed on the wildlife area. Figure 1 shows the number of days of Fremont Weir overtopping and the subsequent YBWA closures.

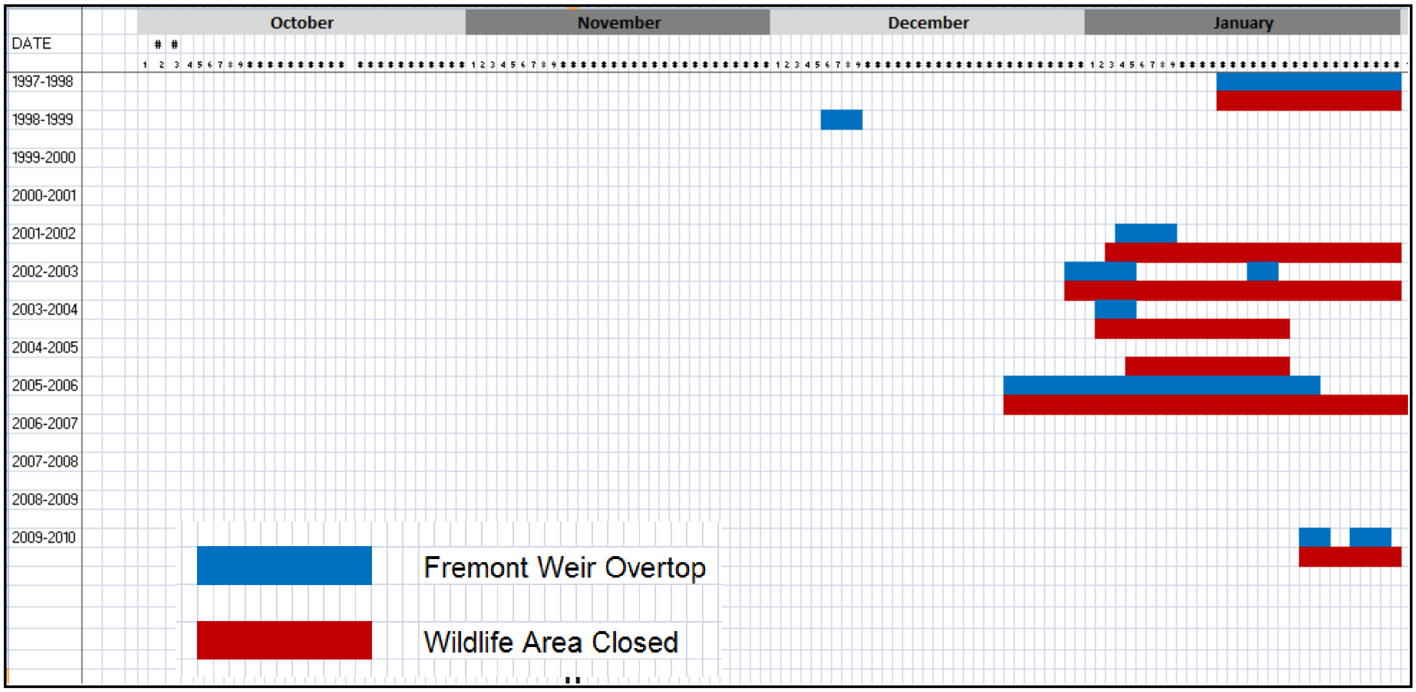


Figure 1. Dates of Fremont Weir overtopping and closure dates for the Yolo Bypass Wildlife Area

For future scenarios, the current baseline closures could be compared with new flooding due to changes in the operating of the Fremont Weir. Future scenarios would be expressed as their effect on the increase or decrease in the number of possible waterfowl hunt days each year. This has the potential to affect both public hunting opportunities on the YBWA and private hunt opportunities on duck clubs and rice fields. If the number of flooded days reach an undefined threshold, private ducks club members may lose interest in maintaining their wetland habitat if there aren't enough hunting days to make it worth their investment. This topic could be further examined when future scenarios are compared.

Over the 13 year record, the YBWA averaged 14 days of closures during the course of a hunting season, which lasts for roughly 100 days between the middle of October through the end of January. In the thirteen seasons, seven years had weir overtopping events. Several flooding events were examined in an effort to understand the time needed for the YBWA to dry sufficiently before opening back up to the public. The first event was the December 1998 event and was unique in that it was the only overtopping event that did not cause any closures. Further inspection revealed that this event had a maximum flow of 1,650 cfs, which is small enough to be fully contained in the flow channel of the Toe Drain and not flood the wildlife area.

The next unique closure event examined was the late December event in 2004. For this occurrence, the Fremont Weir did not overtop yet the YBWA was closed for two and a half weeks. It is suspected that this closure was due to flooding caused by west side tributaries. Since there are no gauging stations on many of the west side tributaries, we looked at local precipitation data to see if a large storm affected the western part of Yolo County to a much higher degree than the remainder of the Sacramento Valley upstream of the Bypass. The Berryessa precipitation station shown in Figure 2 totaled over six inches of rain in late December. An examination of stations farther up the Central Valley showed significantly less rainfall. This corroborated the premise that this occurrence captured the type of event when the Fremont Weir is not spilling, but the west side tributaries are flowing high enough that they can independently flood the YBWA and downstream duck clubs.

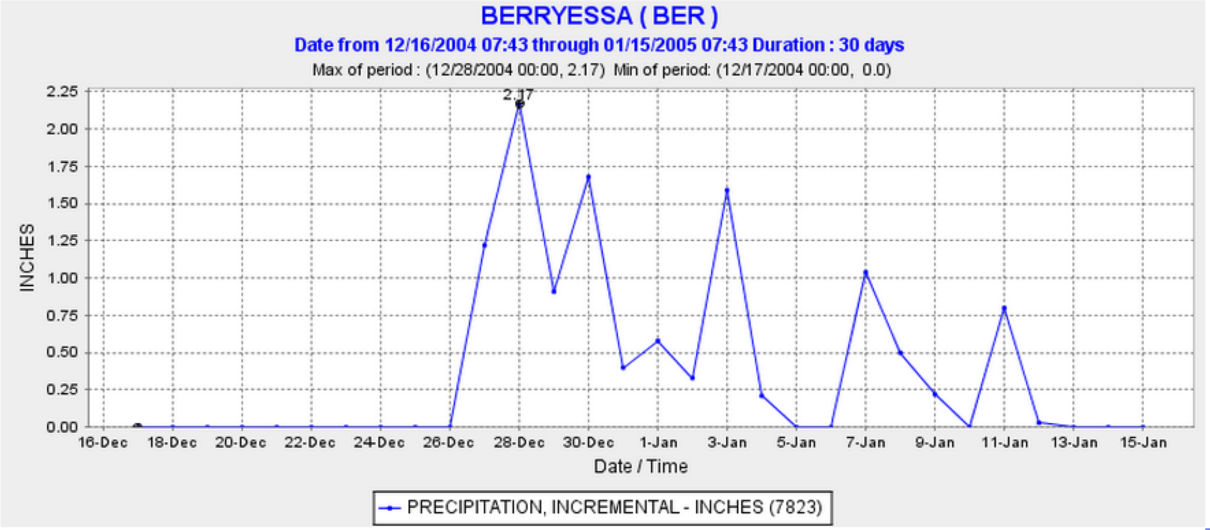


Figure 2. Precipitation at the Berryessa station from 12/16/2004 – 1/15/2005 (CDEC, 2012)

The third event that was examined was the January 2004 event that lasted less than five days and had a peak flow of 3,000 cfs over the Fremont Weir. This flow is in the lower range of the proposed notch flow events currently proposed by Conservation Measure 2. This event closed the YBWA for two weeks. Another larger overtopping event in January 2002 peaked at 35,000 cfs and the YBWA closure lasted for three weeks. Although it is a very small sampling of years, the record establishes a drying time window for the YBWA to reopen after a flood is between two and three weeks with current operating procedures. It may be possible to change the way the YBWA closes and have partial closures in order to accommodate managed flood events. However, any changes would be needed to be developed and approved by the Department of Fish and Game with respect to YBWA Management Plan.

3.2 Income Loss

The landowners in the Bypass may experience several types of income loss due to the proposed Conservation Measure 2, which could have ramifications on waterfowl habitat management. Yolo County recently completed an agricultural impact analysis that monetized the direct loss of income from farming operations and the indirect effects on the local economy (Howitt et al., 2012) from a potential Bypass flooding scenario. In the County's analysis, they examined a series of dates that represent the last day in a season for the overtopping of Fremont Weir and the resulting effects on crop planting. The study documents significant agricultural income losses from a flooding scenario that lasts past a March 24 overtopping date. For many crops, including rice, to be grown at all in the Bypass, flooding needs to end by April 10 for the east side and April 24 for the west side due to differential drying times.

In addition to the agricultural losses on growers and the local economy, the YBWA depends on income from agricultural leases including rice, grazing and other crops to support annual management and operational costs. This income is significant as it is greater than the annual appropriations from the Department of Fish and Game. Although Yolo County's study monetized potential private agricultural losses in the Bypass as a result of Conservation Measure 2, it did not specifically describe how the YBWA's wetlands could be affected by losing the agricultural lease income.

Other sources of potential income losses supporting wetland management as a result of Conservation Measure 2 may include waterfowl hunter expenditures for reservations at the YBWA or membership fees at private duck clubs. On the YBWA, increased duration and frequency of flood events can close the area to the public thereby reducing hunter access fees. On private wetlands that are managed as duck hunting clubs, there is a potential loss to property value since this value is primarily derived from the amount and quality of hunting opportunities available each year. With more flooding the annual maintenance costs may increase while the hunt days decrease. This will effectively increase the cost per day of hunting.

3.3 Deep Winter Flooding

One of the potential impacts of an increase in winter flooding due to Conservation Measure 2 is that the Bypass may be covered in deep water that precludes dabbling ducks from foraging. This guild of waterfowl prefer to forage in very shallowly flooded seasonal wetlands, but can feed in relatively deeper areas by upending as shown in Figure 3. Due to their physiology, they are limited to foraging in water depths of less than 18 inches (Nelson, 2012; Fredrickson, 1982) with preferred foraging depths less than

10 inches. This is in contrast to the diving duck guild that dives or swims to their food sources in water deeper than 18 inches. The population objectives for dabbling ducks and diving ducks in the Central Valley are shown in Figure 4; this figure also shows the corresponding dabbler species-level population objectives (CVJV, 2006).

Figure 3. Upending dabbling ducks have a limit to the depth of water that allows foraging (Garg, 2007)

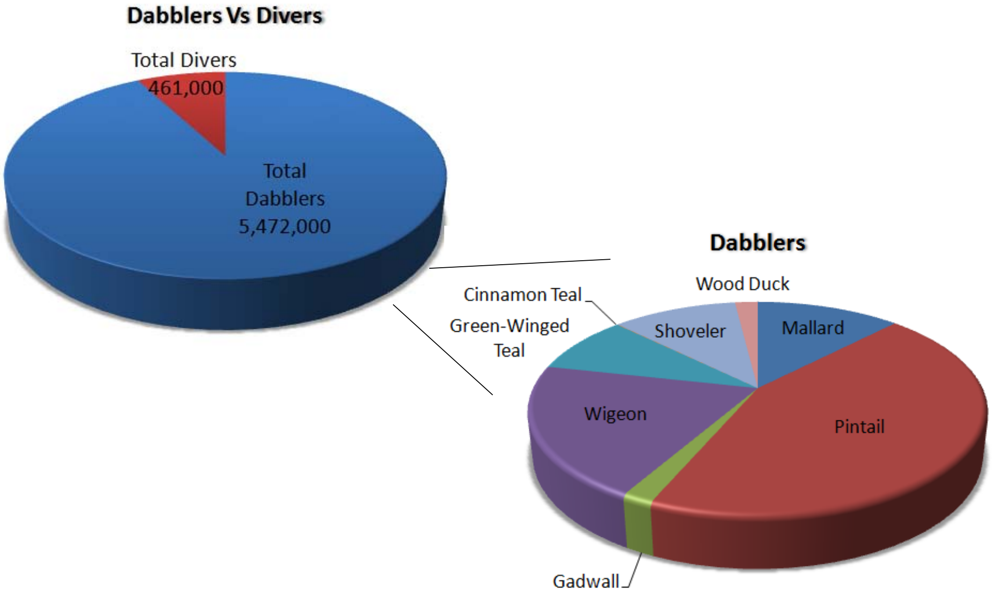


Figure 4. Dabbling duck population objectives for the Central Valley (CVJV, 2006)

The Central Valley Joint Venture's (CVJV) dabbling duck population objectives were developed for each of the major 'basins' within the Central Valley, including the Yolo Basin. To incorporate the effects of Conservation Measure 2 on dabbling ducks, a series of linked models were used as shown in Figure 5. Land cover was combined with the MIKE21 2-D flood model results and input into the BypassDepth (BDepth) GIS model. This GIS model separates the depth of each land cover class into a dry, managed, shallow or deep water category. These outputs are then used in the TRUEMET model for the Yolo Basin in combination with the Basin's waterfowl population objectives. Final output of this progression is food supply and food demand curves that show how changes in flooding affect the carrying capacity of the waterfowl population in the Yolo Basin, including the Yolo Bypass.

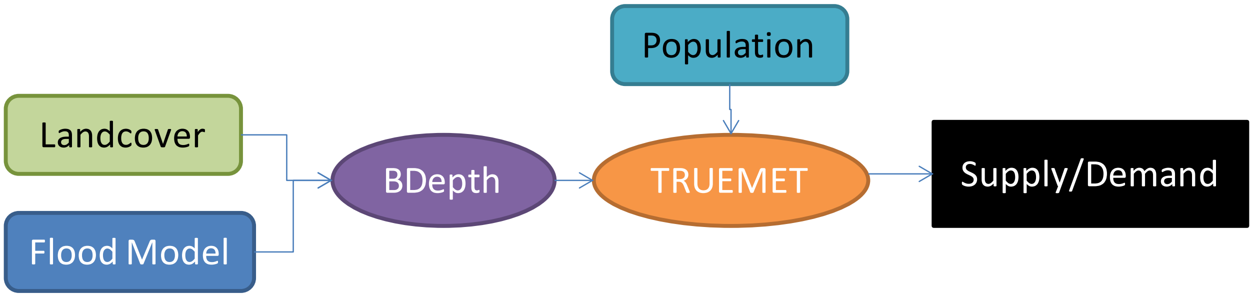


Figure 5. Data inputs and models used in the modeling of the loss of winter foraging habitat

In order to assess the future impact on the available waterfowl foraging habitat in the Yolo Bypass, the 2011 land cover, including the spatial extent of wetlands, in the Bypass was mapped. This effort was aimed at capturing the large areas of wetlands that were restored after the previous mapping effort in 1999. Additionally, the total amount of winter flooded rice base, the other key waterfowl food in the Bypass, was mapped with the assumption that only two-thirds of the rice base is planted in a normal year either due to flooding conditions or the rotation of the ground to fallow every third year. The current conditions are shown in Figure 6.

For the initial run of the BypassDepth model a high end flood flow boundary condition of 6,000 cfs from a proposed notch and additional inputs from west side tributaries (CBEC, 2010) was chosen from the Mike21 model output. This was the largest flow scenario outlined in the document and suitable for demonstrating proof of concept for the evaluation tool. The BypassDepth output is shown in map format in Figure 7.

The second set of output from the BypassDepth model is a land use specific analysis of the dry, managed, shallow and deeply flooded land in the Yolo Bypass. Each category defines the water depth or absence of it on a specific land use. Dry areas are defined as fields that receive no delivered water and are upslope of the example flood. Managed areas are wetlands or rice shallowly inundated in the fall to encourage waterfowl use and/or rice stubble decomposition. Water on these areas is managed to depths preferred by dabbling ducks. Shallow water areas include both managed and unmanaged locations that remain below the 18 inch depth threshold for dabbling ducks to continue to forage. Deep water areas are locations that were inundated by flood waters to depths deeper than 18 inches.

The top chart in Figure 8 shows the initial condition and land use acreages in the Bypass in a dry year, defined as a year with no overtopping of the Fremont Weir. In this example wetlands and rice fields are managed for water depths that promote waterfowl foraging. During a subsequent flood event of 6,000 cfs, the lower chart in Figure 8 shows the extent of the land uses outside of the flood extent as dry or managed water, and the areas inside the floodwater extent as shallow water or deep water. Following the wetland land use through this example from the top chart to the bottom chart, in the initial conditions is all managed water. In this example when the Bypass floods (lower chart), approximately 55% of the wetlands are deeply flooded and the remaining wetlands are split between being shallowly flooded by the new floodwater and those wetlands outside the flood flows that stay as managed wetlands. In relation to foraging potential and food availability, the managed and the shallow categories are equally weighted and available to foraging dabbling ducks.

The next step in the analysis, as shown in Figure 5, is taking the output from the BypassDepth model and inputting it into the TRUEMET model. The other site-specific input into TRUEMET is the waterfowl population objectives for Yolo Basin. The waterfowl population objectives are taken from the CVJV‘s Implementation Plan (CVJV, 2006). The objectives in Figure 9 are given at two week intervals throughout the winter season with peak waterfowl use in February. The Yolo Bypass is completely contained in the CVJV’s Yolo Basin. The Bypass forms the entire east portion of the Yolo Basin as shown in the Figure 10. The inset map shows the Yolo Basin in relation to the other eight planning basins of the Central Valley. The Yolo Basin also contains roughly half of the valley portions of Yolo County and Solano County.

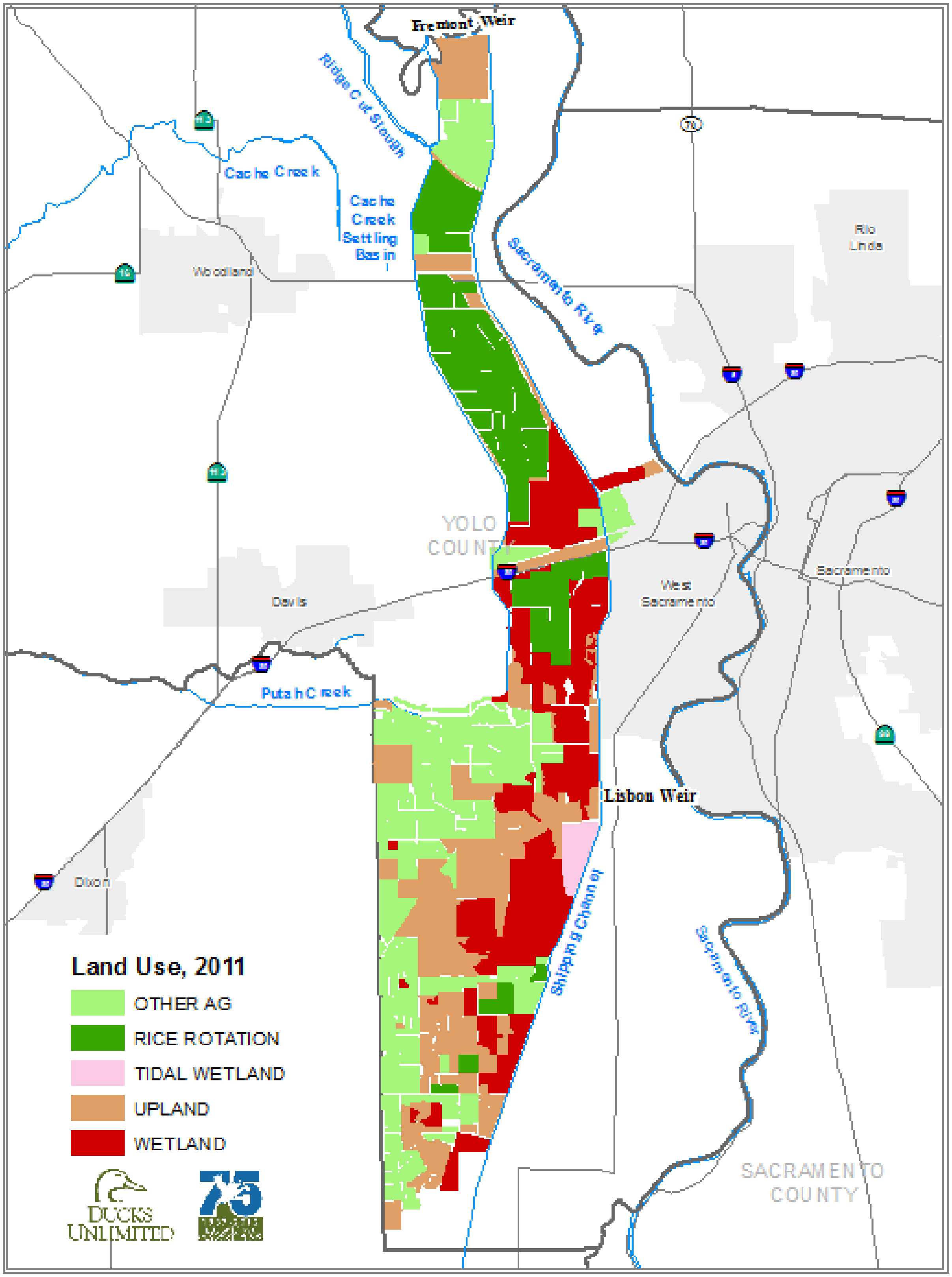


Figure 6. Updated wetland base in the Yolo Bypass, 2011

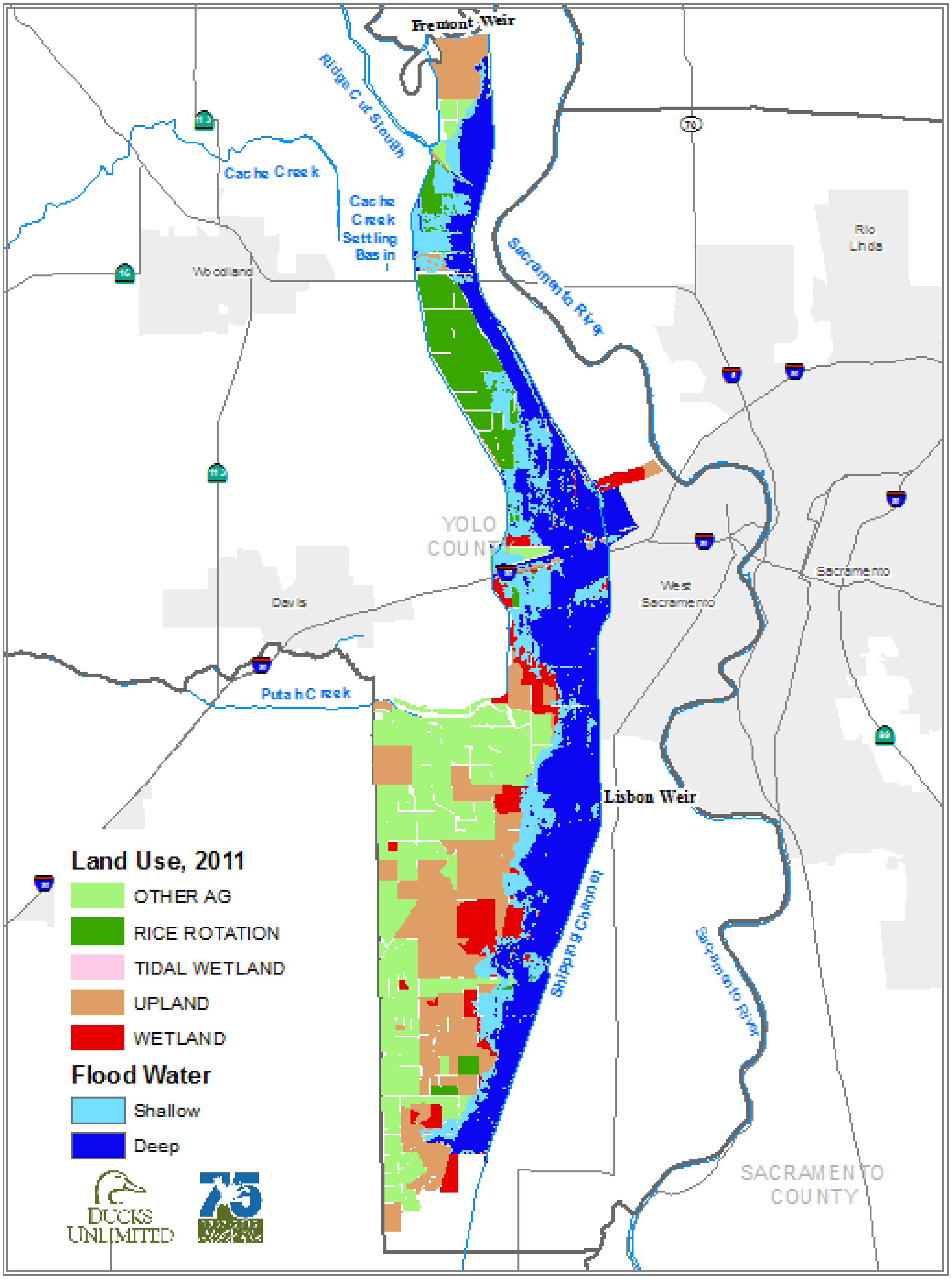


Figure 7. Map of the BypassDepth model output with Yolo Bypass land use showing most wetlands deeply flooded

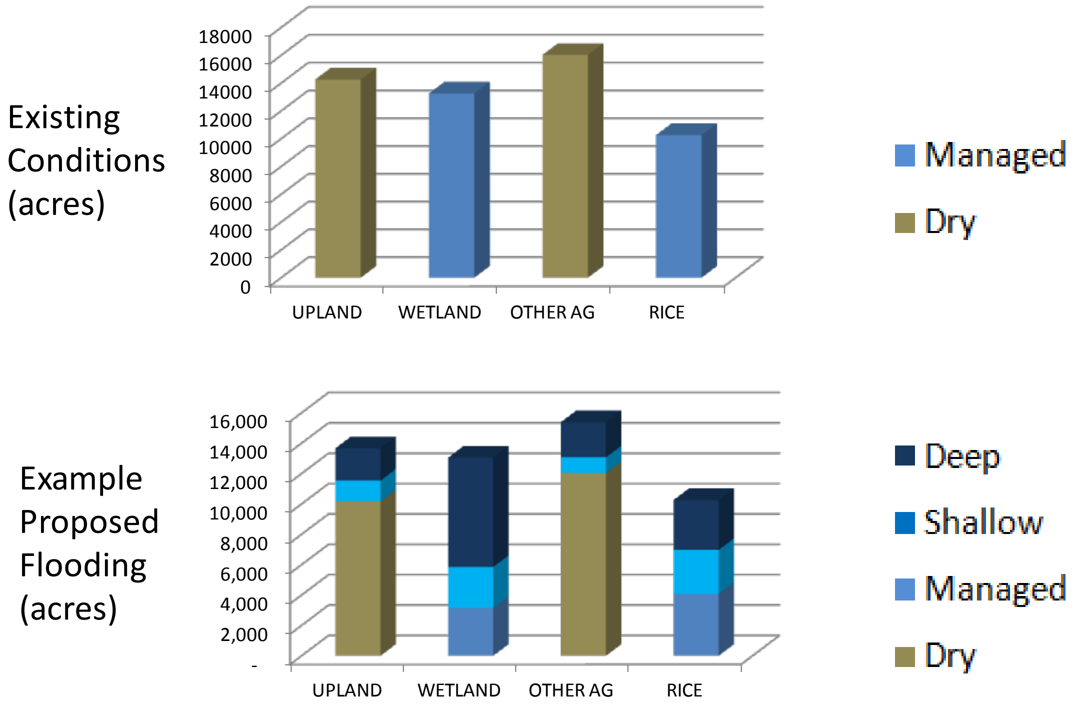


Figure 8. The Bypass Depth model initial conditions and example proposed flooding by land use

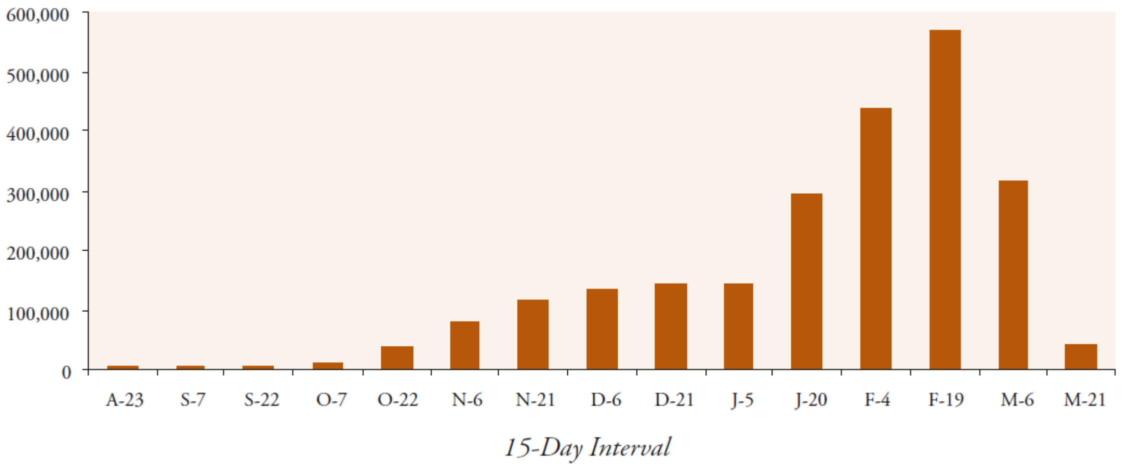


Figure 9. Population of ducks by 15 day interval for the Yolo Basin (CVJV, 2006)

Most of the waterfowl use in the Central Valley occurs in the non-breeding winter season and consists primarily of foraging to survive winter and to accumulate bodily reserves in preparation for spring migration and the breeding season. Adequate winter foraging habitat is important to increase waterfowl survival during winter, migration and to increase breeding season success. Ducks Unlimited collaborated with the CVJV to develop a bioenergetic model, TRUEMET, to establish habitat conservation objectives based on providing sufficient foraging habitat food resources to support waterfowl populations at goal levels for each of the nine basins of the Central Valley. TRUEMET is a daily ration model that calculates a waterfowl population energy demand curve and compares it to a curve for the available true metabolizable energy supplies from different food sources. The energetic demand curve is how the model expresses the daily caloric needs of waterfowl population. The available food supply curve is calculated in two week time steps throughout the winter as the supply of food resources is depleted from foraging and decomposition.

The major food supplies for ducks in the Yolo Basin are seasonal wetlands, winter-flooded rice and harvested corn fields. Previous runs of the TRUEMENT model for the Yolo Basin in the 2006 CVJV Implementation Plan were based on data now out dated and do not reflect the current Bypass land use. In addition, three sources of crop data were used to estimate the existing agricultural food sources for the remainder of the Basin. Rice acres were extracted for the last 15 years from the Yolo County Agricultural Commissioner's annual crop reports. The second source was the Department of Water Resources Land Use Survey available in GIS format that allows for the geographic separation of rice inside the Yolo Basin as opposed to the entire county. Figure 11 shows that approximately half of the rice grown in the County is inside the Yolo Basin. The third source of rice information was the new GIS rice base layer for 2009 produced by Ducks Unlimited. This layer showed a slight drop in rice within the basin while the county trend was for more rice acres. With the dramatic fluctuations in rice acreage over the past 15 years, this analysis uses a conservative value as shown as the dashed line the Figure 11.

Corn was shown to be an even more unstable food source when its acreage was plotted over the same time period. During the past 15 years, corn has been as high as 65,000 acres in the Yolo County and Solano County and as low as 6,000 acres. Based on GIS analysis of two time periods of DWR Land Use Survey data, the corn in the basin can be between 45% and 70% of the corn in Solano County and Yolo County. For this example run, half of the corn acreage in 2009 was used as an input in the TRUEMET model.

The TRUEMET model run in Figure 13 uses the updated 2011 current conditions in the Yolo Basin. Over the course of the winter season the resulting supply and demand curves show a food supply curve that is initially high, but is consumed over the course of the season to a point in March where the birds deplete the food resource just as they leave for their migration northward. This existing conditions run is for a dry year when the Fremont Weir is not overtopped.

To test the model's robustness, two additional boundary conditions were run to test how the Basin's carrying capacity responded. The first was an overtopping event that lasted the month of January. The second was a winter-long flood that lasted from November 15 – April 15.

The January flow condition assumed the full proposed 6,000 cfs flow from a notch as well as west side tributary inputs from the MIKE21 model. This example uses the output from the BypassDepth model and holds that depth for four weeks. Figure 14 shows the decrease in food supply during January. In February the Bypass flood water levels would drop and all wetland seed and rice grain resources would again be available to foraging waterfowl. Since all remaining food resources would be available when bird populations peak in mid-February, the Basin's food supply would last into March, near the same longevity as the current conditions example.

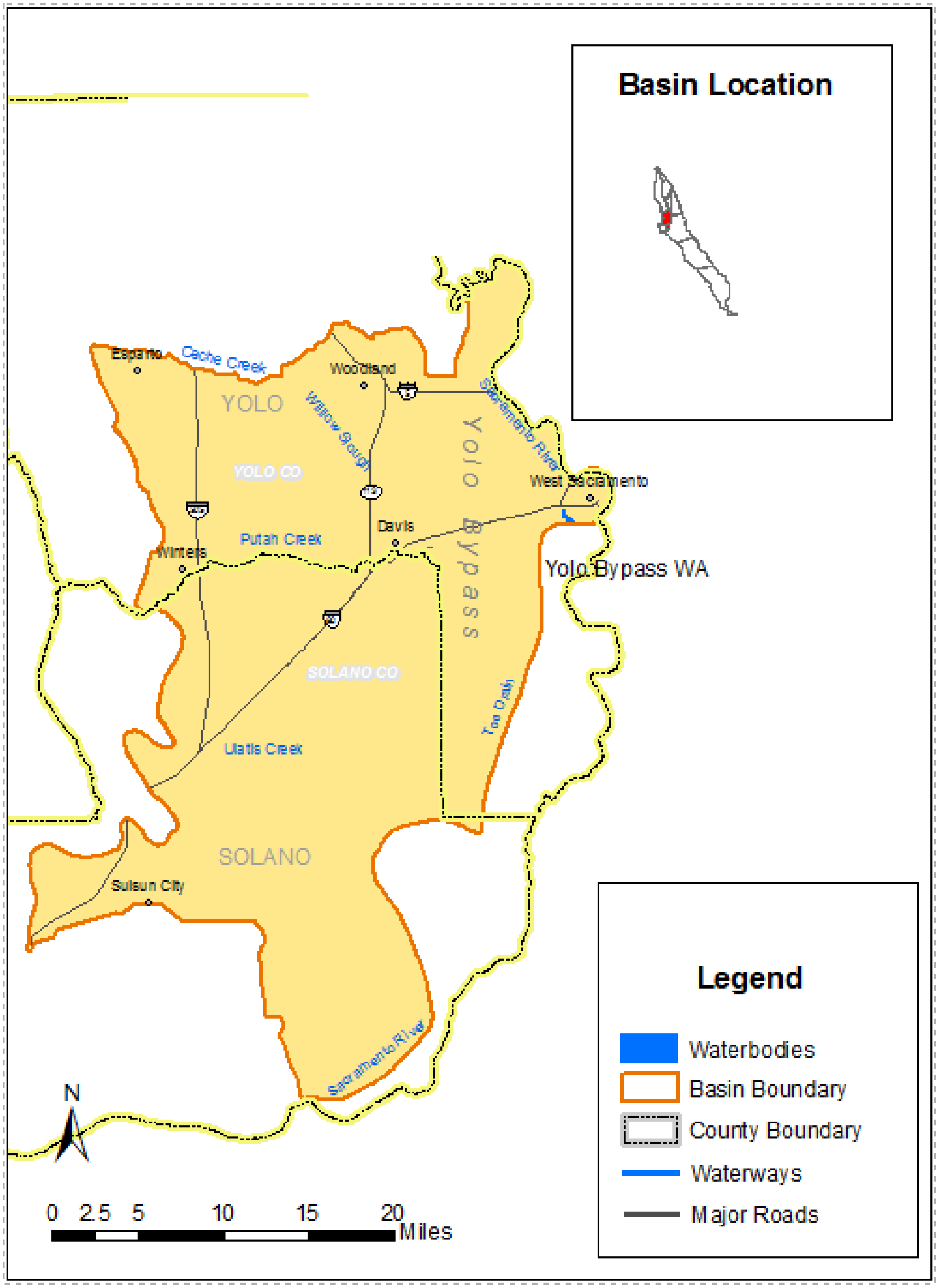


Figure 10. Map of the Yolo Basin including the Yolo Bypass

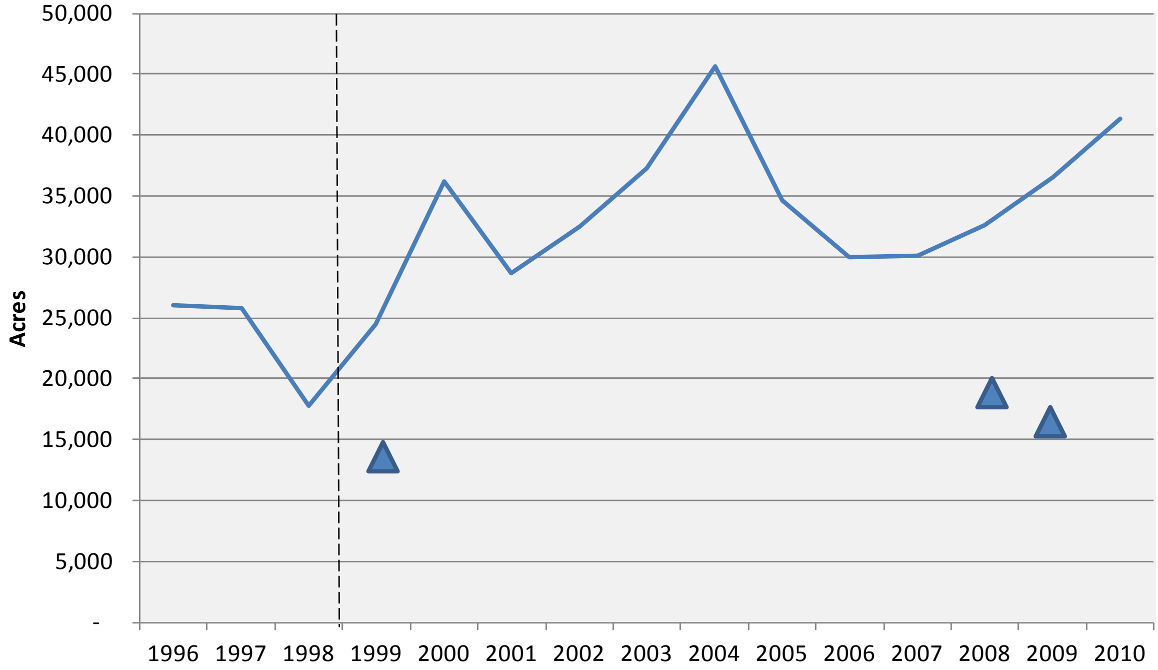


Figure 11. Rice acreage in Yolo County and Yolo Basin

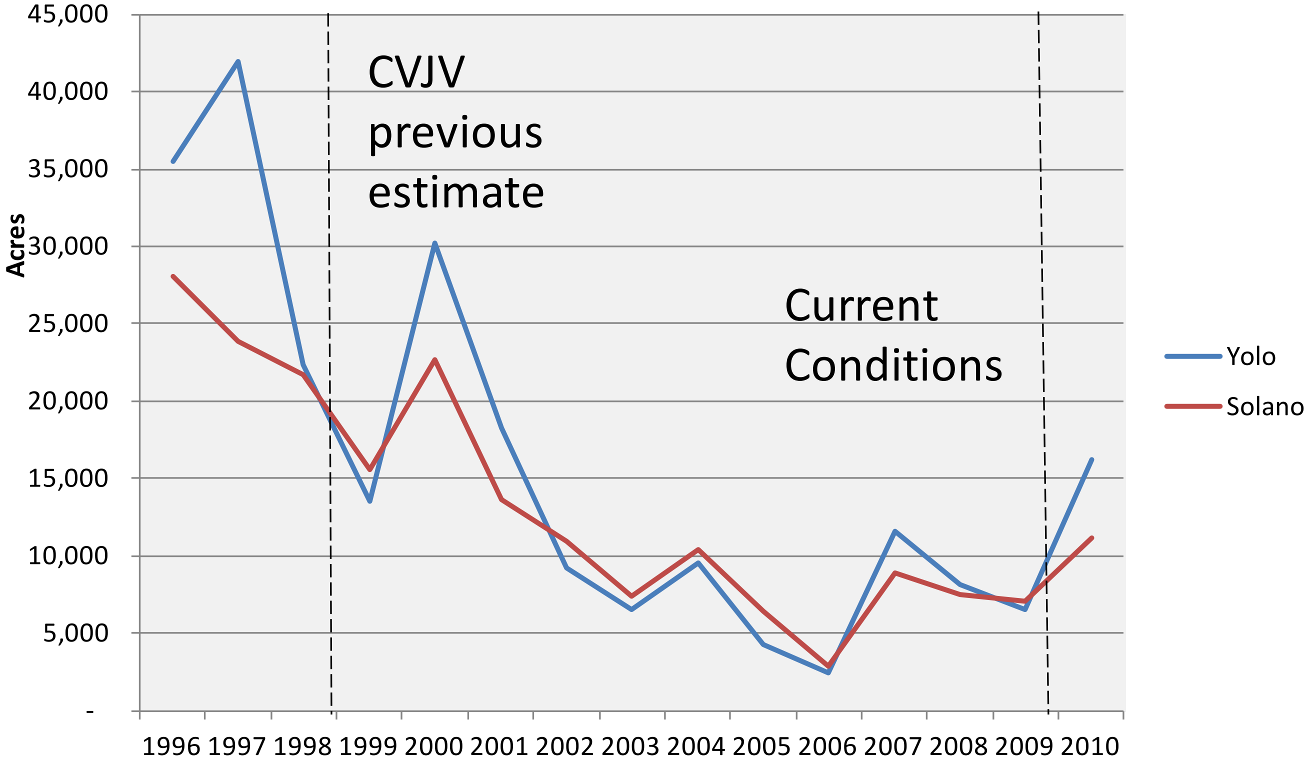


Figure 12. Corn acreage in the two counties that are part of the Yolo Basin

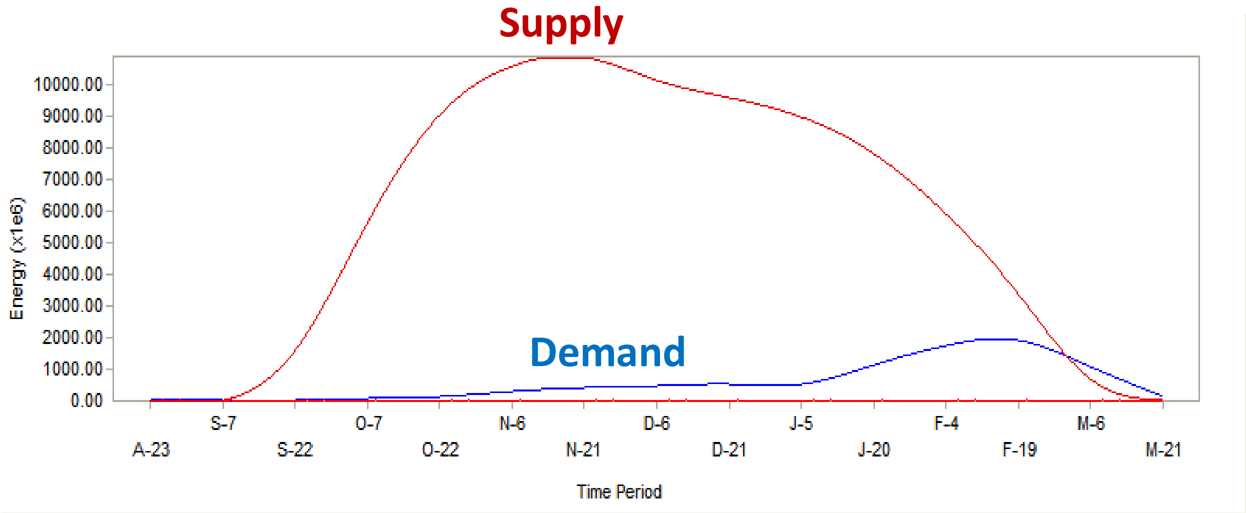


Figure 13. TRUEMET model output for the existing conditions for a dry year in the Yolo Basin

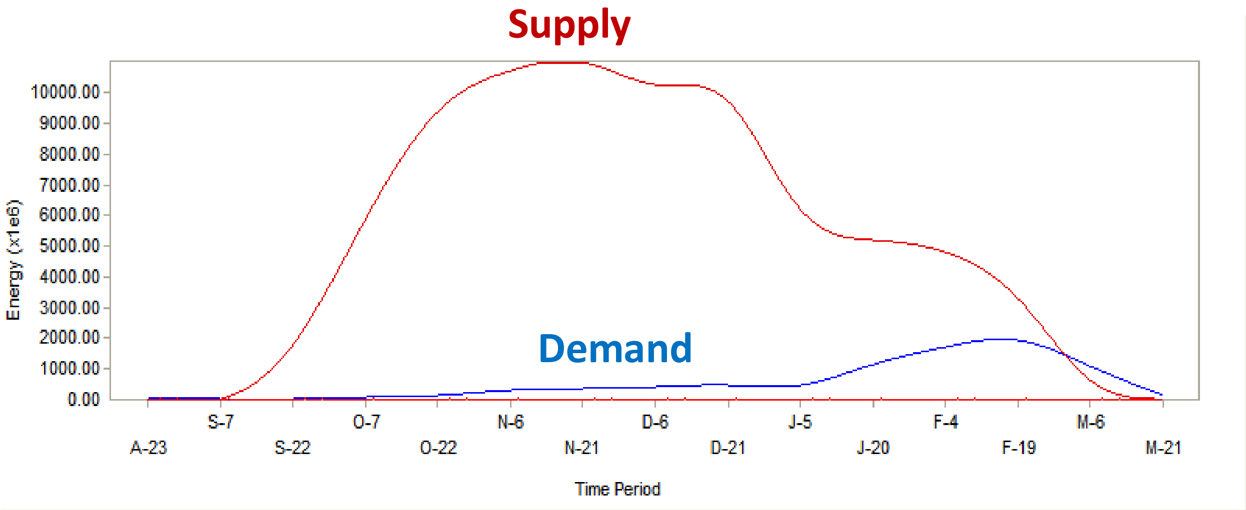


Figure 14. Example TRUEMET run with a January 6,000 cfs notch event and west side tributaries

The second boundary condition run was a winter-long flood event of the same magnitude, 6,000 cfs with west side tributaries. This flood event would start November 15 and end April 15. Even with much of the Yolo Bypass under deep water in the early- to mid-winter, waterfowl have enough food supplies from agricultural sources to maintain population objectives. The carrying capacity of the Basin crashes, as shown in Figure 15, in February when the food supply is depleted. This is at the same time as waterfowl population would be at their highest and food demand is approaching its highest. Another effect of flooding through spring in the Bypass may be a reduction of wetland plant seed production the following year. This potential effect is examined as the fourth driver of the model in the next section.

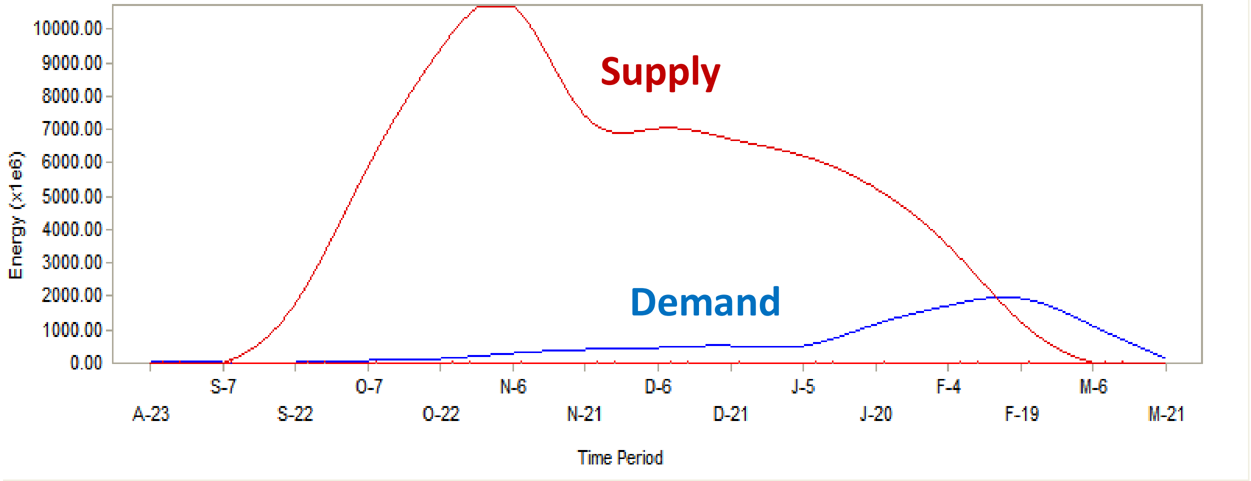


Figure 15. Example of TRUEMET run with a winter long 6,000 cfs notch event and west side tributaries

3.4 Spring Seed Production Loss

The CVJV calibrated the TRUEMET model by measuring energetic values and overall production of seasonal wetland plant seeds in the Central Valley. Different seasonal wetland areas in the Valley are managed for certain wetland plants. Interviews with wetland managers at the YBWA and Bypass private duck clubs were conducted to determine the types of wetland vegetation grown and their timing of seasonal wetland spring draw down. On the YBWA, swamp timothy is the primary plant grown in the seasonal wetlands. This plant provides high seed yield and energy, and is low enough in height to provide the open sheet water habitat that is preferred by dabbling ducks.

Current seasonal wetland water management practices include pulling the water control structure boards on about half of their wetland cells in advance of a pending flood event before floodwaters arrive. This prevents infrastructure damage on some water control structures from the high volumes of flowing water. After the higher water from the flood recedes and some high elevation roadways are exposed, managers try to access the wildlife area as soon as they are able to put the boards back into the drainage structures to retain water within the managed ponds for shallow inundation as the high flood water recedes. These wetlands are topped off with a last supply of delivered water in February then allowing for a slow evaporation of the ponds beginning in March. Wildlife managers monitor the germination rate of swamp timothy along the pond borders. When it reaches a certain threshold during the first two weeks of April, the water is drained rapidly to promote maximum growth.

On the private ducks clubs in the Yolo Bypass, the main vegetation favored by wetland managers is a mix of watergrass and smart weed. These species attract a diverse array of dabbling duck species and provide some vegetative cover preferred by mallards, a highly favored ducks species by hunters. These plants have a much different water management regime. With the hunting season ending in late January, some clubs partially drop their water levels in mid-February to concentrate the water and the invertebrates. Full draw down occurs one month later in mid-March and is a slow process lasting 2-3 weeks. To promote maximum production of wetland seeds and weed control, land managers perform early season irrigation by flooding the wetland unit and holding stable water levels for 2-4 weeks in May.

Overall, late season draw downs in managed wetlands can contribute to annual weed dominance rather than target waterfowl plants (Meeks, 1969). This effect has been documented for swamp timothy in two studies in the Central Valley (Rahilly et al., 2010 and Naylor, 1999). In the Rahilly study, a two year experiment was conducted that documented the effects on swamp timothy seed production by delaying draw down by 4-6 weeks. In this study, seed production was not significantly affected after one year; however, after two spring seasons of delayed draw down there was a 25-30% drop in seed production. Since the study only covered two years, it is unknown how many seasons it would take for seed production to rebound when a wetland is returned to a normal spring draw down schedule. In an effort to put delayed spring draw downs in the context of the Yolo Bypass, the historical record of the Fremont Weir overtopping in late March was examined in Figure 18. In the last 40 years, only one time period had flooding extended into March in two consecutive years, 1973-74 and 1974-75. This was prior to the establishment of the YBWA.

No known studies document the effect of delayed draw down on watergrass. An examination of the literature on watergrass germination yielded that watergrass can germinate soon after the draining of a seasonal wetland in March, April or May. Although many private duck clubs in the Bypass drain their watergrass wetlands in March, they may be able to drain later and still get maximum seed production. Interviews with pubic area wetland managers farther up the Sacramento Valley on this topic acknowledged that some wetland managers can hold water through early May and not experience noticeable seed loss. Any changes in the water management by private duck clubs in the Yolo Bypass to accommodate later spring flooding may have other costs associated with it since many of these areas do not have on-site managers.

To model the effect of seed production loss in the Yolo Bypass from delayed draw down, the land use basemap with 6,000 cfs flooding was examined to quantify which wetlands are directly affected by the flooding footprint and which wetlands are indirectly affected by being adjacent to flooding. Wetlands abutting a flooded area would have their drains already full. Since the outflow control structures would be below the water surface level in the drainage canals, there would not be any down slope elevation gradient to drain the water from the wetland unit. In this boundary condition example the vast majority of the wetlands are either directly under the floodwaters or adjacent to the flooded footprint and would not be able to drain in time for normal seed germination, as shown in Figure 16. Further topographic analysis would be necessary to exactly determine which fields would not be inundated yet unable to drain.

In the TRUEMET seed loss model run, the seasonal wetlands that grow swamp timothy have a 25% reduced food value following two years of delayed draw down. The resulting supply and demand curves are shown in Figure 17. Although the supply loss is observed for much of the winter season, its impact on the basin’s carrying capacity is only significant in February when the waterfowl population peaks and the food resource is completely depleted.

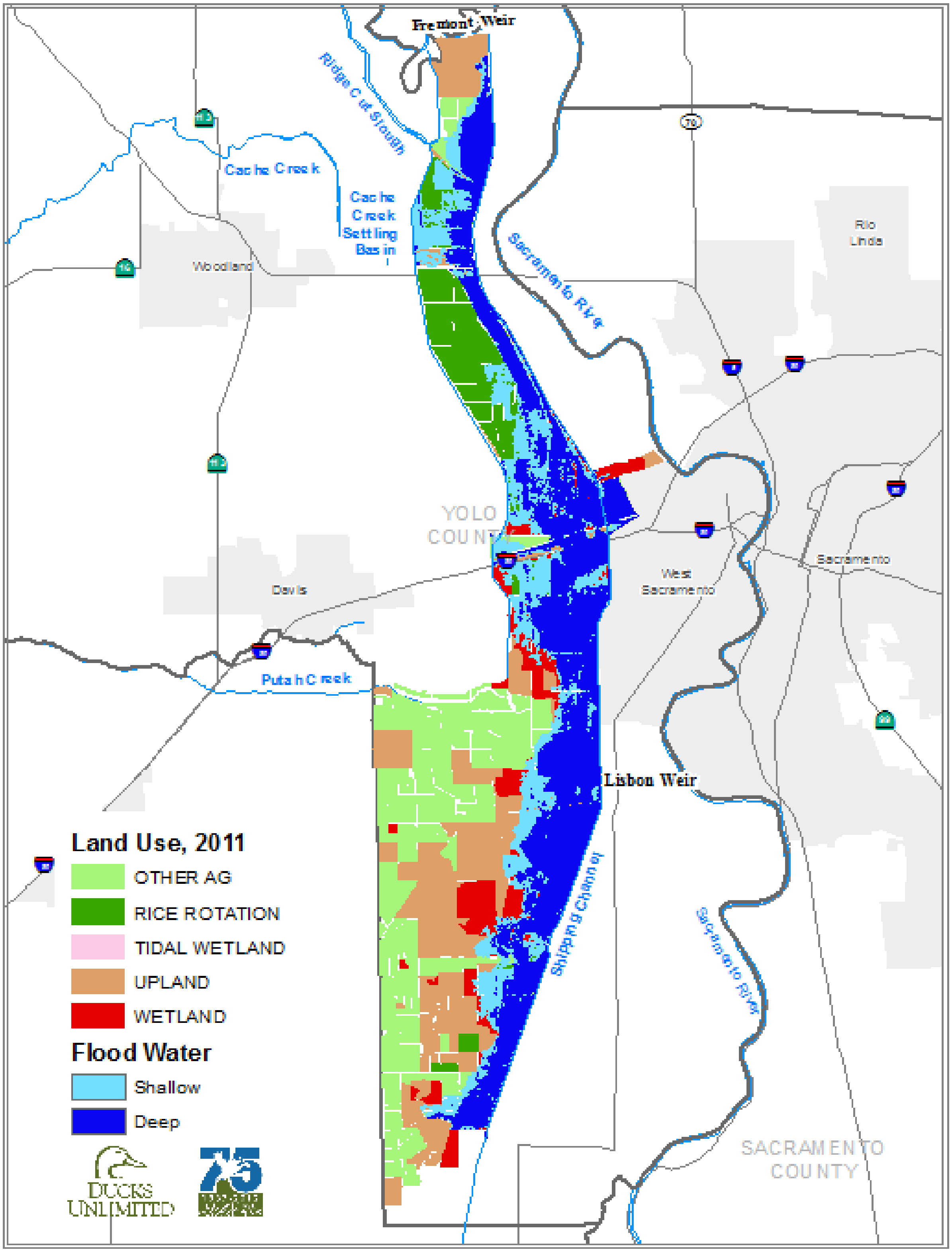


Figure 16. Direct and indirect wetlands affected by late spring draw down

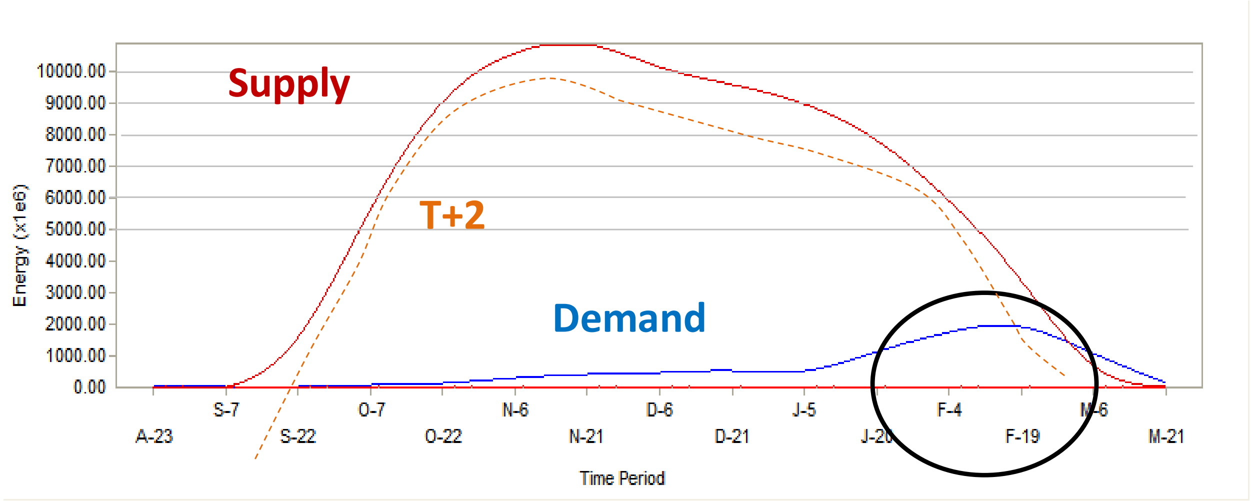
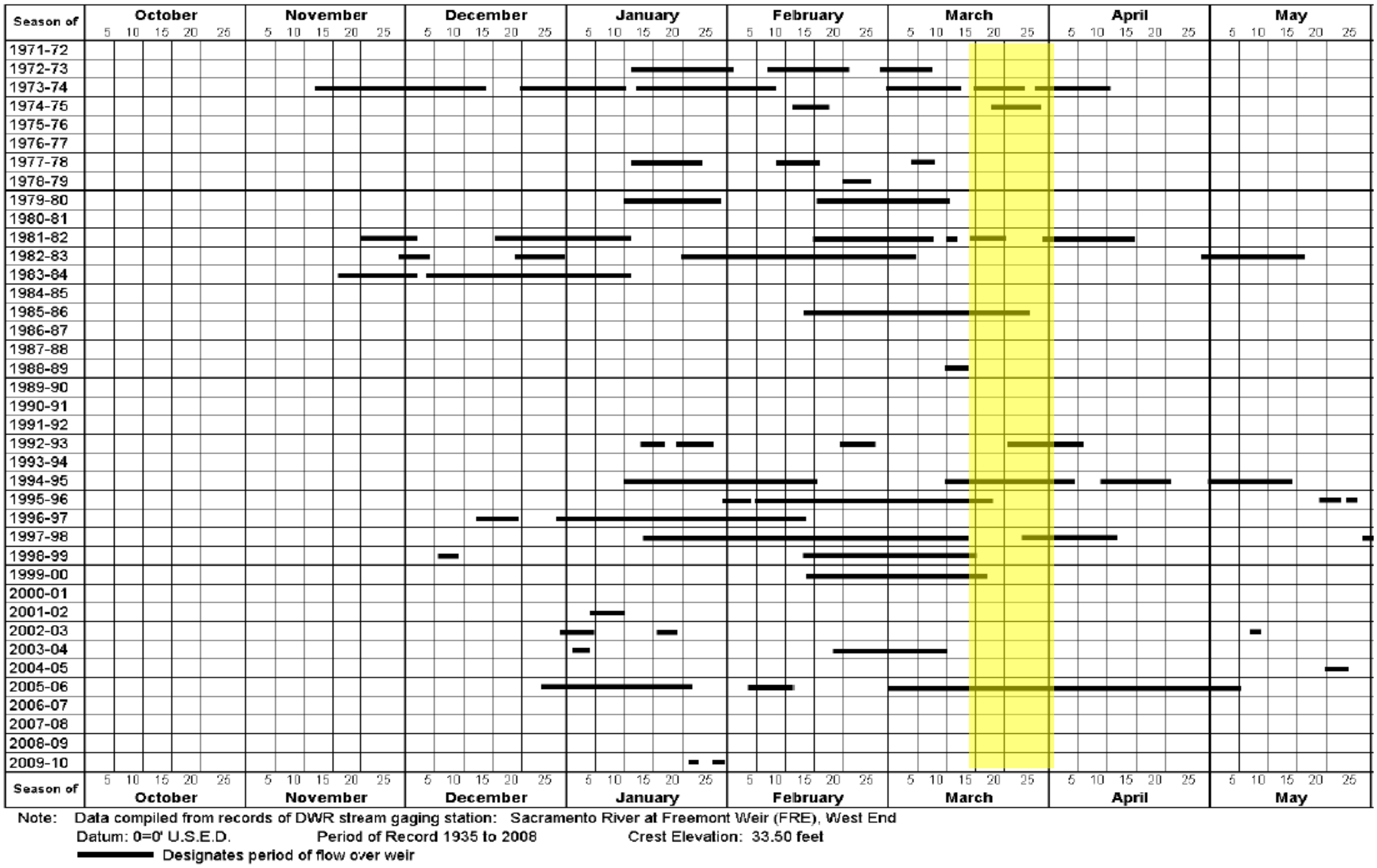


Figure 17. TRUEMET supply and demand curves for current conditions and for delayed draw down plus two.



Note: Data compiled from records of DWR stream gaging station: Sacramento River at Freemont Weir (FRE), West End
Datum: 0=0' U.S.E.D. Period of Record 1935 to 2008 Crest Elevation: 33.50 feet
▬ Designates period of flow over weir

Figure 18. Fremont Weir overtopping dates 1971-2010 with late March highlighted

4 Waterfowl Breeding

Although the changes to Yolo Bypass operations are not expected to significantly affect waterfowl during the breeding time period, the study authors wanted to briefly review the annual breeding chronology of locally nesting waterfowl. In the Yolo Bypass nesting season starts in late March. Nest initiation peaks in late April and can continue into early June. Birds use their nests approximately 50 days for egg laying, incubation and hatching (G. Yarris, personal communication, March 6th, 2012). Waterfowl typically nest near water in grasslands or seasonally dry wetlands. In the May breeding population surveys flown by the Department of Fish and Game, the one aerial transect that covers a portion of the Yolo Bypass has consistently counted high values of mallard breeding pairs. Further discussions would be needed to translate these counts into basin wide breeding numbers. Based on this breeding chronology, breeding is not expected to be significantly impacted if the Fremont Weir notch flooding finished by the end of March. One scenario that would have major impact on nest success is if a dry early spring is followed by a late flood event. This timing would allow waterfowl to establish nests in April and then inundate these nests in late April or May. Depending on how late a flood arrives in the spring, some birds may renest later in the spring.

5 Conclusions

The study's goal was to develop a modeling tool that can be employed to evaluate potential effects on waterfowl from increased duration and frequency of flooding within the Yolo Bypass from Conservation Measure 2. The developed tool incorporates topographic and land use data sets with MIKE21 projected flood depths and extent from a 6,000 cfs event. This tool links the resultant loss of waterfowl foraging habitat from deep flooding to the TRUEMET model so a reduction in waterfowl carrying capacity can be calculated as an effect. The two boundary conditions of a month long and winter long flood event demonstrate proof of concept that all variations of potential flooding scenarios in Conservation Measure 2 and associated effects on waterfowl can be evaluated with this tool.

Additionally, the following conclusions became apparent in the development of the evaluation tool.

- The most sensitive time of the year for waterfowl populations in relation to Conservation Measure 2 is in February when the waterfowl numbers are highest and the food supply is the lowest. This is a critical time period as birds need enough fat reserves to migrate north to their breeding grounds.
- Controlled floods on the order of the notch flooding examples in early and mid-winter temporarily removes food supply from waterfowl populations, but does not impact the annual carrying capacity of the Yolo Basin.
- Consecutive year flooding after mid-March would significantly decrease the seed production of wetland plants and fully deplete food resources at the peak of the annual waterfowl numbers.
- The financial sustainability of the YBWA depends on the agricultural income from some of its leased property. New management of the floodway may require the replacement of this income stream.

- Hunters who use the YBWA or private waterfowl hunt clubs in the Bypass current lose approximately two weeks of hunting opportunities according to the baseline flooding regime. One measure of impact for future scenarios is how they change the number of available hunt days. Changes in infrastructure may allow the YBWA to partially close due to managed flooding and lessen the effect on hunting opportunities.
- Elevation data on the west side tributaries is needed to improve the MIKE21 flood model to more accurately depict the extent and depth of flooding in the Bypass.
- Flood events that continue into April have the potential to substantially impact breeding waterfowl in the Yolo Bypass.

6 Next Steps

Several steps are needed to improve the accuracy of the modeling effort and to support the establishment of Conservation Measure 2 and quantify its impact on waterfowl populations and waterfowl habitats in the Yolo Bypass. The first step is a more comprehensive review and calibration on the MIKE21 2-D flood model. Current model documentation states that the water depth in some areas of the Bypass may differ by as much as one foot from the modeled water depths. With a foraging threshold of 18 inches for dabbling ducks, it is important that some of the uncertainty in water depth be minimized. Yolo County is currently reviewing the Mike21 model and this effort should be supported.

A portion of the errors in the Mike21 model is model assumptions of the west side tributaries. Currently, two west side tributaries are not properly modeled and are falsely assumed to enter the Bypass on the east side as proper bathymetry is not available for their channels. The elevation data should be collected and Mike21 should be rerun to show more accurate water extents for each flooding scenario.

A major uncertainty in the modeling of future flooding scenarios on waterfowl populations is the impact of a delayed spring draw down on seed production by wetland plants in subsequent years. Current studies show significant losses can occur with multiple years of delayed draw down, but it is unknown how quickly or slowly seed production can rebound in wetland plants when spring draw down is returned. Any pilot studies to study changes in the operation of Yolo Bypass should include a seed-head study to examine the potential effects of flooding on spring seed production.

The example 6,000 cfs flood flow analyzed in this report is from the MIKE21 model as reviewed in CBEC, 2010. In May, 2012 the CBEC modeling group revised their flood model and produced a new flooding footprints and depths. Future runs of this waterfowl effects analysis tool will use the updated flood model data.

Conservation Measure 2 flooding scenarios are not currently identified. Specific flood scenarios including magnitude, duration and frequency need to be refined so that the waterfowl effects can be quantified. Future scenario runs of this tool will quantify each of the 4 main drivers in relation to the impact over baseline conditions.

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