Appendix B. Compatibility Determinations

<u>COMPATIBILITY DETERMINATION</u>
(June 2008)

Use: Bicycling

Refuge Name: Sacramento and Colusa National Wildlife Refuges, located in Glenn and Colusa Counties, California.

Establishing and Acquisition Authority(ies):
Sacramento National Wildlife Refuge (Refuge) was established in 1937. Legal authorities include: Executive Order 7562, February 27, 1937, Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Colusa Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Refuge Purpose(s):

Sacramento Refuge purposes include:

> "... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February 27, 1937.
>
> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).
>
> "... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ..." 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).
>
> "... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. 742f(a)(4) "... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services.

> Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956)

Colusa Refuge purposes include:

> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... for the management and control of migratory waterfowl and other wildlife ..." 16 U.S.C. 695 (Lea Act of 1948).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).

National Wildlife Refuge System Mission: "To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use:
Bicycles may be used on Sacramento and Colusa Refuges on designated public roadways, including the entrance roads and auto tour routes from May through August from one hour before sunrise to one hour after sunset. Bicycles are currently allowed only on Sacramento Refuge (1994 Bicycling Compatibility Determination). This use is identified and discussed in detail in the Draft Comprehensive Conservation Plan (CCP) and Environmental Assessment (USFWS 2008) which are incorporated by reference.

Bicycling facilitates priority public uses, including wildlife observation, photography, environmental education, and interpretation, and involves observing the natural landscape, animals, and plant communities from a bicycle. On the auto tour routes, riders may stop at designated park and stretch areas only.

The use mainly occurs in groups, with an average group size of 2-4 riders. Groups of 10 or more riders will contact the Refuges for a special use permit prior to using the Refuges. This will help protect the Refuges' resources and ensure that larger groups do not conflict with concurrent public uses.

Bicycle travel on the Refuges will be conducted in accordance with the stipulations necessary to ensure compatibility. Travel will be limited to designated roads (i.e. off-road cycling is prohibited).

Availability of Resources: The following funding/annual costs (based on FY 2007 costs) would be required to administer and manage plant gathering activities as described above:

	Annual Costs
Administration, monitoring. And law enforcement	$1,000
TOTAL	**$1,000**

Refuge operational funds are currently available through the Service budget process to administer this program.

Anticipated Impacts of Use:
Soil Impacts: Bicycle wheels can cause physical impacts on soil surfaces. Cessford (1995) notes the shearing action of wheels creates damage to trails, which increases when trail conditions are wet or when traveling up a steep slope. It is anticipated that bicycle use of designated routes will cause minor to no soil erosion and compaction. Routes designated for this use have very little elevation change, with no steep grades. The designated routes are existing paved or gravel roads that have been previously altered by vehicles and equipment; therefore, soils are generally compacted and less susceptible to physical impact and mechanical erosion. Based on the conditions of designated routes and current levels of use, this activity will have very minor impacts to soils.

Plant Impacts: Bicycle use will occur on designated roads that have little to no vegetation, since they are graveled or paved. Off-road cycling is not permitted. Therefore, it is anticipated that bicycles will have very minor impacts on plant communities.

Wildlife Impacts: Human uses can result in habitat modification and can create disturbances to wildlife. Disturbances vary with the wildlife species involved and the type, level, frequency, duration, and the time of year such activities occur. Whittaker and Knight (1998) note that wildlife response can include attraction, habituation, and avoidance. Human induced avoidance by wildlife can prevent animals from using otherwise suitable habitat. Knight and Cole (1991) describe behavioral changes as a result of disturbance from recreational use. Effects range from short-term shifts in habitat use, to complete abandonment of disturbed areas in favor of undisturbed sites. Disturbance can have negative effects such as increasing the energy demands on wildlife. Flight in response to other disturbance can lower songbird nesting productivity, cause disease, and in extreme cases (predation) can result in death. Knight and Cole (1991) suggest that recreational activities occurring simultaneously may have a combined negative impact on wildlife. Hammitt and Cole (1998) conclude that the frequent presence of humans in wildland areas can dramatically change the normal behavior of wildlife, mostly as a result of unintentional harassment.

Seasonal sensitivities are also important in wildlife responses to human disturbance. For example, when an animal species is already stressed, human disturbance can compound the effect on that individual. Examples of these disturbances include: regularly flushing birds during nesting, exposing juvenile animals to greater predation levels, or causing mammals to flee during winter months. These disturbances can cause large amounts of stored fat reserves to be consumed. Hammitt and Cole (1998) note that females (such as deer) with young are more likely to flee from a disturbance than those without young. This indicates increased sensitivity to human disturbance during the breeding season.

Anticipated impacts of bicycle use on wildlife include temporal disturbances to species using habitat directly adjacent to the designated routes. Although there is some temporary disturbance to wildlife due to human activities, the disturbance is generally localized and will not adversely impact overall populations. During the proposed time frame of May through August, both visitor use and wildlife disturbance along designated routes would be at its lowest. Bicyclists are required to stay on their bicycle unless in the designated park and stretch areas.

Bicycling is not permitted year-round on the Refuges. During the winter months, hundreds of thousands of waterfowl are present in the wetlands adjacent to the auto tour routes. The Service requires visitors to stay in their vehicles on the auto tour route because of the disturbance to wildlife, except in designated park and stretch areas. Bicycling, other than during the designated timeframe, would cause immense wildlife disturbance and would be incompatible with the purposes for which the Refuges were established. It would also cause a user conflict, as visitors are required to stay inside their vehicles on the auto tour routes.

<u>Education:</u> Education helps make visitors aware that their actions can have negative impacts on birds, and will increase the likelihood that visitors will abide by restrictions on their actions. For example, Klein (1993) demonstrated that visitors who had spoken with refuge staff or volunteers were less likely to disturb birds. Increased surveillance and imposed fines may also help reduce visitor caused disturbance (Knight and Gutzwiller 1995). Monitoring is recommended to adjust management techniques over time, particularly because it is often difficult to generalize about the impacts of specific types of recreation in different environments. Local and site -specific knowledge is necessary to determine effects on birds, and to develop effective management strategies (Hockin et al. 1992; Klein et al. 1995; Hill et al. 1997).

Disturbance of wildlife is the primary concern regarding this use. Disturbance to wildlife, such as the flushing or interruption of feeding, resting, or nesting birds, is inherent to this activity.

Bicycling on designated roads is not anticipated to have significant short-term or long-term impacts. The anticipated use is viewed as an effective and justifiable method of travel that allows the public to discover, experience, and enjoy priority public uses on the

Refuges. Continued monitoring of the effects of bicycling and associated human activities is necessary to better understand the impacts of the use on the Refuges' habitats, plant and wildlife communities, and visitors. Monitoring will identify any actions needed to respond to new information (adaptive management) and correct problems that may arise in the future.

The bicycling program is designed to avoid or minimize impacts anticipated to the Refuges' resources and visitors. The Refuges' have requested Section 7 consultation with USFWS and NOAA-Fisheries on the Draft CCP/EA (USFWS 2008) and its effects on any of the special status species/designated critical habitat occurring on the Refuges including: palmate-bracted bird's beak, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, giant garter snake, western yellow-billed cuckoo, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, fall-run Chinook salmon, and late fall-run Chinook salmon.

Anticipated Impacts of Uses on future lands within the approved boundary: The following conditions must be met before allowing existing uses to occur on newly acquired lands: (1) There is no indirect, direct, or cumulative threat anticipated to human health or safety; (2) There is no indirect, direct, or cumulative threat anticipated to natural or cultural resources; (3) The use is consistent with management of existing Sacramento and Colusa Refuge lands and would contribute to achieving the Refuges' goals. In particular, existing Refuge regulations would not be compromised; (4) The newly acquired lands represent a meaningful unit within which to manage the activity; and (5) There are no anticipated conflicts with priority public uses.

Public Review and Comment: Public review and comments will be solicited in conjunction with distribution of the Draft CCP/EA for the Sacramento, Delevan, Colusa, and Sutter Refuges (USFWS 2008).

Determination:

_____ Use is Not Compatible

__X__ Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

- Bicycling is allowed only on the entrance roads and auto tour routes on Sacramento and Colusa Refuges from May through August.

- Access to the Refuges is allowed from one hour before sunrise to one hour after sunset.

- A special use permit is required of 10 or more riders, prior to the use occurring.

- Off road cycling is prohibited.

- Bicyclists are required to stay on their bicycle on the auto tour routes unless in the designated park and stretch areas.

- Regulatory and directional signs clearly mark designated routes of travel and areas closed to the public.

Maps and public use information are available at the Refuge Headquarters, kiosks, and the Complex's website http://sacramentovalleyrefuges.fws.gov.

- Refuge biologists and visitor services staff conduct regular surveys of public activities on the Refuges. The data is analyzed and used by the refuge manager to develop future modifications if necessary to ensure compatibility bicycling.

- Routine law enforcement patrols are conducted throughout the year.

Justification: While not listed as priority wildlife-dependent recreational use under the National Wildlife Refuge Improvement Act, as amended, bicycling is believed to be a compatible public use under the stipulations outlined in this compatibility determination. Primary reasons for this determination include the following: wildlife observation can be an element of bicycling and impacts associated with this activity is not believed to exceed impacts already caused by other public use activities, during the months of May through August.

The stipulations outlined above should minimize potential impacts relative to wildlife/human interactions. Based upon impacts described in the Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2008), it is determined that bicycling within the Sacramento and Colusa National Wildlife Refuges as described herein, will not materially interfere with or detract from the purposes for which the Refuges were established or the mission of the Refuge System. In our opinion, implementing the bicycling to facilitate wildlife-dependent recreation and its associated stipulations will not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the Refuges.

Mandatory Re-Evaluation Date (2018):

_____ Mandatory 15-year Re-Evaluation, Date will be provided in Final EA/CCP (for priority public uses)

__X__ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

_____ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

__X__ Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

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Refuge Determination

Prepared by: __________________________________ ____________
(Signature) (Date)

Wildlife Refuge Manager/
Project Leader
Approval: __________________________________ ____________
(Signature) (Date)

Concurrence

Refuge Supervisor: __________________________________ ____________
(Signature) (Date)

Assistant Regional
Director, Refuges: __________________________________ ____________
(Signature) (Date)

COMPATIBILITY DETERMINATION
(June 2008)

Use: Commercial Photography

Refuge Name: Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, located in Glenn, Colusa, and Sutter Counties, California.

Establishing and Acquisition Authority(ies):
Sacramento National Wildlife Refuge (Refuge) was established in 1937. Legal authorities include: Executive Order 7562, February 27, 1937, Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Delevan Refuge was established in 1962. Legal authority includes: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d).

Colusa Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Sutter Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), and the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884).

Refuge Purpose(s):

Sacramento Refuge purposes include:

> "... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February 27, 1937.
>
> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).
>
> "... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use

... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).

“... for the development, advancement, management, conservation, and protection of fish and wildlife resources ...” 16 U.S.C. 742f(a)(4) “... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ...” 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

Delevan Refuge purpose includes:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

Colusa Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

Sutter Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

National Wildlife Refuge System Mission: “To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the

benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use: The National Wildlife Refuge System Improvement Act of 1997 identifies wildlife photography as well as hunting, fishing, wildlife observation, interpretation, and environmental education as priority wildlife dependent public uses for Refuges. As one of the six priority public uses of the Refuge System, wildlife photography is to be encouraged when compatible with the purposes of the Refuge.

The guiding principles of the System's wildlife photography program are to:

- Provide safe, enjoyable, and accessible wildlife viewing opportunities and facilities.
- Promote visitor understanding of, and increase visitor appreciation for, America's natural resources.
- Provide opportunities for quality recreational and educational experiences consistent with criteria describing quality found in 605 FW 1.6.
- Minimize conflicts with visitors participating in other compatible wildlife-dependent recreation activities

Commercial photography is a visual recording (motion or still) by firms or individuals (other than news media representatives) who intend to distribute their photographic product for money or other consideration. This includes the creation of educational, entertainment, or commercial enterprises as well as advertising audio-visuals created for the purpose of paid product or services publicity, and commercially oriented photo contests (Service Manual 605 FW 5). These uses are identified and discussed in detail in the Draft Comprehensive Conservation (CCP) and Environmental Assessment (EA) (USFWS 2008) which are incorporated by reference.

The photography objective of the Draft Comprehensive Conservation Plan (CCP) (USFWS 2008) states that the Refuges will provide 80 photography blind annual visits and 10,000 annual photography visits by 2023. This includes photographic opportunities from the auto tours, walking trails, and photography blinds. A portion of the hunt area (2,275 acres) is open for photography from February through June on Sacramento, Colusa, and Sutter Refuges. The in-ground, concrete hunting blinds in this area on Sacramento Refuge are available for photographic use from February through June with no user fees or reservations required.

The best time of year for photography occurs from November through February when a variety of waterfowl is present. The auto tour routes and walking trails on Sacramento and Colusa Refuges provide excellent photographic opportunities. The viewing blind on the Discovery Trail at Colusa Refuge will be replaced with a universally accessible blind and boardwalk.

There are two photography blinds on Sacramento Refuge and one on Colusa Refuge. A universally accessible photography blind will be constructed at Delevan Refuge with access via Four Mile Road. The photography blinds may be reserved only one day each week, on Wednesdays through Sundays. The current fee for photo blind use is $10 per visit. Photographers may request up to three total reservations during October through March and unlimited visits during the spring and summer. Photographers may be placed on a waiting list if the blind or day requested is filled. Photographers also complete an evaluation that reports photographed species, time spent, and comments. Photographers must be in the blind at least one hour before sunrise. They must park in the designated parking area and proceed directly to the assigned blind on foot. The route from the parking area to the blind is marked by stakes with reflective tape. The route is designed to minimize disturbance; therefore, deviation from the staked route is not allowed. Photographers may leave the blind at any time, but once the blind has been vacated, returning to the blind is not permitted.

The blinds are approximately 300 yards within the wetlands. They are approximately 4.5' x 6' wide and 5' high. They have adjustable camera size openings in three sides. The blinds accommodate one person comfortably; however, two people at a time are allowed. There is one chair in each blind. Islands or tree snags and islands have been placed to encourage birds to perch or rest about 40 feet from the blind. Photography Blind 2 on Sacramento Refuge will be replaced with a universally accessible blind and boardwalk.

Availability of Resources: The following funding/annual costs (based on FY 2007 costs) would be required to administer and manage commercial photography activities as described above:

	Costs
Monthly costs to monitor a large scale commercial operation (e.g. motion picture filming, etc.) on an as needed basis:	
Vehicle rental	$ 500
One temporary GS-5 Park Ranger	$ 2,400
TOTAL	**$ 2,900**

Additional funds would be required to operate and maintain the commercial photography program. User fees are collected for issuing special use permits (SUP) to recreational and commercial photographers. The standard fee for commercial photography is $100 per year. This category applies to any photography that result in images that are intended for sale, or where the photographer is otherwise paid for the work by salary or contract. A permit and fee (other than the daily Refuge entrance fee at the Sacramento Refuge and photo blind use fee if appropriate) is not required when the photographer is utilizing areas and facilities that are open to the general public. If any special attention (such as transportation, access to restricted areas, food, lodging, or guide service) is provided by the refuge staff, these costs (see table above) will be added to the standard fee for issuing a SUP (USFWS 1992).

Anticipated Impacts of Use: Once considered "non-consumptive", it is now recognized that wildlife photography can negatively impact wildlife by altering wildlife behavior, reproduction, distribution, and habitat (Purdy et al. 1987, Knight and Cole 1995).

Of the wildlife observation techniques, photographers tend to have the largest disturbance impacts (Klein 1993, Morton 1995, Dobb 1998). While wildlife observers frequently stop to view species, wildlife photographers are more likely to approach wildlife (Klein 1993). Even slow approach by photographers tends to have behavioral consequences to wildlife species (Klein 1993). Other impacts include the potential for photographers to remain close to wildlife for extended periods of time, in an attempt to habituate the wildlife subject to their presence (Dobb 1998) and the tendency of casual photographers, with low-power lenses, to get much closer to their subjects than other activities would require (Morton 1995), including wandering off trails. This usually results in increased disturbance to wildlife and habitat, including trampling of plants. Klein (1993) recommended that refuges provide observation and photography blinds to reduce disturbance of waterbirds when approached by visitors.

Disturbance of wildlife is the primary concern regarding this use. Disturbance to wildlife, such as the flushing of feeding, resting, or nesting birds, is inherent to these activities. There is some temporary disturbance to wildlife due to human activities on trails (hiking, bird watching), however, the disturbance is generally localized and will not adversely impact overall populations. Increased facilities and visitation would cause some displacement of habitat and increase some disturbance to wildlife, although this is expected to be minor given the size of the Refuges and by avoiding or minimizing intrusion into important wildlife habitat.

The commercial photography program is designed to avoid or minimize impacts anticipated to Refuge resources and Refuge visitors. The Refuges' have requested Section 7 consultation with USFWS and NOAA-Fisheries on the Draft CCP/EA (USFWS 2008) and its effects on any of the special status species/designated critical habitat occurring on the Refuges including: palmate-bracted bird's beak, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, giant garter snake, western yellow-billed cuckoo, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, fall-run Chinook salmon, and late fall-run Chinook salmon.

Anticipated Impacts of Uses on future lands within the approved boundary: The following conditions must be met before allowing existing uses to occur on newly acquired lands: (1) There is no indirect, direct, or cumulative threat anticipated to human health or safety; (2) There is no indirect, direct, or cumulative threat anticipated to natural or cultural resources; (3) The use is consistent with management of existing Sacramento, Delevan, Colusa, and Sutter Refuge lands and would contribute to achieving the Refuges' goals. In particular, existing Refuge regulations would not be compromised; (4) The newly acquired lands represent a meaningful unit within which to manage the activity; and (5) There are no anticipated conflicts with priority public uses.

Public Review and Comment: Public review and comments will be solicited in conjunction with distribution of the Draft CCP/EA for the Sacramento, Delevan, Colusa, and Sutter Refuges (USFWS 2008).

Determination:

_____ Use is Not Compatible

__X__ Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

- Refuge visitors are required to remain in vehicles while on the auto tour routes except at designated park and stretch locations.

- Access to the Refuges is allowed from one hour before sunrise to one hour after sunset.

- Visitors, including commercial photographers, are required to obtain a Refuge Day Pass (currently $3 per vehicle) or Refuge Commercial Day Pass (currently $20 per commercial vehicle) for public use activities on Sacramento Refuge unless in possession of a Refuge Annual Pass, Federal Duck Stamp, valid Golden Eagle, Age or Access Passport, National Parks Pass with Hologram, or America the Beautiful Pass.

- Two photography blinds on Sacramento Refuge and a blind on Colusa Refuge are available by reservation from October through March. A universally accessible blind will be constructed at Delevan Refuge and be available by reservation. The photography blinds may be reserved only one day each week, on Wednesdays through Sundays. The current fee for photo blind use is $10 per visit. Photographers may request up to three total reservations during October through March and unlimited visits during the spring and summer.

- Commercial wildlife photographers must obtain a special use permit if the request includes access to closed areas or other special considerations (e.g. access to the Refuges after normal public visitation hours, setting up temporary photography blinds, etc.) (16 USC 460I-6d, Refuge Manual 8 RM 16). A standard fee of $100 per year for commercial photographers will be charged for issuing the SUP (USFWS 1992). Unless otherwise stated on the permit, in addition to the permit fee, a daily Refuge entrance fee of $3 per vehicle is charged on Sacramento Refuge. Areas used will be closely monitored to evaluate the impacts on the resource; if adverse impacts appear, the activity may be moved to secondary locations or curtailed entirely. Specific conditions may apply depending upon the requested activity and will be addressed through the SUP.

- All commercial photography operations that involve models, sets, props, lights, or similar equipment which will result in damage to the resource or which will unduly conflict with normal visitor use require an audio-visual production permit. Photography that includes commercial products for sale, filming motion pictures, documentaries or commercials, and similar related activities also requires an audio-visual production permit. All advertising photography requires an audio-visual production permit. Advertisements must not imply endorsement by the Service. No fee is charged for the permit. A bond or cash deposit is required when an audio-visual production permit is issued. The purpose of the bond is to assure that the area is left in its original condition. A performance bond issued by a bonding company, a cash deposit or certified check may be used for this purpose. Bonds or deposits will be required in amounts equal to the estimated cost to the Service of clean-up or restoration that would be required if the permittee failed to perform. Should the permittee actually fail to perform all or any part of the necessary clean-up or restoration, the refuge manager will have the required work done, assess the charge, deduct it from the bond or cash deposit and return the balance, if any, to the permittee. A Certificate of Insurance also is required naming the Service as certificate holder with the filming company assuming all liability for losses and damages (Refuge Manual 8 RM 16). Areas used will be closely monitored to evaluate the impacts on the resource; if adverse impacts appear, the activity may be moved to secondary locations or curtailed entirely. Specific conditions may apply depending upon the requested activity and will be addressed through the audio-visual production permit.

- News gathering organizations are exempt from formal permits and bonding requirements.

Justification: It is determined that commercial photography within the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges as described herein, will not materially interfere with or detract from the purposes for which the Refuges were established or the mission of the Refuge System. In our opinion, allowing commercial photography with associated stipulations will not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the Refuges.

Mandatory Re-Evaluation Date (2018):

_____ Mandatory 15-year Re-Evaluation, Date will be provided in Final EA/CCP (for priority public uses)

_X_ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

_____ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

_X_ Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

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Refuge Determination

Prepared by: ______________________________ ____________
(Signature) (Date)

Wildlife Refuge Manager/
Project Leader
Approval: ______________________________ ____________
(Signature) (Date)

Concurrence

Refuge Supervisor: ______________________________ ____________
(Signature) (Date)

Assistant Regional
Director, Refuges: ______________________________ ____________
(Signature) (Date)

COMPATIBILITY DETERMINATION
(June 2008)

Use: Environmental Education and Interpretation

Refuge Name: Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, located in Glenn, Colusa, and Sutter Counties, California.

Establishing and Acquisition Authority(ies):
Sacramento National Wildlife Refuge (Refuge) was established in 1937. Legal authorities include: Executive Order 7562, February 27, 1937, Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Delevan Refuge was established in 1962. Legal authority includes: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d).

Colusa Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Sutter Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), and the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884).

Refuge Purpose(s):

Sacramento Refuge purposes include:

> "... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February 27, 1937.
>
> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).
>
> "... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use

... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).

“... for the development, advancement, management, conservation, and protection of fish and wildlife resources ...” 16 U.S.C. 742f(a)(4) “... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ...” 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

Delevan Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

Colusa Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

Sutter Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

National Wildlife Refuge System Mission: “To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the

benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use: The National Wildlife Refuge System Improvement Act of 1997 identifies environmental education and interpretation as well as hunting, fishing, wildlife observation, and photography as priority wildlife-dependent public uses for Refuges. As two of the six priority public uses of the Refuge System, these uses are to be encouraged when compatible with the purposes of the Refuges. Environmental education and interpretation are considered simultaneously in this compatibility determination. Many elements of environmental education and interpretation are also similar to opportunities provided in the wildlife observation and photography program programs. These uses are identified and discussed in detail in the Draft Comprehensive Conservation Plan (CCP) and Environmental Assessment (EA) (USFWS 2008a) which are incorporated by reference.

The guiding principles of the Refuge System's environmental education programs (605 FW 6 of the Service Manual) are to:

- Teach awareness, understanding, and appreciation of our natural and cultural resources and conservation history.
- Allow program participants to demonstrate learning through refuge-specific stewardship tasks and projects that they can carry over into their everyday lives.
- Establish partnerships to support environmental education both on- and off-site.
- Support local, State, and national educational standards through environmental education on refuges.
- Assist refuge staff, volunteers, and other partners in obtaining the knowledge, skills, and abilities to support environmental education.
- Provide appropriate materials, equipment, facilities, and study locations to support environmental education.
- Give refuges a way to serve as role models in the community for environmental stewardship.
- Minimize conflicts with visitors participating in other compatible wildlife-dependent recreation activities.

The guiding principles of the Refuge System's interpretive programs(605 FW 7 of the Service Manual) are to:

- Promote visitor understanding of, and increase appreciation for, America's natural and cultural resources and conservation history by providing safe, informative, enjoyable, and accessible interpretive opportunities, products, and facilities;
- Develop a sense of stewardship leading to actions and attitudes that reflect interest and respect for wildlife resources, cultural resources, and the environment;
- Provide quality interpretive experiences that help people understand and appreciate the individual refuge and its role in the Refuge System;
- Provide opportunities for quality recreational and interpretive experiences consistent with criteria describing quality found in 605 FW 1.6;

- Assist refuge staff, volunteers, and community support groups in attaining knowledge, skills, and abilities in support of interpretation; and
- Minimize conflicts with visitors participating in other compatible wildlife-dependent recreational activities.

Environmental education and interpretation conducted on portions of the Refuges open to the general public do not require a special use permit. These areas are open one hour before sunrise to one hour after sunset on all Refuges.

Environmental Education
Environmental education is comprised of teacher or leader-conducted activities that are intended to actively involve students or others in hands-on activities. These activities are designed to promote discovery and fact-finding, develop problem-solving skills, and lead to personal involvement and action. The Service focuses on kindergarten through twelfth grade students.

The Environmental Education Guide for the Complex describes the activities, facilities and resources available. The environmental education program was restructured in 2005 to increase the involvement of teachers or leaders in conducting their pre-selected activities. The program offers several ways for the classes to experience the Complex. Specifically at the Sacramento Refuge, they are welcomed by visitor services staff and have access to the diorama, Discovery Room and refuge videos/DVDs. For the remainder of their visit, the teachers or leaders guide their group through their pre-planned tour.

Although the Refuges are open to the public from one hour before sunrise to one hour after sunset daily, we require groups to make reservations two weeks in advance to ensure that they will have the best possible experience and that needed resource materials are available. They may call, fax or visit the Complex's website to make reservations.

For an even more comprehensive environmental education experience, there is the fully equipped backpack or Discovery Pack to teach as many as five activities along the Wetlands Walk. The Pack contains dip nets, field guides, plant mounts, bug boxes, lenses, and other written materials. A teacher's guide can be sent, upon request, prior to the visit. Binoculars and waterfowl guides are available on loan. The Environmental Education Guide and the Complex's website list many other resources available.

The environmental education program will be greatly expanded in the future with the development of the Wetlands Resource Center near the Refuge Headquarters. The Wetlands Resource Center would accommodate 5,000 teachers, students, and adults annually. The Wetlands Resource Center would be located on the east side of Logan Creek between the existing headquarters and easement buildings. A wetland could be created south of the Center for habitat viewing and environmental education activities. A foot bridge would be constructed over Logan Creek so that the current parking area and

Wetlands Walk may be used. The Center could be a one-story building with a covered viewing porch at roof height. Large picture windows would accommodate views to the south and west. Part of the entry area would descend below the pond surface to allow visitors to view aquatic organisms and soil profiles. An auditorium would provide seating for up to 100 and include a surround-sound system, High Definition (HD) television, and retracting screens for projectors, videos, and DVDs. Separate laboratory rooms would provide a secluded work area, storage and sinks. Computer work stations with internet/satellite access and a resource library would be available for students and teachers.

Interpretation

Interpretation involves participants of all ages who learn about the complex issues confronting fish and wildlife resource management as they voluntarily engage in stimulating and enjoyable activities. First-hand experience with the environment is emphasized although presentations, audiovisual media, and exhibits are often necessary components of the interpretive program. The interpretation visits would significantly expand and enhanced with the development of the Wetlands Resource Center to accommodate up to 20,000 visits annually.

In 2007, the Service declared that "connecting people with nature" is among the agencies highest national priorities (USFWS 2008b). A connection with nature, whether it's hiking, fishing, camping, hunting, or simply playing outside, helps children develop positive attitudes and behaviors towards the environment. Positive interactions with the environment can lead to a life-long interest in enjoying and preserving nature. People's interest in nature is crucial to the Service mission of conserving, protecting, and enhancing fish, wildlife, plants, and their habitats.

When Service employees were asked to describe a childhood experience where they felt a connection with nature, the answers ranged from memories of riding on the laps of loved ones while mowing the lawn, to family vacations along a lake, beach, or forest, to hiking, climbing trees, and discovering insects, frogs, and birds. Many employees credit these memorable moments for placing them in the career that they are in today. Those experiences were the spark that led to a lifetime of stewardship and conservation. The Service wants to capture that spark and share it with the next generation of conservationists. The Connecting People with Nature Program goals for Region 8 include 1) Rekindle the spark, 2) Share the spark and 3) Ignite the spark. The Refuges are currently beginning to implement these goals by developing "Sense of Wonder Zones" or naturalized play areas for family-oriented activities on the Sacramento and Colusa Refuges where people of all ages can reconnect with nature. The Refuges will also create interpretive geocaching opportunities on the Sacramento and Colusa Refuges.

Refuge brochures pertaining to information on the Complex, Watchable Wildlife, and hunting have been developed and revised over the years. The Wetlands Walk Guide and the birding trail guide were completed in 2006. Varieties of videos/DVDs are also available for viewing upon request. The Sacramento Valley Refuge: An Unfinished Symphony and America's National Wildlife Refuge System: Where Wildlife Comes First, are the most popular videos. The Unfinished Symphony was written and filmed on location in 2003 as part of the Refuge System Centennial Celebration.

A bookstore in the Sacramento Refuge visitor center (Refuge Headquarters) was created in 1990 via cooperative agreement with the San Francisco Bay Wildlife Society. Additional shelving was added in 1996 increasing the sales to a consistent $14,000 annually. The cooperative agreement was terminated with San Francisco Wildlife Society in 2001 and a new cooperative agreement was signed with Altacal Audubon Society of Chico, CA in 2002.

Refuge related information is provided at annual local festivals or during special events, such as the State Fair, International Migratory Bird Day, Snow Goose Festival, National Wildlife Refuge Week, Pacific Flyway Decoy Association, Coleman National Fish Hatchery Salmon Festival, Chico Endangered Species Fair, California Waterfowl Association (CWA) Art Camp, CWA Marsh Madness, Orland's Community Expo, Willow's Business Expo and Colusa's Farm Day. During 2005, approximately 13,000 individuals attended the presentations and saw exhibits at these events.

Availability of Resources: The following funding/annual costs (based on FY 2007 costs) would be required to administer and manage environmental education and interpretation activities as described above:

	One-Time Costs	Annual Costs
New Construction		
Construct Wetland Resource Center (Sacramento)	$5,984,000	
Obtain equipment and supplies for Wetland Resource Center (Sacramento)	$ 184,800	
Improve entrance road and visitor parking area including railroad crossing device (Sacramento)	$ 540,000	
Construct accessible restroom (Sacramento)	$ 227,000	
Repair visitor entrance road and parking areas (Sacramento)	$ 60,800	
Replace domestic well and water lines at headquarters (Sacramento)	$ 190,000	
Predicted Maintenance of Facilities		
Regular maintenance of Wetland Resource Center, restrooms, etc.		$ 20,000
Equipment, vehicles, and supplies (e.g. brochures, etc.)		$ 22,000
New Staffing		
One full-time (1.0 FTE) GS-7/9 interpretive specialist		$ 64,430
One full-time (1.0 FTE) WG-3 maintenance worker		$ 42,209
TOTAL	**$7,186,600**	**$148,639**

Additional funds would be required to fully implement the environmental education and interpretation programs. Additional visitor services staff and volunteers would be needed. Funding will be sought through the Service budget process. Other sources will be sought through strengthened partnerships, grants, and additional refuge operations funding to support a safe and quality program as described above.

Anticipated Impacts of Use: Disturbance of wildlife is the primary concern regarding these uses. Disturbance to wildlife, such as the flushing of feeding, resting, or nesting birds, is inherent to these activities. There is some temporary disturbance to wildlife due to human activities on trails (hiking, bird watching) however, the disturbance is generally localized and will not adversely impact overall populations. Increased facilities and visitation would cause some displacement of habitat and increase some disturbance to wildlife, although this is expected to be minor given the size of the Refuges and by avoiding or minimizing intrusion into important wildlife habitat.

Individual animals may be disturbed by human contact to varying degrees. Human activities on trails can result in direct effects on wildlife through harassment, a form of disturbance that can cause physiological effects, behavioral modifications, or death (Smith and Hunt 1995). Many studies have shown that birds can be impacted from human activities on trails when they are disturbed and flushed from feeding, resting, or nesting areas. Flushing, especially repetitive flushing, can strongly impact habitat use patterns of many bird species. Flushing from an area can cause birds to expend more energy, be deterred from using desirable habitat, affect resting or feeding patterns, and increase exposure to predation or cause birds to abandon sites with repeated disturbance (Smith and Hunt 1995). Migratory birds were observed to be more sensitive than resident species to disturbance (Klein 1989).

Herons and shorebirds were observed to be the most easily disturbed (when compared to gulls, terns and ducks) by human activity and flushed to distant areas away from people (Burger 1981). A reduced number of shorebirds were found near people who were walking or jogging, and about 50 percent of flushed birds flew elsewhere (Burger 1981). In addition, the foraging time of sanderlings decreased and avoidance (e.g., running, flushing) increased as the number of humans within 100 meters increased (Burger and Gochfeld 1991). Nest predation for songbirds (Miller et al. 1998), raptors (Glinski 1976), colonial nesting species (Buckley and Buckley 1976), and waterfowl (Boyle and Samson 1985) tends to increase in areas more frequently visited by people. In addition, for many passerine species, primary song occurrence and consistency can be impacted by a single visitor (Gutzwiller et al. 1994). In areas where primary song was affected by disturbance, birds appeared to be reluctant to establish nesting territories (Reijnen and Foppen 1994).

Depending on the species (especially migrants vs. residents), some birds may habituate to some types of recreation disturbance and either are not disturbed or will immediately return after the initial disturbance (Hockin et al. 1992; Burger et al. 1995; Knight and Temple 1995; Madsen 1995; Fox and Madsen 1997). Rodgers and Smith (1997) calculated buffer distances that minimize disturbance to foraging and loafing birds based on experimental flushing distances for 16 species of waders and shorebirds. They recommended 100 meters as an adequate buffer against pedestrian traffic, however, they suggest this distance may be reduced if physical barriers (e.g., vegetation screening) are provided, noise levels are reduced, and traffic is directed tangentially rather than directly toward birds. Screening may not effectively buffer noise impacts, thus visitors should be educated on the effects of noise and noise restrictions should be enforced (Burger 1981, 1986; Klein 1993; Bowles 1995; Burger and Gochfeld 1998). Seasonally restricting or prohibiting recreation activity may be necessary during spring and fall migration to alleviate disturbance to migratory birds (Burger 1981, 1986; Boyle and Samson 1985; Klein et al. 1995; Hill et al. 1997).

Education helps make visitors aware that their actions can have negative impacts on birds, and will increase the likelihood that visitors will abide by restrictions on their actions. For example, Klein (1993) demonstrated that visitors who had spoken with refuge staff or volunteers were less likely to disturb birds. Increased surveillance and imposed fines may also help reduce visitor caused disturbance (Knight and Gutzwiller 1995). Monitoring is recommended to adjust management techniques over time, particularly because it is often difficult to generalize about the impacts of specific types of recreation in different environments. Local and site-specific knowledge is necessary to determine effects on birds and to develop effective management strategies (Hockin et al. 1992; Klein et al. 1995; Hill et al. 1997). Informed management decisions coupled with sufficient public education could do much to mitigate disturbance effects of wildlife-dependent recreations (Purdy et al 1987).

Environmental education and interpretation activities generally support the Refuges purposes and impacts can largely be minimized (Goff et al. 1988). The minor resource impacts attributed to these activities are generally outweighed by the benefits gained by educating present and future generations about refuge resources. Environmental education is a public use management tool used to develop a resource protection ethic within society. While it targets school age children, it is not limited to this group. This tool allows us to educate refuge visitors about endangered and threatened species management, wildlife management and ecological principles and communities. A secondary benefit of environmental education is that it instills an 'ownership' or 'stewardship' ethic in visitors and most likely reduces vandalism, littering and poaching. It also strengthens Service visibility in the local community.

The disturbance by environmental education activities is considered to be of minimal impact because: (1) the total number of students permitted through the reservation system is limited to 100 per day; (2) students and teachers will be instructed in trail etiquette and the best ways to view wildlife with minimal disturbance; (3) education groups will be required to have a sufficient number of adults to supervise the group; (4) trail design will provide adequate cover for wildlife; and (5) observation areas and scopes are provided to view wildlife at a distance which reduces disturbance.

Education staff coordinates with biologists regarding activities associated with restoration or monitoring projects to ensure that impacts to both wildlife and habitat are minimal. As with any restoration and monitoring activities conducted by refuge personnel, these activities conducted by students would be at a time and place where the least amount of disturbance would occur.

The environmental education and interpretation programs are designed to avoid or minimize impacts anticipated to the Refuges' resources and visitors. The Refuges' have requested Section 7 consultation with USFWS and NOAA-Fisheries on the Draft CCP/EA (USFWS 2008a) and its effects on any of the special status species/designated critical habitat occurring on the Refuges including: palmate-bracted bird's beak, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, giant garter snake, western yellow-billed cuckoo, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, fall-run Chinook salmon, and late fall-run Chinook salmon.

Anticipated Impacts of Uses on future lands within the approved boundary: The following conditions must be met before allowing existing uses to occur on newly acquired lands: (1) There is no indirect, direct, or cumulative threat anticipated to human health or safety; (2) There is no indirect, direct, or cumulative threat anticipated to natural or cultural resources; (3) The use is consistent with management of existing Sacramento, Delevan, Colusa, and Sutter Refuge lands and would contribute to achieving the Refuges' goals. In particular, existing Refuge regulations would not be compromised; (4) The newly acquired lands represent a meaningful unit within which to manage the activity; and (5) There are no anticipated conflicts with priority public uses.

Public Review and Comment: Public review and comments will be solicited in conjunction with distribution of the Draft CCP/EA for the Sacramento, Delevan, Colusa, and Sutter Refuges (USFWS 2008a).

Determination:

_____ Use is Not Compatible

__X__ Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

- Participants in the Refuges' environmental education and interpretation programs are restricted to established trails, the visitor center, the Wetland Resource Center, and other designated sites.

- All groups using the Refuges for environmental education are required to make reservations two-weeks in advance. They may call, fax, or visit the Complex's website to make reservations. This reservation process, allows refuge staff to manage the number and location of visitors for each day. Currently, educational groups are not charged a fee or required to have a special use permit. A daily limit of 100 students participating in the education program will be maintained through this reservation system. Efforts are made to spread out use by large groups, reducing disturbance to wildlife and over-crowding of the Refuges' facilities during times of peak demand.

- Trail etiquette including ways to reduce wildlife disturbance is discussed with teachers during orientation workshops and with students upon arrival during their welcome session. On the Refuges, the teacher(s) is responsible for ensuring that students follow required trail etiquette.

- Refuge biologists and visitor services staff conduct regular surveys of public activities on the Refuges. The data is analyzed and used by the refuge manager to develop future modifications if necessary to ensure compatibility of environmental education programs.

- Educational groups are required to have a sufficient number of adults to supervise their groups, a minimum of 1 adult per 12 students.

Justification: These wildlife-dependent uses are priority public uses of the National Wildlife Refuge System. Providing opportunities for environmental education and interpretation, would contribute toward fulfilling provisions of the National Wildlife Refuge System Administration Act, as amended in 1997, and one of the goals of the Sacramento, Delevan, Colusa, and Sutter Refuges (Goal 3, Chapter 4, CCP). Environmental education and interpretation would provide an excellent forum for allowing public access and increasing understanding of Refuge resources. The stipulations outlined above should minimize potential impacts relative to wildlife/human interactions. Based upon impacts described in the Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2008a), it is determined that environmental education and interpretation within the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges as described herein, will not materially interfere with or detract from the purposes for which the Refuges were established or the mission of the Refuge System. In our opinion, implementing the visitor services plan and associated stipulations will not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the Refuges.

Mandatory Re-Evaluation Date (2023):

__X__ Mandatory 15-year Re-Evaluation, Date will be provided in Final EA/CCP (for priority public uses)

_____ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

_____ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

__X__ Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

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Refuge Determination

Prepared by:	______________________ (Signature)	__________ (Date)
Wildlife Refuge Manager/ Project Leader Approval:	______________________ (Signature)	__________ (Date)

Concurrence

Refuge Supervisor:	______________________ (Signature)	__________ (Date)
Assistant Regional Director, Refuges:	______________________ (Signature)	__________ (Date)

COMPATIBILITY DETERMINATION
(June 2008)

Use: Grazing

Refuge Name: Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, located in Glenn, Colusa, and Sutter Counties, California.

Establishing and Acquisition Authorities:
Sacramento National Wildlife Refuge (Refuge) was established in 1937. Legal authorities include: Executive Order 7562, February 27, 1937, Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Delevan Refuge was established in 1962. Legal authority includes: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d).

Colusa Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Sutter Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), and the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884).

Refuge Purpose(s):

Sacramento Refuge purposes include:

> "... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February 27, 1937.
>
> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).
>
> "... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use

... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).

“... for the development, advancement, management, conservation, and protection of fish and wildlife resources ...” 16 U.S.C. 742f(a)(4) “... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ...” 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

Delevan Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

Colusa Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

Sutter Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

National Wildlife Refuge System Mission: “To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the

benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use: Livestock grazing is conducted annually for a specified period (i.e., seasonally) to manage vegetation for the benefit of native plants and wildlife habitat on Sacramento, Delevan, Colusa, and Sutter Refuges, where appropriate. Grazing is administered with a livestock cooperator under a Special Use Permit (SUP). The SUP states provisions for habitat objectives, expected wildlife benefits, shared staffing, facility maintenance, pest management, remedies, operating rules and laws, and reporting requirements. An annual grazing plan identifies the refuge tract to be grazed and specifies: vegetation and habitat type, grazing objective (primary target weed and/or primary native species or taxa), prescribed expected tract conditions (vegetation height), date by which expected conditions are to be met, livestock turn-in/turn-out dates and Animal Unit Months (AUM).

The specific dates are determined by the refuge manager through consultation with the refuge biologist and cooperator to develop a strategy that meets target tract objectives. Each year the needs for vegetation management, including grazing, are evaluated during the annual review of the habitat management plan. The plan has built-in flexibility due to the uncertainties of annual and seasonal precipitation, flooding, and temperatures, and their consequent affect on vegetation growth. This flexibility insures that expected conditions are met and that refuge vegetation is neither over-grazed nor under-grazed—both conditions result in degraded habitat. Included in the annual habitat management plan is a project plan, which also specifies by refuge tract: identified facilities and maintenance projects, materials, shared responsibilities, and special management problems and considerations. This is a refuge management economic activity and its utilization helps the Refuges achieve the purposes for which they were created and the mission of the Refuge System. The proposed grazing program is described in the Draft Comprehensive Conservation Plan (CCP) and associated Environmental Assessment (EA), which are incorporated by reference (USFWS 2008).

Grazing is used as a management tool to improve habitat conditions on the Refuges. Privately owned livestock (sheep, goats, or cattle) will graze on the Refuges to improve vegetative composition by reducing exotic weed species. Grazing will be timed to reduce undesirable vegetation and will be conducted in grassland habitats (March 1 through November 1) and in seasonal wetland habitats (May 1 through October 1).

Livestock will be kept in areas that have undesirable vegetative composition and in numbers that can have an impact on the undesirable vegetation. If sheep were used, a herder and dogs would be allowed to stay in a small trailer on the Refuge to tend the animals.

Of the management tools available to be used to control exotic weeds (herbicides, mowing, burning, discing, grazing) in grassland habitats, grazing is often the most practical and cost efficient.

Availability of Resources: The following funding/annual costs (based on FY 2007 costs) would be required to administer and manage grazing activities as described above:

	Annual Costs
Administration	$1,000
Facilities maintenance	$5,000
TOTAL	**$6,000**

Monitoring is addressed in the annual habitat management plans. The Refuges may charge user fees; however, in-kind services have been used to the advantage of the Refuge and are determined annually during annual grazing plan meetings. Refuge operational funds are currently available through the Service budget process to administer this program.

Anticipated Impacts of Use: Grazing by native wildlife species has long occurred in the California landscape where it has shaped its botanical and zoological resources (Edwards 1992; Edwards 1996). Currently, livestock grazing is an important method of vegetation management (Barry 2003; Griggs 2000). Beneficial effects to Refuge habitat, wildlife and native plants would occur as a result of a well managed livestock grazing program. Primary benefits associated with the grazing program include: a reduction in the accumulation of dead plant material; reduction in non-native invasive weeds (Thomsen et al. 1993); increases in native plants, including special status species, from reduced competition for sunlight, water and nutrients with non-native annual grasses (Coppoletta and Moritsch 2001; Davis and Sherman 1992; Menke 1992; Muir and Moseley 1994); increases primary production and resultant increases in plant biomass (McNaughton 1985); and increases in flowering, with consequent increases in macro-invertebrate populations, including native pollinators of native plants, and prey items for refuge wildlife such as migratory birds. Grazing would provide optimal shorebird foraging habitat (Colwell and Dodd 1995; Knopf and Rupert 1995) and would provide short, nutritious grasses for grazing migratory waterfowl (Buchsbaum et al. 1986), and local deer. Aquatic invertebrates, insects, and special status species would benefit from grazed herbaceous habitats (Bratton 1990; Bratton and Fryer 1990; Panzer 1988; Germano et al. 2001; Knopf and Rupert 1995). Primary burrowing mammals such as California ground squirrel would increase with grazing and this would result in increases of secondary burrowing animals such as burrowing owls and various snake taxa. Primary, long-term benefits include continued annual native plant production, control of non-native invasive plant species, and, seasonal use of refuge habitat by migratory birds and resident deer.

Within grassland habitats on the Refuges, invasive weeds include yellow star-thistle (*Centaurea solstitialis*), black mustard (*Brassica nigra*), Mediterranean annual grasses, perennial pepperweed (*Lepidium latifolium*), and others. Yellow star-thistle is a noxious weed in grassland habitats on the Refuges. Yellow star-thistle reduces the values of grassland areas to many native wildlife species. Properly timed grazing will reduce yellow star-thistle biomass and seed productions (Thomson et al 1996, Thomson et al 1993). At some sites on the Refuges, grazing will be used to reduce the seed production of yellow star-thistle and other weeds prior to native grass restoration efforts, thereby reducing competition and improving success of the restoration efforts.

Refuge wetlands are intensively managed to provide optimal habitat for large concentrations of wintering waterfowl. Discing is often used as a tool to set back succession within wetland habitats, which have become dominated by perennial species. Bermuda grass (*Cynodon dactylon*) and knotgrass (*Paspalum distichum*) have become dominant in some management units, and out-compete more desirable annual plants. Bermuda grass and knotgrass form thick mattes, which reduces the effectiveness of discing. Fire is an alternative tool to reduce plant biomass and is often used prior to discing. However, Bermuda grass and knotgrass often remain green throughout the summer and in many years cannot be burned. By reducing biomass of Bermuda grass and knotgrass, grazing can improve the effectiveness of subsequent discing.

The grazing program could also impact the Refuges' wildlife and habitat. Impacts to some nesting waterfowl and songbirds could occur (Kirsch 1969; Krueper 1993). Grazing in grasslands will reduce tall grass cover, which is used by nesting mallards, cinnamon teal, gadwall, northern harriers, American bitterns and ring-necked pheasants. Pheasants use grasslands with tall vegetation throughout the year and may be impacted by grazing. At locations where native grass restoration is planned, the short-term impacts of grazing to ground nesting birds and pheasants will be reversed as native grasses are established. Mammals, which burrow through thatch such as California meadow vole would likely decrease with grazing. However, these impacts would be short-term because the program would stipulate seasonal grazing. Songbirds, harriers and larger mammals, such as black-tailed jackrabbit, would move to other areas of the Refuges, which would provide cover outside the grazed areas. Seasonal grazing would improve plant species composition and structure so that short-term impacts to wildlife and habitat would be mitigated by long-term benefits to the Refuges' vegetation, native plants, and overall wildlife habitat quality. Therefore, the long-term benefits to habitat, migratory birds, resident deer, and native plants would mitigate the short-term, localized impacts to local ground-nesting birds and some small mammals.

Potential impacts of grazing activities on the Refuges' resources will be minimized because sufficient restrictions would be included as part of the annual grazing plan and grazing activities will be monitored by the refuge manager and biologist. The refuge manager and biologist ensure the grazing plan and associated projects contribute to the enhancement, protection, conservation, and management of native Refuge wildlife populations and their habitats thereby helping the Refuges fulfill the purposes for which they were established, the mission of the National Wildlife Refuge System, and the need to maintain ecological integrity, diversity, and environmental health.

The grazing program is designed to avoid or minimize impacts anticipated to the Refuges' resources and visitors. The Refuges' have requested Section 7 consultation with USFWS and NOAA-Fisheries on the Draft CCP/EA (USFWS 2008) and its effects on any of the special status species/designated critical habitat occurring on the Refuge including: palmate-bracted bird's beak, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, giant garter snake, western yellow-billed cuckoo, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, fall-run Chinook salmon, and late fall-run Chinook salmon.

Anticipated Impacts of Uses on future lands within the approved boundary: The following conditions must be met before allowing existing uses to occur on newly acquired lands: (1) There is no indirect, direct, or cumulative threat anticipated to human health or safety; (2) There is no indirect, direct, or cumulative threat anticipated to natural or cultural resources; (3) The use is consistent with management of existing Refuge lands and would contribute to achieving the Refuges' goals. In particular, existing Refuge regulations would not be compromised; (4) The newly acquired lands represent a meaningful unit within which to manage the activity; and (5) There are no anticipated conflicts with priority public uses.

Public Review and Comment: Public review and comments will be solicited in conjunction with distribution of the Draft CCP/EA for the Sacramento, Delevan, Colusa, and Sutter Refuges (USFWS 2008).

Determination:

_____ Use is Not Compatible

__X__ Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

- The criteria for evaluating need for vegetation management, including grazing, are determined during the annual review of the habitat management plans.

- Grazing is conducted in accordance with the SUPs which include special conditions that specifies timing of grazing, location(s) of grazing, stocking densities, types of livestock permitted, access locations, predator management restrictions, and personnel and equipment allowed. The specific conditions will vary annually due to differences in objectives, habitat conditions, and weather.

- Grazing is not allowed in sensitive natural areas or cultural resource sites.

- Grazing will comply with the Section 7 consultations with USFWS and NOAA-Fisheries.

Justification: The grazing program as described is determined to be compatible. Based upon impacts described in the Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2008), it is determined that grazing within the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, as described herein, will not materially interfere with or detract from the purposes for which the Refuges were established or the mission of the Refuge System. Refuge livestock grazing will directly benefit and support refuge goals, objectives and management plans and activities. Fish, wildlife, plants and their habitat will improve through vegetation management which will result in short-term and long-term reductions of non-native invasive plant species, increases in native plants, increases in biomass, improved foraging conditions for migratory birds and local deer herds, and long-term improved nesting conditions for some species. Consequently, the livestock grazing program would increase or maintain biological integrity, diversity and environmental health. The wildlife-dependent, priority public uses (hunting, fishing, wildlife observation, photography, environmental education and interpretation) would also benefit as a result of increased biodiversity and wildlife and native plant populations from improved habitat conditions associated with the grazing program. In our opinion, grazing will not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the Refuges.

Mandatory Re-Evaluation Date (2018):

_____ Mandatory 15-year Re-Evaluation, Date will be provided in Final EA/CCP (for priority public uses)

__X__ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

_____ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

__X__ Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

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Refuge Determination

Prepared by: ____________________________ __________
(Signature) (Date)

Wildlife Refuge Manager/
Project Leader
Approval: ____________________________ __________
(Signature) (Date)

Concurrence

Refuge Supervisor: ____________________________ __________
(Signature) (Date)

Assistant Regional
Director, Refuges: ____________________________ __________
(Signature) (Date)

COMPATIBILITY DETERMINATION
(June 2008)

Use: Hunting

Refuge Name: Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, located in Glenn, Colusa, and Sutter Counties, California.

Establishing and Acquisition Authority(ies):
Sacramento National Wildlife Refuge (Refuge) was established in 1937. Legal authorities include: Executive Order 7562, February 27, 1937, Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Delevan Refuge was established in 1962. Legal authority includes: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d).

Colusa Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Sutter Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), and the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884).

Refuge Purpose(s):

Sacramento Refuge purposes include:

> "... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February 27, 1937.
>
> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
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... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).

“... for the development, advancement, management, conservation, and protection of fish and wildlife resources ...” 16 U.S.C. 742f(a)(4) “... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ...” 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

Delevan Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

Colusa Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

Sutter Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

National Wildlife Refuge System Mission: “To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the

benefit of present and future generations of Americans.” (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use: Hunting is identified in the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd-ee) as a priority use for refuges when it is compatible with the refuge purposes and mission of the Refuge System. As a result, the Service is proposing to allow waterfowl, coot, common moorhen, pheasant, and snipe hunting on approximately 8,525 acres of Sacramento, Delevan, Colusa, and Sutter Refuges. The Proposed Action (Alternative C) analyzed in the Draft Comprehensive Conservation Plan (CCP) and Environmental Assessment (EA) (USFWS 2008a) and the Hunt Plan (USFWS 2008b), which are incorporated by reference, contain maps and Refuge descriptions where hunting will be allowed. The hunting program will provide high quality, safe, and cost-effective hunting opportunities, and will be carried out consistent with State regulations. The guiding principles of the Refuge System’s hunting programs (Service Manual 605 FW 2) are to:

- Manage wildlife populations consistent with Refuge System-specific management plans approved after 1997 and, to the extent practicable, State fish and wildlife conservation plans;
- Promote visitor understanding of and increase visitor appreciation for America’s natural resources;
- Provide opportunities for quality recreational and educational experiences consistent with criteria describing quality found in 605 FW 1.6;
- Encourage participation in this tradition deeply rooted in America’s natural heritage and conservation history; and
- Minimize conflicts with visitors participating in other compatible wildlife-dependent recreational activities.

The Hunt Plan (USFWS 2008b) was developed to provide safe hunting opportunities, while minimizing conflicts with other priority wildlife-dependent recreational uses. The Refuges’ hunting program will comply with the Code of Federal Regulations Title 50, 32.1 and be managed in accordance with Service Manual 605 FW2, Hunting.

Hunting will be permitted in accordance with State and Federal regulations and seasons (Table 1 gives an example of annual State hunt seasons for areas within the Refuges) to ensure that it will not interfere with the conservation of fish and wildlife and their habitats. Therefore, the sport hunting of migratory birds and upland game birds on the Refuges is in compliance with State regulations and seasons, the National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd-ee), and the Refuge Recreation Act of 1962 (16 U.S.C. 460k).

Table 1. Sacramento, Delevan, Colusa, and Sutter Refuges, Hunting Season Bag Limit Summary for 2006-2007

Species	Dates	Daily Bag Limits
Waterfowl – Ducks	Third Saturday in October extending for 100 consecutive days	Up to 7 ducks; see below; possession double the bag limit*
Waterfowl – Geese	October - concurrent with duck season	Up to 4 geese any species; possession double the bag limit
American Coot and Common Moorhen	October - concurrent with duck season	25/day, 25 in possession, either all of one species or a mixture of these species
Snipe	Third Saturday in October extending for 107 days	8/day; possession double the bag limit
Pheasants – General	Second Saturday in November extending for 44 days	2 – males first two days; 3 males thereafter; possession double the bag limit

*Duck Bag Limits: 7 ducks/ but not more than 2 hen mallards, 1 pintail, 1 canvasback, 2 redhead, 3 scaup, throughout the season

Limited spring turkey hunting opportunities on Sacramento, Delevan, and Colusa Refuges could be allowed based on sufficient wild turkey populations, habitat conditions, and the development of a turkey hunt management plan as well as appropriate National Environmental Policy Act compliance.

The hunting program is administered by the Service in cooperation with the California Department of Fish and Game (CDFG). The Service manages the Refuges' land, habitat and facilities; and the CDFG selects and processes the Refuge hunters and operates the check stations. A valid California hunting license, including appropriate stamps, is required for taking any bird. Entry permits are issued at the check stations, which are used to track daily hunter quotas, hunter refill, and bird species harvest.

Hunting is permitted on designated portions of Sacramento, Delevan, Colusa and Sutter Refuges (Figures 11-14 in the CCP). Hunting of waterfowl, coot, common moorhen, snipe, and pheasant is permitted on Saturdays, Sundays, and Wednesdays during hunting seasons established by the California Fish and Game Commission. Pheasants may only be hunted in the free roam areas, except for the Special Monday Pheasant Hunt, which is held the first Monday after the opening day of pheasant season. On this day, the entire hunt areas are opened to pheasant hunting, including the spaced blind areas.

Hunting areas are divided into designated areas— free roam, spaced hunt blind, spaced hunt site (island), or assigned pond (Figures 11-14 in the CCP). The overall harvest success, as measured by the number of birds per hunter per day, has remained relatively constant (approximately 2.0 birds per hunter) since the hunting programs were established in 1963. This consistency has occurred despite rather significant fluctuations in total birds harvested annually for the Complex and trends on individual Refuges. Harvest data indicate that ducks make up 95 percent of the hunter bag. The top six species of ducks harvested are mallard (22.3 percent), gadwall (18.5 percent), green-winged teal (14.5 percent), northern shoveler (13.5 percent), American wigeon (12.6 percent), and northern pintail (7.5 percent). Geese harvested include snow (53.8 percent), white-fronted (30.2 percent), and Ross's (13.4 percent). The majority of the goose harvest occurs on Sacramento and Delevan Refuges.

The Refuges have approximately 22,000 annual hunting visits, including up to 500 annual visits by hunters with disabilities. Hunters must report take of waterfowl and pheasants to the check station located at Sacramento Refuge south of Road 68, at Delevan Refuge off of Four Mile Road, at Colusa Refuge south of Abel Road, and at Sutter Refuge south of Hughes Road (Figures 11-14 in the CCP). Field checks by refuge law enforcement officers will be planned, conducted, and coordinated with staff and other agencies to maintain compliance with regulations and assess species and number harvested. Dogs will be required to be kept on a leash, except for hunting dogs engaged in authorized hunting activities and under the immediate control of a licensed hunter.

The Refuge Hunting Program Working Group was established in 1991 to exchange ideas and information regarding the Complex's hunting program. The Disabled Access Working Group was established in 1999 to discuss disabled hunting access issues on the Complex. In 2006, the groups were combined to form the Complex Hunting Program Working Group. The State game wardens and Federal law enforcement officers also attend the Working Group meeting.

With the number of waterfowl hunters declining in California, it is important to offer opportunities for new hunters to experience quality refuge hunting. In the early 1990s, the Service began hosting a one-day, in-season junior waterfowl hunt on Sacramento and Delevan Refuges. The spaced hunt site areas were reserved for junior hunters (age 16 and younger). These hunts resulted in up to 145 junior hunt visits annually. In the late 1990s, post season youth only hunts (age 15 and younger) began on Sacramento and Colusa Refuges and were later added to Delevan Refuge. These hunts have resulted in up to 372 annual junior hunter visits. Many local partners (i.e. California Waterfowl Association, Willows Rotary, Willows Kiwanis, and National Wild Turkey Federation) have also assisted by providing free morning beverages, barbecue lunches, raffles, and educational displays and activities.

Sacramento Refuge

Hunting is allowed on 3,566 acres south of Road 68 (Table 2).

Table 2. Hunt area acreage and hunter quotas for Sacramento Refuge

	Spaced Blind Area	Assigned Pond Area (# parties)	Free Roam Area	Pheasant Only
Acres dry	220	48	336	127
Acres flooded	1,233	428	1,146	
Total acres	1,453	476	1,482	127
Number of blinds	37			
Number of assigned ponds		9		
Maximum adult hunter quota	148	36 (9)	75	
Wetland acre/hunter or hunt site	33.3	47.5	15.3	

Sacramento Refuge has spaced blinds, assigned ponds, and free roam areas that consist of managed wetland, watergrass, permanent pond, grassland, and vernal pool/alkali meadow habitats. Blinds are in-ground, concrete pits spaced 250-400 yards apart. Hunters must remain within 100 feet of their assigned blind. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas, while additional reflective stakes direct hunters to their assigned blind. The hunting areas are accessible by foot only from four parking areas.

Pheasant and snipe may be hunted on waterfowl hunt days in the free roam and pheasant only areas. Pheasant may also be hunted on the first Monday of the season in free roam, spaced blind, and assigned pond areas. Maximum quota for this day is 100 hunters.

Hunter quotas are based on acres of available wetland habitat and are adjusted depending upon water conditions. Fully-flooded conditions provide up to 37 blinds (up to four people per blind), nine assigned ponds (up to four people per pond), and up to 75 free roam hunters (15.3 wetland acres/hunter). In addition to quotas, hunter distribution is influenced by habitat management, pond size, daily weather conditions, and waterfowl flight patterns.

Sacramento Refuge has three spaced blinds (Blinds 5D, 23D, and 27D) designated for hunters with mobility impairments. These sites may be accessed by motor vehicle or all-terrain-vehicle (ATV) from the parking areas. Additionally, a parking area to access Blinds 23D and 27D and a designated accessible boat launch in the free roam area (Tract 38) is available. In 2006-07, there were 212 visits by 62 individual hunters with disabilities.

Delevan Refuge

Hunting is allowed on 1,922 acres within the south half of Delevan Refuge (Table 3).

Table 3. Hunt area acreage and hunter quotas for Delevan Refuge.

	Spaced Hunt Area	Assigned Pond Area (# parties)	Free Roam Area
Acres dry	22	0	192
Acres flooded	746	129	*833
Total acres	768	129	1,025
Number of blinds	26		
Number of assigned ponds		3	
Maximum adult hunter quota	104	12 (3)	**58
Wetland acre/hunter or hunt site	28.7	43.0	14.4

* Does not include acres for T41.2 when it gets flooded in December-January.
**Increased to 62 during December-January when T41.2 is flooded.

Delevan Refuge has spaced hunt sites, assigned pond, and free roam areas that consist of managed wetland, watergrass, permanent pond, grassland, and vernal pool/alkali meadow habitats. Hunt sites consist of a dirt island (approximately 10'x20') surrounded by cattail or bulrush. Hunters must remain within 100 feet of their assigned hunt site. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas, while additional reflective stakes direct hunters to their assigned hunt site. The hunting areas are accessible by foot only from three parking areas.

Pheasant and snipe may be hunted on waterfowl hunt days in the free roam areas. Pheasant may also be hunted on the first Monday of the season in free roam, spaced hunt sites, and assigned pond areas. Maximum quota for this day is 50 hunters.

Hunter quotas are based on acres of available wetland habitat and will be adjusted depending upon water conditions. Fully-flooded conditions provide up to 26 hunt sites (up to four people per hunt site), three assigned ponds (up to four people per pond) and up to 58 free roam hunters (14.4 wetland acres/hunter). In addition to quotas, hunter distribution is influenced by habitat management, pond size, daily weather conditions, and waterfowl flight patterns.

Delevan Refuge has three spaced blinds (Blinds 13D, 29D, and 30D) designated for disabled hunters. These blinds may be accessed by motor vehicle or ATV from the parking areas. A floating pontoon blind is located in T34.3 as a free roam hunting opportunity. Additionally, there are designated accessible boat launches in the free roam area of Tract 33 and Tract 34.3. In 2006-07, there were 223 visits by 53 individual hunters with disabilities.

Colusa Refuge

Hunting is allowed on 1,921 acres south of Abel Road (Table 4).

Table 4. Hunt area acreage and hunter quotas for Colusa Refuge.

	Assigned Pond Area (# parties)	**Free Roam Area - Westside**	**Free Roam Area - Eastside**
Acres dry	1	488	126
Acres flooded	386	292	491
Total acres	387	780	617
Number of assigned ponds	10		
Maximum adult hunter quota	30 (15)	14	36
Wetland acres/hunter or hunt site	25.7	20.8	13.6

Colusa Refuge has assigned pond and free roam areas that consist of managed wetland, watergrass, permanent pond, grassland, and vernal pool/alkali meadow habitats. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas. The hunting areas are accessible by foot only from four parking areas. Disabled hunters may access Pool 2 (P2) from the disabled parking area via a boat ramp or access a blind in the northeast corner. In 2006-07, P2 had 236 hunter visits and hunters reported using the P2 blind on 10 days resulting in 22 visits.

Pheasant and snipe may be hunted on waterfowl hunt days in the free roam areas only. Pheasant may also be hunted on the first Monday of the season in free roam and assigned pond areas. Maximum quota for this day is 10 hunters on the east side and 35 hunters on the westside.

Hunter quotas are based on acres of available wetland habitat and are adjusted depending upon water conditions. Fully-flooded conditions provide up to 10 assigned ponds (two adult hunters per party) and up to 50 free roam hunters. Assigned ponds T24.4- 5, T24.7-10, and T19.1-2 allow one party per pond, Pool 1 allows up to 4 parties per pond. P2 allows up to three parties: 2 disabled and one party, which must have a junior hunter. In addition to quotas, hunter distribution is influenced by habitat management, pond size, daily weather conditions and waterfowl flight patterns.

The eastside free roam area has 1 hunter per 13.6 wetland acres at its maximum quota of 36 hunters. The westside free roam area has 1 hunter per 20.8 wetland acres at its maximum quota of 14. The westside free roam area is not in as strong a flight path and thus the hunter density allowed is lower.

Sutter Refuge

Currently hunting is allowed on 1,116 acres on the south half of Sutter Refuge (Table 5).

Table 5. Hunt area acreage and hunter quotas for Sutter Refuge.

	Assigned Pond Area (# parties)	Free Roam Area	Pheasant Only Area
Acres dry	0	0	125
Acres flooded	540	265	
Total acres	540	265	125
Number of assigned ponds	10		
Maximum adult hunter quota	44 (22)	20	10
Wetland acres/hunter or hunt site	24.5	13.2	

Sutter Refuge has assigned pond and free roam areas that primarily consist of managed wetland, watergrass, and grassland habitats. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas. The hunting areas are accessible by foot only from two parking areas. In addition, there is a designated boat launch with a parking area available to hunters with disabilities, in the southeast corner of assigned pond T17. There was minimal visitation by hunters with disabilities.

Pheasant and snipe can be hunted in the free roam and pheasant only areas on the Refuge on waterfowl hunt days.

Hunter quotas are based on acres of available wetland habitat and are adjusted depending upon water conditions. Fully-flooded conditions provide up to 10 assigned ponds and up to 20 free roam hunters. Assigned ponds T10 and T12.1-.3 allow one party per pond; T12.4, T14.1 and T14.2 allow up to two parties each and T15-17 allow up to four parties each, including two adult disabled hunting parties in T17. A hunting party may include up to two adults. A disabled hunting party must include at least one disabled hunter. In addition to quotas, hunter distribution is influenced by habitat management, pond size, daily weather conditions, and waterfowl flight patterns.

The free roam area has 1 hunter per 13.2 wetland acres at its maximum quota of 20 hunters. Tract 18 will remain as a pheasant hunting only area and will have a quota up to 10 hunters.

Availability of Resources: The following funding/annual costs (based on FY 2007 costs) would be required to administer and manage hunting activities as described above:

	One-Time Costs	Annual Costs
Install electric line for hunter check station (Delevan)	$172,000	
Replace hunter access bridges with culverts (Sacramento and Delevan)	$20,000	
Printing (brochures, signs, posters, etc)		$3,000
Law Enforcement (permit compliance, access control, protection)		$22,000
Maintenance (check stations, blinds, disking, mowing, etc.)		$33,000
Personnel Services (managerial, biological, clerical, etc.)		$27,000
New Staffing		
One full-time (1.0 FTE) GS-5 office automation clerk		$25,514
TOTAL	**$192,000**	**$110,514**

Funds are currently available to operate and maintain the hunt program. Funding is acquired through the Service budget process and as a reimbursement via a cooperative agreement with the CDFG. To defray expenses connected with the operation and maintenance of the hunting program, the CDFG is authorized to charge and retain a fee from each adult hunter. Hunter fees are determined annually in advance of the hunting season by the California Fish and Game Commission. At present, the Refuge entry permit fees are: one-day $14.75, two-day $25.45, or a season pass with a one-time, base fee of $117.85. These fees are adjusted annually, as required under Fish and Game Code Section 713. Holders of valid junior hunting licenses and non-shooters are exempt from these fees.

Anticipated Impacts of Use: Direct effects of hunting include mortality, wounding, and disturbance (De Long 2002). Hunting can alter behavior (i.e. foraging time), population structure, and distribution patterns of wildlife (Owens 1977, Raveling 1979, White-Robinson 1982, Thomas 1983, Bartelt 1987, Madsen 1985, and Cole and Knight 1990). There also appears to be an inverse relationship between the numbers of birds using an area and hunting intensity (DeLong 2002). In Connecticut, lesser scaup were observed to forage less in areas that were heavily hunted (Cronan 1957). In California, the numbers of northern pintails on Sacramento Refuge non-hunt areas increased after the first week of hunting and remained high until the season was over in early January (Heitmeyer and Raveling 1988). Following the close of the hunting season, ducks generally increased their use of the hunt area; however, use was lower than before the hunting season began. Human disturbance associated with hunting includes loud noises and rapid movements, such as those produced by shotguns and boats powered by outboard motors. This disturbance, especially when repeated over a period of time, compels waterfowl to change food habits, feed only at night, lose weight, or desert feeding areas (Madsen 1995, Wolder 1993).

These impacts can be reduced by the presence of adjacent sanctuary areas where hunting does not occur, and birds can feed and rest relatively undisturbed. Sanctuaries or non-hunt areas have been identified as the most common solution to disturbance problems caused from hunting (Havera et. al 1992). Prolonged and extensive disturbances may cause large numbers of waterfowl to leave disturbed areas and migrate elsewhere (Madsen 1995, Paulus 1984). In Denmark, hunting disturbance effects were experimentally tested by establishing two sanctuaries (Madsen 1995). Over a 5-year period, these sanctuaries became two of the most important staging areas for coastal waterfowl. Numbers of dabbling ducks and geese increased 4 to 20 fold within the sanctuary (Madsen 1995). Thus, sanctuary and non-hunt areas are very important to minimize disturbance to waterfowl populations to ensure their continued use of the Refuges.

Intermittent hunting can be a means of minimizing disturbance, especially if rest periods in between hunting events are weeks rather than days (Fox and Madsen 1997). It is common for Refuges to manage hunt programs with non-hunt days. At Sacramento Refuge, 3-16 percent of pintails were located on hunted units during non-hunt days, but were almost entirely absent in those same units on hunt days (Wolder 1993). In addition, northern pintails, American wigeon, and northern shovelers decreased time spent feeding on days when hunting occurred on public shooting areas, as compared to non-hunt days (Heitmeyer and Raveling 1988). The intermittent hunting program of three hunt days per week at Sacramento Refuge resulted in lower pintail densities on hunt areas during non-hunt days than non-hunt areas (Wolder 1993). However, intermittent hunting may not always greatly reduce hunting impacts.

The impacts addressed here are discussed in detail in the Environmental Assessment (EA) (Appendix A) for the Draft Comprehensive Conservation Plan (CCP) (USFWS 2008a) which is incorporated by reference. Biological conflicts will be minimized by following proper zoning and regulations. Refuge seasons will be designated to minimize negative impacts to wildlife.

Hunting is a highly regulated activity, and generally takes place at specific times and seasons (fall and winter) when the game animals are less vulnerable, reducing the magnitude of disturbance to the Refuges' wildlife. Managed and regulated hunting will not reduce species populations to levels where other wildlife-dependent uses will be affected.

The use of retrieving dogs would be permitted and encouraged in all areas open to waterfowl hunting. These dogs would be required to be under control at all times. Any hunter who allows his/her dog to disturb wildlife is not well received by other hunters who do not want waterfowl disturbed on the ponds that they are hunting. Law enforcement officers will enforce regulations requiring owners to maintain control over their dogs while on the Refuges. Although the use of dogs is not a form of wildlife-dependent recreation; they do in this case support a wildlife dependent use. Implementing the prescribed restrictions outlined in the Stipulations section should alleviate any substantial impacts.

Hunting is an appropriate wildlife management tool that can be used to manage wildlife populations. Some wildlife disturbance will occur during the hunting seasons. Proper zoning, regulations, and Refuge seasons will be designated to minimize any negative impacts to wildlife populations using the Refuges. Harvesting these species, or any other hunted species, would not result in a substantial decrease in biological diversity on the Refuges.

Conflicts between hunting and other public uses will be minimized by the following:

- Physically separate non-hunting and hunting acres to spatially divide the activities.
- Hunting will be limited to occur only on Wednesdays, Saturdays, and Sundays during hunting seasons established by the California Fish and Game Commission.
- Boundary and hunting area signs will be maintained to clearly define the designated hunting areas.
- Allow vehicle traffic only on designated roads and parking areas.
- Parking areas will be signed and gated to allow only pedestrian access.
- The hunting program will be highly regulated and managed in strict accordance with all applicable Federal laws (Code of Federal Regulations, Title 50 subchapter C) and to the extent practicable, consistent with applicable State laws.
- Field checks by refuge law enforcement officers will be planned and coordinated with staff and other agencies to maintain compliance with regulations and assess species and number harvested.
- Provide information about the Refuges' hunting program through signs, kiosks, brochures, and Complex's website (http://sacramentovalleyrefuges.fws.gov).
- No camping or tents are allowed on the Refuges.

Wildlife populations on the Refuges are able to sustain hunting and support other wildlife-dependent priority uses. To manage the populations to support hunting, the Refuges adopt harvest regulations set by the State within Federal framework guidelines.

By its very nature, hunting has very few positive effects on the target species while the activity is occurring. However, in our opinion, hunting has given many people a deeper appreciation of wildlife and a better understanding of the importance of conserving their habitat, which has ultimately contributed to the Refuge System mission. Furthermore, despite the potential impacts of hunting, a goal of the Sacramento, Delevan, Colusa, and Sutter Refuges is to provide visitors of all ages an opportunity to enjoy wildlife-dependent recreation. Of key concern is to offer a safe and quality program and to ensure adverse impacts remain at an acceptable level.

Recreational hunting will remove individual animals, but does not negatively affect wildlife populations. To assure that populations are sustainable, the California Fish and Game Commission, in consultation with the CDFG, annually review the population censuses to establish season lengths and harvest levels. Each year the refuge staff conducts habitat management reviews of each unit on the Complex to evaluate wildlife population levels, habitat conditions and public use activities. The areas closed to various hunting activities provide adequate sanctuaries for wildlife.

The Service believes that there will be minimal conflicts between hunters and the other wildlife-dependent recreational uses. The uses are not occurring on the same area at the same time.

The hunting program has been designed to avoid or minimize impacts anticipated to Refuge resources and Refuge visitors. The Refuges have requested Section 7 consultation with USFWS and NOAA-Fisheries on the Draft CCP/EA (USFWS 2008a) and its effects on any of the special status species/designated critical habitat occurring on the Refuges including: palmate-bracted bird's beak, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, giant garter snake, western yellow-billed cuckoo, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, fall-run Chinook salmon, and late fall-run Chinook salmon.

Anticipated Impacts of Uses on future lands within the approved boundary: The following conditions must be met before allowing existing uses to occur on newly acquired lands: (1) There is no indirect, direct, or cumulative threat anticipated to human health or safety; (2) There is no indirect, direct, or cumulative threat anticipated to natural or cultural resources; (3) The use is consistent with management of existing Sacramento, Delevan, Colusa, and Sutter Refuge lands and would contribute to achieving the Refuges' goals. In particular, existing Refuge regulations would not be compromised; (4) The newly acquired lands represent a meaningful unit within which to manage the activity; and (5) There are no anticipated conflicts with priority public uses.

Public Review and Comment: Public review and comments will be solicited in conjunction with distribution of the Draft CCP/EA for the Sacramento, Delevan, Colusa, and Sutter Refuges (USFWS 2008a).

Determination:

_____ Use is Not Compatible

__X__ Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

- Refuge Specific Regulations.
    - Hunting of Migratory Game Birds: We allow the hunting of geese, ducks, coots, moorhens, and snipe on designated areas of the refuge subject to the following conditions [for Sacramento Refuge (see regulations 1-13 below), Delevan Refuge (see regulations 1-13 below), Colusa Refuge (see regulations 4-13 below), and Sutter Refuge (see regulations 4-13 below)]:
        1. You must unload firearms while transporting them between parking areas and spaced blind areas.
        2. We do not allow snipe hunting in the spaced blind area.
        3. We restrict hunters to the spaced blind unit to within 100 feet (30 m) of their assigned hunt site except for retrieving downed birds, placing decoys, or traveling to and from the parking area.
        4. You may possess only approved nontoxic shot while in the field.
        5. You may possess no more than 25 shells while in the field.
        6. Access to the hunt area is by foot traffic only. We do not allow bicycles and other conveyances. Mobility-impaired hunters should consult the refuge manager for allowed conveyances.
        7. No person may build or maintain fires, except in portable gas stoves.
        8. You may enter or exit only at designated locations.
        9. Vehicles may stop only at designated parking areas. We prohibit the dropping of passengers or equipment or stopping between designated parking areas.
        10. We require dogs to be kept on a leash, except for hunting dogs engaged in authorized hunting activities and under the immediate control of a licensed hunter (see 50 CFR 26.21(b).*
        11. We do not allow cutting or removal of vegetation for blind construction or for making trails.*
        12. We allow only electric motors on boats used by hunters with disabilities.*
        13. Consumption or possession of an open container of alcohol within public areas on the Refuges is prohibited.*

        *Indicates a new regulation.

    - Upland Game Hunting: We allow hunting of pheasant on designated areas of the refuge subject to the following conditions [for Sacramento Refuge (see regulations 1-9 below), Delevan Refuge (see regulations 1-9 below), Colusa Refuge (see regulations 2-9 below), and Sutter Refuge (see regulations 2-9 below)]:

1. We do not allow pheasant hunting in the spaced blind and assigned pond areas except during a special 1 day only pheasant hunt on the first Monday after the opening of the State pheasant hunting season.
2. You may possess only approved nontoxic shot while in the field.
3. Access to the hunt area is by foot traffic only. We do not allow bicycles and other conveyances. Mobility-impaired hunters should consult the refuge manager for allowed conveyances.
4. You may possess no more than 25 shells while in the field.
5. No person may build or maintain fires, except in portable gas stoves.
6. You may enter or exit only at designated locations.
7. Vehicles may stop only at designated parking areas. We prohibit the dropping of passengers or equipment or stopping between designated parking areas.
8. We require dogs to be kept on a leash, except for hunting dogs engaged in authorized hunting activities and under the immediate control of a licensed hunter.*
9. Consumption or possession of an open container of alcohol within public areas is prohibited.*

*Indicates a new regulation.

- All hunting activities and operations will be reviewed annually to ensure compliance with all applicable laws, regulations, and policies.
- Population censuses will be reviewed annually with the CDFG to ensure that harvest from hunting is not unacceptably impacting the targeted populations. The program will be modified accordingly.
- Each year the Refuge staff will conduct habitat management reviews of each unit to evaluate wildlife population levels, habitat conditions and public use activities.
- Refuge specific hunting information will be available via signs, information panels, brochures and the website (http://sacramentovalleyrefuges.fws.gov).
- Refuge law enforcement officers will patrol, monitor, and collect data on hunting activities in the field to assure that it does not interfere with wildlife resources and other wildlife dependent uses on a weekly basis. The program will be modified accordingly.
- Dog training on the Refuges will not be allowed.
- Harvest will be recorded at each of the Refuges' check stations.

Justification: Hunting is a wildlife-dependent recreational use listed in the National Wildlife Refuge System Improvement Act. Providing a quality hunting program contributes to achieving one of the Refuges' goals (Goal 3, Objective 3.1, Chapter 4 of the CCP). By facilitating this use on the Refuges, we will increase the visitors' knowledge and appreciation of fish and wildlife, which may lead to increased public stewardship of wildlife and their habitats on the Refuges. Increased public stewardship will support and complement the Service's actions in achieving the Refuges' purposes and the mission of the National Wildlife Refuge System. Approximately 15,448 acres will be closed to hunting and 11,152 acres will be closed to all public use to ensure an adequate amount of high-quality feeding and resting habitat (USFWS 2008a).

Based upon impacts described in the Hunt Plan and the Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2008a,b), it is determined that hunting within the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, as described herein, will not materially interfere with or detract from the purposes for which the Refuges were established or the mission of the Refuge System. In our opinion, implementing the Hunt Plan and associated stipulations will not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the Refuges.

Mandatory Re-Evaluation Date (2023):

__X__ Mandatory 15-year Re-Evaluation, Date will be provided in Final EA/CCP (for priority public uses)

_____ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

_____ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

__X__ Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

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Refuge Determination

Prepared by: ______________________________ ____________

(Signature) (Date)

Wildlife Refuge Manager/
Project Leader
Approval: ______________________________ ____________

(Signature) (Date)

Concurrence

Refuge Supervisor: ______________________________ ____________

(Signature) (Date)

Assistant Regional
Director, Refuges: ______________________________ ____________

(Signature) (Date)

<u>COMPATIBILITY DETERMINATION</u>

(June 2008)

Use: Mosquito Monitoring and Control

Refuge Names: Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, located in Glenn, Colusa, and Sutter counties, California.

Establishing and Acquisition Authorities:
Sacramento National Wildlife Refuge (Refuge) was established in 1937. Legal authorities include: Executive Order 7562, February 27, 1937, Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Delevan Refuge was established in 1962. Legal authority includes: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d).

Colusa Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Sutter Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), and the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884).

Refuge Purpose(s):

Sacramento Refuge purposes include:

> "... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February 27, 1937
>
> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).
>
> "... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use

... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).

“... for the development, advancement, management, conservation, and protection of fish and wildlife resources ...” 16 U.S.C. 742f(a)(4) “... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ...” 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

Delevan Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

Colusa Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

Sutter Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

National Wildlife Refuge System Mission: “To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the

benefit of present and future generations of Americans" (National Wildlife Refuge System Administration Act of 1996, as amended [16 U.S.C. 668dd-ee]).

Description of Use: The proposed use is the implementation of mosquito monitoring and control activities requested and conducted by local mosquito control districts (Districts) within the Sacramento, Delevan, Colusa, and Sutter Refuges. These Districts include Glenn County Mosquito and Vector Control District (MVCD), Colusa Mosquito Abatement District, and Sutter-Yuba MVCD. This is not a wildlife-dependent public use. This represents an update of a compatibility determination approved in August 1994 (USFWS 1994).

The Districts have verbally informed the wildlife refuge manager of their desire to conduct mosquito monitoring and, if necessary, control activities in order to protect the public from any mosquito borne diseases. While mosquitoes are considered a nuisance because of their biting, some species are known vectors of serious diseases in California. There are primarily five mosquito species of concern potentially produced or harbored on the Refuges*: Aedes melanimon, Aedes nigromaculis, Aedes vexans, Culex tarsalis*, and *Anopheles freeborni*.

The main diseases of concern for mosquito control programs in northern California are Western Equine Encephalitis (WEE), St. Louis Encephalitis (SLE), California Encephalitis, West Nile Virus (WNV), and malaria (USFWS 2008b). *Culex tarsalis* is the main vector identified in the transmission of these diseases, with the exception of malaria, which is vectored by *Anopheles freeborni* mosquitoes. The other mosquito species listed above can also potentially transmit WEE, SLE, and WNV, but are less competent vectors compared to *C. tarsalis*. WEE and SLE have caused significant outbreaks of human disease (CA Dept. of Health Services 2003). Public concern over human health issues related to mosquito-borne disease has intensified on the west coast with the advance of WNV across the United States, and its detection in California in 2003.

Guidelines to address mosquito management have been developed for implementation on refuges in the Pacific Region (USFWS 2003), as well as similar guidance developed at the national level for the National Wildlife Refuge System (USFWS 2005a). At the local level, the Sacramento Refuge Complex (Complex) has a Draft Integrated Pest Management Plan for Mosquito Control (IPM Plan), initially developed in 1999, and updated to incorporate the above current regional and national policies. The proposed use would apply the principles in the IPM Plan incorporated herein by reference (USFWS 2008b).

The purposes of this IPM plan are to: 1) describe Refuge habitats and their role in the production or harborage of mosquitoes; 2) describe the use of approved mosquito control methods and materials in an IPM program that is consistent with the goals of the Complex, Department of Interior (DOI) and Service policy, and minimizes public health risk from Refuge-produced or harbored mosquitoes; 3) provide long-term planning to meet the Service's goal of using IPM to minimize effects of mosquito control on trust resources to the greatest extent possible; and 4) provide long-term planning to meet the Service's goals of reducing overall pesticide use on DOI trust resources to the greatest extent possible and using the least toxic options when pesticide use is deemed necessary. The IPM Plan outlines a risk-based, hierarchical approach to mosquito management adapted from national guidance (Figure 1). This approach uses an understanding of mosquito biology and ecology whereby intervention measures depend on continuous monitoring of mosquito populations.

The IPM approach ensures legitimate human, fish, and wildlife health concerns are addressed. It incorporates a combination of best management practices (BMPs) in managed wetlands (Kwasny et al. 2004), biological controls, and a select group of pesticides if warranted. Treatment thresholds (i.e. adult and larval mosquito population levels, and disease activity) and appropriate corresponding responses are identified (USFWS 2008b). Under this program, if mosquito population monitoring and disease surveillance indicate that human health thresholds are exceeded, the use of larvicides, pupicides, and/or adulticides may become necessary. In some cases, emergency actions may be required that are not addressed by this compatibility determination.

Mosquito monitoring and control is currently authorized on the Complex through Special Use Permits (SUP) and approved Pesticide Use Proposals (PUP), both of which are issued to the Districts on an annual basis. In addition, the Districts have received a copy of the most current IPM Plan. The SUP identifies permitted dates, access points and conditions, monitoring and data reporting requirements, treatment thresholds, approved PUPs, treatment notification requirements, and sensitive areas to be avoided. The SUP makes specific reference to the IPM Plan for many of these items. The PUPs identify specific mosquito control products approved for use on the Refuges, and include details on target pests, products applied, application dates, rates, methods, number of applications, site description, sensitive habitats and best management practices to avoid them. Because the U.S. Fish and Wildlife Service (Service) uses insecticides, herbicides and fungicides on national wildlife refuges a formal pesticide use review process is employed to ensure that all chemical pesticides approved for use have been reviewed for their potential impacts to groundwater, surface water and terrestrial and aquatic non-target vegetation and wildlife, including threatened and endangered species. Pesticides approved for use must be shown to pose the lowest toxicity-related threat to non-target terrestrial and aquatic ecosystems, while addressing the specific pest control objectives. Depending on the product, PUPs are reviewed and approved at the wildlife refuge manager, Regional Office, or Washington Office level.

Refuge and District staff meet annually to evaluate past and proposed mosquito management activities and to coordinate all necessary permitting and implementation planning required to conduct mosquito monitoring and control on the Complex for the upcoming year. During these meetings, Refuge and District staffs discuss ways to further minimize pesticide use on the Refuges, use the least toxic materials practicable, and identify research needs. As part of this coordination process, refuge staff provides District personnel with habitat management data and maps for the Refuges that identify planned habitat types, water management schedules, and locations of sensitive areas and species. District personnel are responsible for monitoring mosquitoes and are required to provide refuge staff with timely data collected on mosquito population trends and disease activity on the Refuge.

Mosquito monitoring and control is discussed in Chapter 3 of the Comprehensive Conservation Plan (CCP) and Environmental Assessment (EA) (USFWS 2008a) which are incorporated by reference. It is also detailed in the Draft IPM Plan (which is included as Appendix F of the CCP), which is also incorporated by reference (USFWS 2008b).

Availability of Resources: The following funding/annual costs (based on FY 2007 costs) would be required to administer and manage activities as described above:

	ANNUAL COSTS
Administration (Evaluation of applications, permit compliance, and monitoring)	$5,000
TOTAL	**$5,000**

Refuge operational funds are currently available through the Service budget process to administer this program.

Anticipated Impacts of Use: One of the major objectives of the Refuges is to provide high quality feeding areas for migratory birds and other wildlife; there is concern that mosquito control treatments may be interfering with that objective by reducing the existing food base. Effects on non-target organisms (i.e., those other than mosquitoes) can be loss of biomass, loss of diversity, interference with normal ecological relationships, bioaccumulation, or other unknown effects. Another concern is that rare insects and/or insects that may function as important pollinators for rare plants may be impacted by mosquito control treatments. Use of non-native biological controls such as mosquitofish may alter ecological relationships of native species.

Significant bioaccumulation has not been associated with any of the chemical treatments proposed in the IPM Plan. In a study conducted on Colusa and Sutter Refuges, researchers found no reductions in total abundance or biomass of aquatic macro-invertebrates in the treated (i.e., application of pyrethrin, permethrin, or malathion) or control fields (Lawler et al. 1997). Adult midges and some other flying insects experienced apparent short-term decreases, rebounding to pre-application levels within 24 hours. While this study provided encouraging information about adulticide use there are still some questions about their effects on refuge resources. This study focused on the effects of a single adulticide treatment. During most years, Colusa and Sutter Refuges, and the Butte Sink Wildlife Management Area receive multiple adulticide treatments, often weekly during the fall flood-up season. Effects of multiple applications may have cumulative effects not detected in the 1997 study. In addition, effects on smaller common invertebrates (i.e. cladocera, copepods) were not studied, but should be included in future research efforts, given their lower acute toxicity tolerances (Johnson and Finley 1980). Some of these questions are being addressed in a current research effort being conducted on Colusa Refuge by USFWS-Sacramento Contaminants Division and University of California-Davis. As results of this investigation become available, they will factor into the IPM process. Sub-lethal effects on non-target species have also not been studied in detail.

Mosquito monitoring includes regular visits by District personnel to sample mosquito larvae (dip counts) and adults (landing counts) in wetlands and adjacent areas. Mosquito monitoring will cause direct and indirect disturbance effects. Disturbance would include altering wildlife behavior and habitat use, and entering a number of wetland areas to collect mosquito samples. However, most of these effects would be short-term. The sampling interval would typically be once a week during May through October. Long-term effects would be eliminated/reduced because sufficient restrictions would be included as part of the SUP, and District activities would be monitored by refuge staff. Refuge staff would ensure that mosquito monitoring does not detract from the purposes of the Refuges, the mission of the National Wildlife Refuge System, and the need to maintain ecological integrity. Additionally, SUP conditions would include conditions to further ensure that impacts to wildlife and habitats are avoided and minimized.

Mosquito control will have minimal impact to public use activities on the Refuges. Using the approach identified in this determination and the IPM Plan, mosquito control will utilize the least toxic and the least amount of insecticide required to achieve mosquito control and public health protection objectives. Adulticide treatments will occur in evenings or early mornings when adult mosquitoes are active and refuge personnel and visitors are not present.

The Refuges have requested Section 7 consultation with USFWS and NOAA-Fisheries on the Draft CCP/EA (USFWS 2008) and its effects on any of the special status species/ designated critical habitat occurring on the Refuges including: palmate-bracted bird's beak, hairy orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, giant garter snake, western yellow-billed cuckoo, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, fall-run Chinook salmon, and late fall-run Chinook salmon.

Following the IPM approach, including the implementation of adequate monitoring, will lessen potential short-term, long-term, and cumulative impacts of mosquito control activities to acceptable levels. The annual PUP and SUP processes would continue to be used by the Complex staff.

Anticipated Impacts of Uses on future lands within the approved boundary: The following conditions must be met before allowing existing uses to occur on newly acquired lands: (1) There is no indirect, direct, or cumulative threat anticipated to human health or safety; (2) There is no indirect, direct, or cumulative threat anticipated to natural or cultural resources; (3) The use is consistent with management of existing Sacramento, Delevan, Colusa, and Sutter Refuge lands and would contribute to achieving the Refuges' goals. In particular, existing Refuge regulations would not be compromised; (4) The newly acquired lands represent a meaningful unit within which to manage the activity; and (5) There are no anticipated conflicts with priority public uses.

Public Review and Comment: Public review and comments will be solicited in conjunction with distribution of the Draft CCP/EA for the Sacramento, Delevan, Colusa, and Sutter Refuges (USFWS 2008a).

Determination:

_____ Use is Not Compatible

__X__ Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

1. All mosquito control activities proposed by the Districts are evaluated and authorized through an annual SUP, supported by the risk-based, hierarchical approach outlined in the IPM Plan (Figure 1).
2. The application of any mosquito control products are conducted in accordance with approved PUPs, which is referenced in the SUP.
3. The implementation of mosquito monitoring and control are conducted in accordance with Section 7 of the Endangered Species Act. The Refuges provide the Districts a map of sensitive areas and identifies measures to avoid them.
4. Districts are required to notify the wildlife refuge manager prior to any treatments or expected series of treatments, which can only occur after mosquito populations and virus activity levels exceed treatment thresholds as documented by monitoring data.
5. An annual report summarizing the mosquito control activities is provided to the wildlife refuge manager each year.
6. The Refuges will monitor District activities on the Refuges to ensure compliance with the Stipulations presented here and any additional conditions specified in the SUP, to ensure any impacts remain at an acceptable level.

Justification: Mosquito-borne disease issues are a real threat in the northern Central Valley. Mosquito management activities are controlled by a process that involves incorporating USFWS National and Regional Mosquito Guidance, the local IPM Plan, annual PUPs and SUPs, which would contribute towards a compatible program consistent with purposes of the Refuges and Refuge System mission. Appropriate safeguards are incorporated into the planning efforts to ensure that the level of mosquito control is commensurate with the associated public health risk. In particular, the above stipulations and those within the PUPs and SUPs will help to avoid or minimize any impacts to fish, wildlife, plants and their habitats along with the Refuges' ability to maintain the biological integrity, diversity, and environmental health of the Refuges. Any additional terms and conditions included in the SUP will be based, at least in part, on the results of monitoring efforts. If monitoring demonstrates an unacceptable impact to the Refuges' resources, this use will be reevaluated. Based upon impacts described in the IPM Plan, Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2008a), it is determined that mosquito management activities within the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, as described herein, will not materially interfere with or detract from the purposes for which the Refuges were established or the mission of the Refuge System. In our opinion, these mosquito management activities will not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the Refuges.

Refuge staff has also worked with local Districts on mosquito control at other Refuges within the Complex, in a manner consistent with this compatibility determination (USFWS 2005b).

This compatibility determination may need to be reevaluated in the event that a national policy for management of mosquitoes on National Wildlife Refuges is finalized.

Mandatory Re-Evaluation Date (2018):

_____ Mandatory 15-year Re-Evaluation, Date will be provided in Final EA/CCP (for priority public uses)

__X__ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

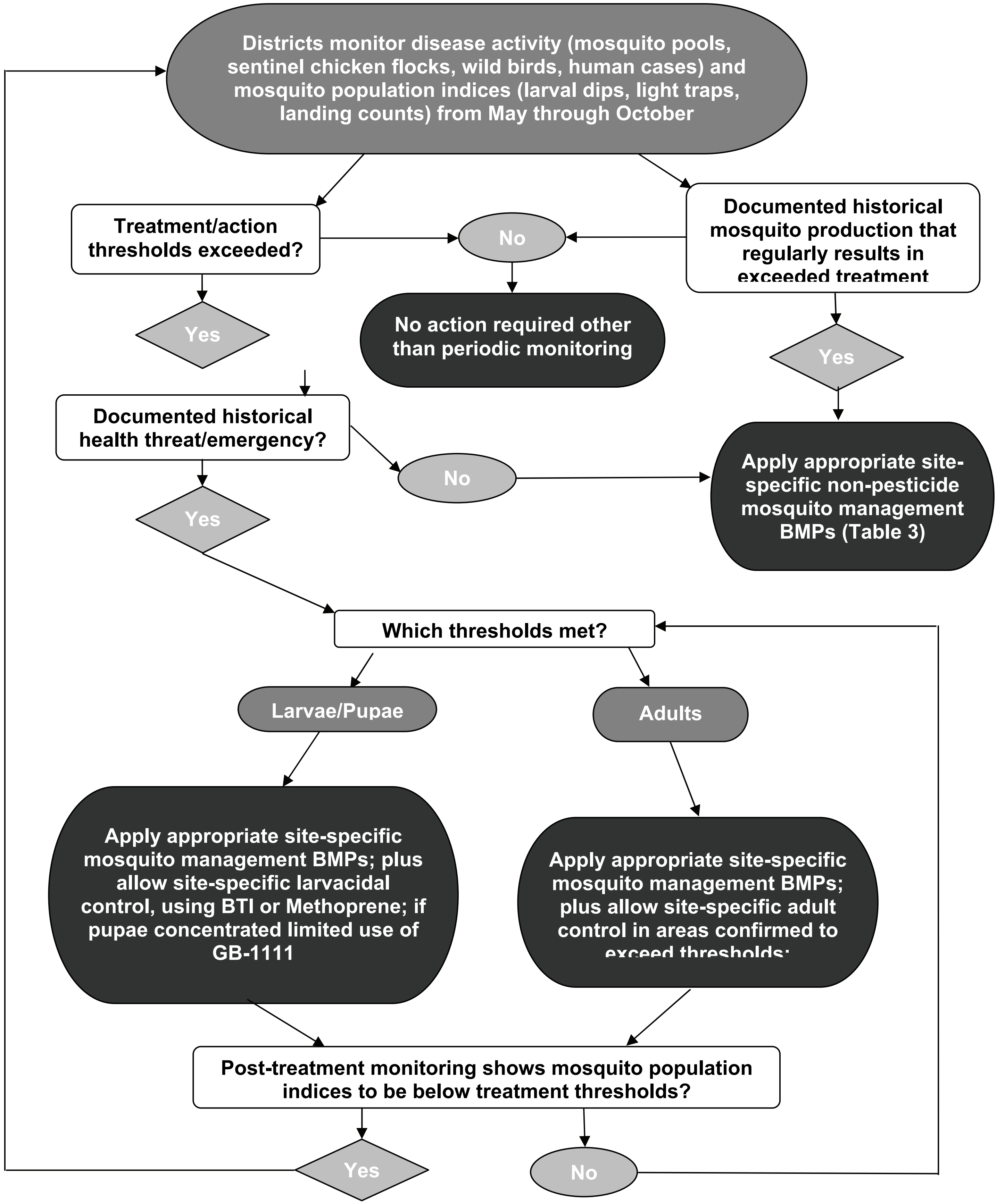
_____ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

__X__ Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

Figure 1. Decision-making process regarding mosquito control on an individual refuge at the Sacramento NWR Complex, adapted from Interim Guidance for Mosquito Management on National Wildlife Refuges, Table 1 (2005).



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Refuge Determination

Prepared by: ______________________________ __________
(Signature) (Date)

Wildlife Refuge Manager/
Project Leader
Approval: ______________________________ __________
(Signature) (Date)

Concurrence

Refuge Supervisor: ______________________________ __________
(Signature) (Date)

Assistant Regional
Director, Refuges: ______________________________ __________
(Signature) (Date)

COMPATIBILITY DETERMINATION
(June 2008)

Use: Plant Material Gathering

Refuge Name: Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, located in Glenn, Colusa, and Sutter Counties, California.

Establishing and Acquisition Authority(ies):
Sacramento National Wildlife Refuge (Refuge) was established in 1937. Legal authorities include: Executive Order 7562, February 27, 1937, Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Delevan Refuge was established in 1962. Legal authority includes: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d).

Colusa Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Sutter Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), and the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884).

Refuge Purpose(s):

Sacramento Refuge purposes include:

> "... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February 27, 1937.
>
> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. ¤ 1534 (Endangered Species Act of 1973).
>
> "... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use

... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).

“... for the development, advancement, management, conservation, and protection of fish and wildlife resources ...” 16 U.S.C. 742f(a)(4) “... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ...” 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

Delevan Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

Colusa Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

Sutter Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

National Wildlife Refuge System Mission: “To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the

benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use: Gathering of plants in and around Sacramento, Delevan, Colusa, and Sutter Refuges by Native Americans has occurred historically and continues to be a periodic use today. Plants are gathered for a variety of uses; for food, medicinal uses, ceremonial uses, and for artistic purposes such as basket weaving. Plants gathered for traditional uses may include: tule (*Schoenoplectus acutus*), cattail (*Typha* spp.), and other common species. The amount of plant material being harvested is traditionally small and is not expected to increase. The use of Refuge lands for plant gathering is important to Native American cultural groups.

In addition, native plant seeds may also be collected and propagated for use in habitat restoration activities on the Complex. Species may include salt grass (*Distichlis spicata*), gumweed (*Grindelia camporum*) and other common species.

A Special Use Permit (SUP) will be issued for all plant gathering/collection activities. SUPs will contain specific terms and conditions that the gatherer(s) must follow relative to activity, location, duration, seasonality, etc. to ensure continued compatibility. All Refuge rules and regulations must be followed unless otherwise provided in writing by Refuge management.

The proposed program is described in the Draft Comprehensive Conservation Plan (CCP) and associated Environmental Assessment (EA), which are incorporated by reference (USFWS 2008).

Availability of Resources: The following funding/annual costs (based on FY 2007 costs) would be required to administer and manage plant gathering activities as described above:

	Annual Costs
Administration	$1,000
TOTAL	**$1,000**

Anticipated Impacts of Use: Anticipated impacts to habitat and wildlife associated with plant gathering on the Refuges are expected to be minimal. The amount of plant material being harvested is very minor (<1 percent of any Refuge unit) and will have an insignificant impact on habitat. Cuttings from perennial plant species are typically requested, which result in no plant mortality. In addition, cuttings are usually harvested from areas that are identified for thinning. No rare or sensitive species will be gathered.

The level of disturbance to wildlife is also minor and long-term effects would be negligible because conditions of SUPs would ensure that impacts, such as disturbance to wildlife and habitats, are avoided or minimized. Areas used will be closely monitored to evaluate the impacts on the resource; if adverse impacts appear, the activity may be moved to secondary locations or eliminated entirely.

While the activity of gathering may have short-term impacts on individual plants and wildlife, no adverse long-term impacts on wildlife or plant populations are anticipated. This activity should not result in short- or long-term impacts that adversely affect the purposes of the Refuges or the mission of the National Wildlife Refuge System.

Plant gathering on the Refuges has been designed to avoid or minimize impacts anticipated to the Refuges' resources and visitors. The Refuges have requested Section 7 consultation with USFWS and NOAA-Fisheries on the Draft CCP/EA (USFWS 2008) and its effects on any of the special status species/designated critical habitat occurring on the Refuges including: palmate-bracted bird's beak, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, giant garter snake, western yellow-billed cuckoo, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, fall-run Chinook salmon, and late fall-run Chinook salmon.

Anticipated Impacts of Uses on future lands within the approved boundary: The following conditions must be met before allowing existing uses to occur on newly acquired lands: (1) There is no indirect, direct, or cumulative threat anticipated to human health or safety; (2) There is no indirect, direct, or cumulative threat anticipated to natural or cultural resources; (3) The use is consistent with management of existing Sacramento, Delevan, Colusa, and Sutter Refuge lands and would contribute to achieving the Refuges' goals. In particular, existing Refuge regulations would not be compromised; (4) The newly acquired lands represent a meaningful unit within which to manage the activity; and (5) There are no anticipated conflicts with priority public uses.

Public Review and Comment: Public review and comments will be solicited in conjunction with distribution of the Draft CCP/EA for the Sacramento, Delevan, Colusa, and Sutter Refuges.

Determination:

_____ Use is Not Compatible

__X__ Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

- Access to the Refuges is allowed from one hour before sunrise to one hour after sunset.

- A special use permit (SUP) will be issued for all plant gathering activities. SUPs will contain specific terms and conditions that the gatherer(s) must follow relative to activity, location, duration, seasonality, etc. to ensure continued compatibility. All Refuge rules and regulations must be followed unless otherwise excepted in writing by Refuge management.

- Areas used will be closely monitored to evaluate the impacts on the resource; if adverse impacts appear, the activity may be moved to secondary locations or eliminated.

Justification: Though plant gathering is not a wildlife-dependent recreational use, it is an activity that contributes to environmental education and awareness. The stipulations outlined above should minimize potential impacts relative to wildlife/human interactions. Based upon impacts described in the Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2008), it is determined that plant gathering within the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges as described herein, will not materially interfere with or detract from the purposes for which the Refuges were established or the mission of the Refuge System. In our opinion, implementing the plant gathering and associated stipulations will not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the Refuges.

Mandatory Re-Evaluation Date (2018):

_____ Mandatory 15-year Re-Evaluation, Date will be provided in Final EA/CCP (for priority public uses)

__X__ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

_____ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

__X__ Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

References

U.S. Fish and Wildlife Service. 2008. Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges Draft Comprehensive Conservation Plan and Environmental Assessment. Region 8. Sacramento, CA.

Refuge Determination

Prepared by: ______________________________ __________
(Signature) (Date)

Wildlife Refuge Manager/
Project Leader
Approval: ______________________________ __________
(Signature) (Date)

Concurrence

Refuge Supervisor: ______________________________ __________
(Signature) (Date)

Assistant Regional
Director, Refuges: ______________________________ __________
(Signature) (Date)

COMPATIBILITY DETERMINATION
(June 2008)

Use: Research

Refuge Name: Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, located in Glenn, Colusa, and Sutter Counties, California.

Establishing and Acquisition Authority(ies):
Sacramento National Wildlife Refuge (Refuge) was established in 1937. Legal authorities include: Executive Order 7562, February 27, 1937, Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Delevan Refuge was established in 1962. Legal authority includes: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d).

Colusa Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Sutter Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), and the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884).

Refuge Purpose(s):

Sacramento Refuge purposes include:

> "... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February 27, 1937
>
> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).
>
> "... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use

... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).

“... for the development, advancement, management, conservation, and protection of fish and wildlife resources ...” 16 U.S.C. 742f(a)(4) “... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ...” 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

Delevan Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

Colusa Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

Sutter Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

National Wildlife Refuge System Mission: “To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the

benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use: Two provisions of the National Wildlife Refuge Improvement Act are to "maintain biological integrity, diversity and environmental health" and to conduct "inventory and monitoring." Research investigations are designed to address these provisions by answering specific management questions. These include, but are not limited to, evaluation of vegetation and wildlife response to habitat management techniques, wildlife and plant population monitoring, documentation of seasonal wildlife movements and habitat use, wildlife disease investigations, and development of invasive species management techniques. Pertinent results from research investigations are incorporated into management plans and actions, and help strengthen the decision-making process. The proposed research program is discussed in detail as part of the Proposed Action in the Draft Comprehensive Conservation Plan (CCP) and associated Environmental Assessment (EA), which are incorporated by reference (USFWS 2008).

Sacramento Refuge Complex receives numerous requests each year to conduct scientific research at the Refuges. The Refuges issue Special Use Permits (SUP) for approved research and monitoring projects. SUPs would only be issued for monitoring and investigations, which contribute to the enhancement, protection, preservation, and management of native Refuge plant and wildlife populations and their habitats. Research applicants are required to submit a proposal that outlines: (1) objectives of the study; (2) justification for the study; (3) detailed methodology and schedule; (4) potential impacts on Refuge wildlife or habitat, including disturbance (short and long term), injury, or mortality (this includes a description of measures the researcher will take to reduce disturbance or impacts); (5) research personnel required; (6) costs to Refuge, if any; and (7) progress reports and end products (i.e., reports, thesis, dissertations, publications). Research proposals are reviewed by refuge staff, and if approved, a SUP is issued by the wildlife refuge manager to formally authorize any project.

Evaluation criteria will include, but not be limited to, the following:

- Research that will contribute to specific Refuge management issues will be given higher priority over other research requests.

- Research that will conflict with other ongoing research, monitoring, or management programs will not be granted.

- Research projects that can be accomplished off-Refuge are less likely to be approved.

- Research, which causes undue disturbance or is intrusive will likely not be granted. Level and type of disturbance will be carefully evaluated when considering a request. Suggestions may be made to adjust the location, timing, scope, number of permittees, study methods, number of study sites, etc.

- If staffing or logistics make it impossible for the Refuge to monitor researcher activity in a sensitive area, the research request may be denied.

- The length of the project will be considered and agreed upon before approval. Projects will be reviewed annually.

Availability of Resources: The following funding/annual costs (based on FY 2007 costs) would be required to administer and manage research activities as described above:

	Annual Costs
Administration (Evaluation of applications, management of permits, and monitoring of research projects)	$5,000
TOTAL	**$5,000**

Refuge operational funds are currently available through the Service budget process to administer this program.

Anticipated Impacts of Use: Conducting management-oriented research will benefit Refuge fish, wildlife, plant populations, and their habitat. Monitoring and research investigations will be designed to answer habitat or population management questions, thereby contribute to adaptive management of the Complex. An expected short-term effect of monitoring and research investigations is that Refuge management activities would be modified to improve habitat and wildlife populations, as a result of new information. Expected long-term and cumulative effects include a growing body of science-based data and knowledge from which to draw upon to implement the best Refuge management possible. Natural resources inventory, monitoring and research are necessary tools towards maintaining biological integrity and diversity and environmental health. Information gained from well-thought out research will improve habitat and wildlife populations.

Some negative direct and indirect effects would occur through disturbance, which is expected with some research activities, especially where researchers are entering sanctuaries. Researcher disturbance would include altering wildlife behavior, going off designated trails, collecting soil and plant samples, or trapping and handling wildlife. However, most of these effects would be short-term because only the minimum of samples (e.g., water, soils, vegetative litter, plants, macroinvertebrates) required for identification and/or experimentation and statistical analysis would be permitted and captured and marked wildlife would be released. Long-term effects would be negligible because Refuge evaluation of research proposals and conditions of SUPs would ensure that impacts, such as disturbance, to wildlife and habitats are avoided or minimized. Refuge staff would ensure research projects contribute to the enhancement, protection, preservation, and management of native Refuge wildlife populations and their habitats thereby helping the Refuge fulfill the purposes for which it was established and the mission of the National Wildlife Refuge System.

The Refuges have requested Section 7 consultation with USFWS and NOAA-Fisheries on the Draft CCP/EA (USFWS 2008) and its effects on any of the special status species/designated critical habitat occurring on the Refuges including: palmate-bracted bird's beak, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, giant garter snake, western yellow-billed cuckoo, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, fall-run Chinook salmon, and late fall-run Chinook salmon.

Anticipated Impacts of Uses on future lands within the approved boundary: The following conditions must be met before allowing existing uses to occur on newly acquired lands: (1) There is no indirect, direct, or cumulative threat anticipated to human health or safety; (2) There is no indirect, direct, or cumulative threat anticipated to natural or cultural resources; (3) The use is consistent with management of existing Sacramento, Delevan, Colusa, and Sutter Refuge lands and would contribute to achieving the Refuges' goals. In particular, existing Refuge regulations would not be compromised; (4) The newly acquired lands represent a meaningful unit within which to manage the activity; and (5) There are no anticipated conflicts with priority public uses.

Public Review and Comment: Public review and comments will be solicited in conjunction with distribution of the Draft CCP/EA for the Sacramento, Delevan, Colusa, and Sutter Refuges (USFWS 2008).

Determination: This program as described is determined to be compatible. Potential impacts of research activities on Refuge resources will be minimized because sufficient restrictions and safeguards would be included in the SUP and research activities will be monitored by the refuge manager and biologist. The refuge manager and biologist would ensure that proposed monitoring and research investigations would contribute to the enhancement, protection, conservation, and management of native Refuge wildlife populations and their habitats thereby helping the Refuges fulfill the purposes for which they were established, the mission of the National Wildlife Refuge System, and the need to maintain ecological integrity, diversity, and environmental health.

_____ Use is Not Compatible

__X__ Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:
The criteria for evaluating a research proposal, outlined in the Description of Use section above, will be used when determining whether a proposed study will be approved on the

Refuges. If proposed research methods are evaluated and determined to have potential adverse impacts on Refuge wildlife or habitat, then the Refuges would determine the utility and need of such research to conservation and management of Refuge wildlife and habitat. If the need was demonstrated by the research permittee and accepted by the Refuges, then measures to minimize potential impacts (e.g., reduce the numbers of researchers entering an area, restrict research in specified areas) would be developed and included as part of the study design and on the SUP. SUPs will contain specific terms and conditions that the researcher(s) must follow relative to activity, location, duration, seasonality, etc. to ensure continued compatibility. All Refuge rules and regulations must be followed unless otherwise accepted in writing by Refuge management.

Refuge staff will monitor researcher activities for potential impacts to the Refuges and for compliance with conditions on the SUPs. Research activities will be modified to avoid harm to sensitive wildlife and habitat when unforeseen impacts arise. The refuge manager may determine that previously approved research and SUPs be terminated due to observed impacts. The refuge manager will also have the ability to cancel a SUP if the researcher is out of compliance with the conditions of the SUP.

Justification: This program as described is determined to be compatible. Based upon impacts described in the Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2008), it is determined that research within the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, as described herein, will not materially interfere with or detract from the purposes for which the Refuges were established or the mission of the Refuge System. In fact, well-designed research investigations will directly benefit and support refuge goals, objectives and management plans and activities. Fish, wildlife, plants and their habitat will improve through the application of knowledge gained from monitoring and research. Biological integrity, diversity and environmental health would benefit from scientific research conducted on natural resources at the Refuges. The wildlife-dependent, priority public uses (wildlife viewing and photography, environmental education and interpretation, fishing and hunting) would also benefit as a result of increased biodiversity and wildlife and native plant populations from improved restoration and management plans and activities associated with monitoring and research investigations which address specific restoration and management questions.

<u>Mandatory Re-Evaluation Date</u> (2018):

_____ Mandatory 15-year Re-Evaluation, Date will be provided in Final EA/CCP (for priority public uses)

__X__ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

<u>NEPA Compliance for Refuge Use Decision</u> (check one below):

_____ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

__X__ Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

References

U.S. Fish and Wildlife Service. 2008. Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges Draft Comprehensive Conservation Plan and Environmental Assessment. Region 8. Sacramento, CA.

Refuge Determination

Prepared by: ______________________________ __________
(Signature) (Date)

Wildlife Refuge Manager/
Project Leader
Approval: ______________________________ __________
(Signature) (Date)

Concurrence

Refuge Supervisor: ______________________________ __________
(Signature) (Date)

Assistant Regional
Director, Refuges: ______________________________ __________
(Signature) (Date)

COMPATIBILITY DETERMINATION
(June 2008)

Use: Wildlife Observation and Photography

Refuge Name: Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, located in Glenn, Colusa, and Sutter Counties, California.

Establishing and Acquisition Authority(ies):
Sacramento National Wildlife Refuge (Refuge) was established in 1937. Legal authorities include: Executive Order 7562, February 27, 1937, Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Delevan Refuge was established in 1962. Legal authority includes: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d).

Colusa Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Sutter Refuge was established in 1945. Legal authorities include: Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d), Lea Act of 1948 (16 U.S.C. 695), and the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884).

Refuge Purpose(s):

Sacramento Refuge purposes include:

> "... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February 27, 1937.
>
> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. ¤ 1534 (Endangered Species Act of 1973).
>
> "... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use

... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).

“... for the development, advancement, management, conservation, and protection of fish and wildlife resources ...” 16 U.S.C. 742f(a)(4) “... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ...” 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

Delevan Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

Colusa Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

Sutter Refuge purposes include:

“... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.” 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

“... for the management and control of migratory waterfowl and other wildlife ...” 16 U.S.C. 695 (Lea Act of 1948).

“... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ...” 16 U.S.C. 1534 (Endangered Species Act of 1973).

National Wildlife Refuge System Mission: “To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the

benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use: The National Wildlife Refuge System Improvement Act of 1997 identifies wildlife observation and photography as well as hunting, fishing, interpretation, and environmental education as priority wildlife-dependent public uses for refuges. As two of the six priority public uses of the Refuge System, these uses are to be encouraged when compatible with the purposes of the refuges. Wildlife observation and photography are considered simultaneously in this compatibility determination. Many elements of the wildlife observation and photography programs are also similar to opportunities provided in the environmental education and interpretation programs. These uses are described in the Draft Comprehensive Conservation Plan (CCP) and Environmental Assessment (EA) (USFWS 2008) and are incorporated by reference.

The guiding principles of the Refuge System's wildlife observation and wildlife photography programs (Service Manual 605 FW 4 and 5) are to:

- Provide safe, enjoyable, and accessible wildlife viewing opportunities and facilities.
- Promote visitor understanding of, and increase visitor appreciation for, America's natural resources.
- Provide opportunities for quality recreational and educational experiences consistent with criteria describing quality found in Service Manual 605 FW 1.6.
- Minimize conflicts with visitors participating in other compatible wildlife-dependent recreation activities.

Wildlife observation and photography conducted on portions of the Refuges open to the general public do not require a special use permit (SUP). These areas are open one hour before sunrise to one hour after sunset on all Refuges.

<u>Wildlife Observation</u>
The wildlife observation objective of the Draft CCP states that the Refuges will provide 100,000 wildlife observation annual visits by 2023. A portion of the hunt area (2,275 acres) will be open for wildlife observation from February through June on Sacramento, Colusa, and Sutter Refuges.

Sacramento Refuge is open to the public for wildlife observation and photography daily along the auto tour route and trails from one hour before sunrise to one hour after sunset year-round. The six-mile auto tour route meanders along marshes and riparian areas of Logan Creek. There are two park and stretch areas on the auto tour route where visitors are encouraged to get out of their vehicles to view wildlife. At the first park-and-stretch area halfway along the auto tour route, there is a three-tier wildlife viewing platform with two spotting scopes. The two-mile walking trail also meanders along marshes and riparian areas of Logan Creek. Using the Wetlands Walk Guide, groups may stroll by the fourteen stops for an hour long adventure. If time is limited, visitors may take alternate trail shortcut routes.

Delevan Refuge is open to the public for wildlife observation and photography along perimeter roads only. A primitive off-refuge parking area is currently available for visitors along Maxwell Road on the southern boundary of the Refuge. Construction of a viewing platform and other improvements to this site are planned. An additional parking area and viewing platform along Four Mile Road is also planned.

On Colusa Refuge, visitors enjoy wildlife viewing and photography as they drive the three-mile, graveled auto tour route adjacent to wetlands. A one-mile walking trail is located along a lush riparian slough. The auto tour route and trail are open one hour before sunrise to one hour after sunset year-round. The walking trail will be upgraded to provide for universal access and the wildlife viewing blind will be replaced with a universally accessible blind and boardwalk.

Roads adjacent to Sutter Refuge provide the public with opportunities for wildlife observation throughout the year. In addition, scheduled guided tours on the southern portion of the Refuge will be conducted during February through June when staff and funding are available. In addition, a walking trail utilizing the existing roads will be constructed.

<u>Photography</u>
The photography objective of the Draft CCP states that the Refuges will provide 80 photography blind annual visits and 10,000 annual photography visits by 2023. This includes photographic opportunities from the auto tours, walking trails, and photography blinds. A portion of the hunt area (2,275 acres) is open for photography from February through June on Sacramento, Colusa, and Sutter Refuges. The in-ground, concrete hunting blinds in this area on Sacramento Refuge are available for photographic use from February through June with no user fees or reservations required.

The best time of year for photography occurs from November through February when a variety of waterfowl is present. The auto tour routes and walking trails on Sacramento and Colusa Refuges provide excellent photographic opportunities. The viewing blind on the Discovery Trail at Colusa Refuge will be replaced with a universally accessible blind and boardwalk.

There are two photography blinds on Sacramento Refuge (Blinds 1 and 2) and one on Colusa Refuge (Blind 3). A universally accessible photography blind will be constructed at Delevan Refuge (Blind 4). The blinds are approximately 300 yards within the wetlands. They are approximately 4.5' x 6' wide and 5' high. They have adjustable camera size openings in three sides. The blinds accommodate one person comfortably; however, two people at a time are allowed. There is one chair in each blind. Islands or tree snags and islands have been placed to encourage birds to perch or rest about 40 feet from the blind.

Photography Blind 2 on Sacramento Refuge will be replaced with a universally accessible blind and boardwalk.

Photography blind use will be limited to one day (Wednesdays through Sundays) each week from October through March. Limiting use promotes continued bird use of the surrounding areas, and thereby improving the potential for good photography opportunities.

Lottery:
Photographers may apply through a lottery system, for up to three reservations annually. Photographers will be assigned up to three reservations in an August lottery. Then, depending on availability, reservations will be assigned by a first-come, first-serve process.

Lottery Process:
- The lottery is held in August (applications must be received between August 1-31).
- Photographers may select up to 10 date/blind combinations in priority order [e.g. Choice 1: Dec. 17, 2008 – Blind 1, Choice 2: Dec. 17 – Blind 3, Choice 3: Nov. 12 – Blind 1, etc.], including the option to be on a blind waiting list (indicate which week or month and blind is desired).
- All reservation applications are randomly drawn and assigned a number, which indicates the order in which the reservations will be processed.
- The reservations are then processed in numerical order by reserving the remaining highest priority of date/blind choice available for all of the reservation applicants.
- After all of the applicants have received one reservation, the blind assignment continues until all applicants receive their next priority date of choice.

First come, first serve process:
Photographers that missed the lottery will fill any remaining dates by a first-come, first-serve process.

Waiting list:
In addition, there is a blind waiting list that is used to refill blinds when there are reservation cancellations.

Fees:
The photography blind fee has two required components:
- Purchase of a Refuge entrance pass (Refuge Day Pass or Refuge Annual Pass is required by all photographers who do not possess either a Federal Duck Stamp, Golden Eagle, Golden Age, Golden Access or America the Beautiful Pass).
- A non-refundable $15 fee per photography blind visit.

For photographers participating in the lottery, the fee is due by October 1.

For photographers participating in the first come, first serve or in the waiting list, the reservations are confirmed when the photography blind fee is paid prior to the visit.

Some of the photography blinds may also be available for use from April through June when habitat is suitable. Inquiries about availability should be directed to Sacramento National Wildlife Refuge Complex, 752 County Road 99W, Willows, CA 95988 (530/934-2801).

Photographers also complete a blind evaluation that reports photographed species, time spent, and comments. Photographers must be in the blind at least one hour before sunrise. They must park in the designated parking area and proceed directly to the assigned blind on foot. Stakes with reflective tape mark the route from the parking area to the blind. The route is designed to minimize disturbance; therefore, deviation from the staked route is not allowed. Photographers may leave the blind at any time, but once the blind has been vacated, returning to the blind is not permitted.

Availability of Resources: The following funding/annual costs (based on FY 2007 costs) would be required to administer and manage wildlife observation and photography activities as described above:

	One-Time Costs	Annual Costs
New Construction		
Improve Maxwell Road parking area including viewing platform (Delevan)	$102,200	
Obtain Wayside Exhibit materials for viewing platform (Delevan)	$ 94,600	
Construct parking area and viewing platform along 4-Mile Road (Delevan)	$ 80,000	
Construct universally accessible photography blind including boardwalk (Sacramento)	$ 33,100	
Construct universally accessible photography blind including boardwalk (Delevan)	$ 18,000	
Replace wildlife observation blind with an accessible blind and boardwalk (Colusa)	$ 75,000	
Predicted Maintenance of Facilities		
Modifications in hunt areas for spring-summer use (e.g. signs, parking lot modifications, etc.)	$ 30,000	

(Sacramento, Colusa and Sutter)		
Renovate existing trails for universal access (Sacramento)	$116,000	
Renovate existing trail for universal access (Colusa)	$ 75,000	
Regular maintenance of kiosks, auto tours, viewing platforms, photography blinds, trails, restrooms, etc.		$ 20,000
Equipment, vehicles, and supplies (e.g. brochures, etc.)		$ 22,000
New Staffing		
One full-time (1.0 FTE) WG-6 tractor operator		$ 54,431
One full-time (1.0 FTE) WG-8 maintenance worker		$ 62,895
TOTAL	**$623,900**	**$159,326**

Additional funds would be required to operate and maintain the programs. Funding will be sought through the Service budget process. User fees are collected for photography blind use, commercial photography activities and for issuing special use permits (SUPs). Other sources will be sought through strengthened partnerships, grants, and additional refuge operations funding to support a safe and quality program as described above.

User fees are collected for issuing SUPs for access to closed areas or other special considerations (e.g. access to the Refuges after normal public visitation hours, setting up temporary photography blinds, etc.) (16 USC 460I-6d, Refuge Manual 8 RM 16). The standard fee for noncommercial photography and wildlife observation is $50 per year. The standard fee for commercial photography is $100 per year. This category applies to any photography that result in images that are intended for sale, or where the photographer is otherwise paid for the work by salary or contract. The standard fee for commercial tours is $150. A SUP and fee (other than daily Refuge entrance fees at the Sacramento Refuge and photo blind use fees, if appropriate) is not required when the use is conducted in areas and facilities that are open to the general public. If any special attention (such as transportation, access to restricted areas, food, lodging, or guide service) is provided by the refuge staff, these costs will be added to the standard fee for the SUP (USFWS 1992).

Anticipated Impacts of Use: Once considered "non-consumptive", it is now recognized that wildlife observation and wildlife photography can negatively impact wildlife by altering wildlife behavior, reproduction, distribution, and habitat (Purdy et al. 1987, Knight and Cole 1995).

Purdy et al. (1987) and Pomerantz et al. (1988) described six categories of impacts to wildlife as a result of visitor activities. They are:

1) Direct mortality: immediate, on-site death of an animal;
2) Indirect mortality: eventual, premature death of an animal caused by an event or agent that predisposed the animal to death;
3) Lowered productivity: reduced fecundity rate, nesting success, or reduced survival rate of young before dispersal from nest or birth site;
4) Reduced use of refuge: wildlife not using the refuge as frequently or in the manner they normally would in the absence of visitor activity;
5) Reduced use of preferred habitat on the refuge: wildlife use is relegated to less suitable habitat on the refuge due to visitor activity; and
6) Aberrant behavior/stress: wildlife demonstrating unusual behavior or signs of stress likely to result in reduced reproductive or survival rates.

Individual animals may be disturbed by human contact to varying degrees. Human activities on trails can result in direct effects on wildlife through harassment, a form of disturbance that can cause physiological effects, behavioral modifications, or death (Smith and Hunt 1995). Many studies have shown that birds can be impacted from human activities on trails when they are disturbed and flushed from feeding, resting, or nesting areas. Flushing, especially repetitive flushing, can strongly impact habitat use patterns of many bird species. Flushing from an area can cause birds to expend more energy, be deterred from using desirable habitat, affect resting or feeding patterns, and increase exposure to predation or cause birds to abandon sites with repeated disturbance (Smith and Hunt 1995). Migratory birds were observed to be more sensitive than resident species to disturbance (Klein 1989).

Herons and shorebirds were observed to be the most easily disturbed (when compared to gulls, terns and ducks) by human activity and flushed to distant areas away from people (Burger 1981). A reduced number of shorebirds were found near people who were walking or jogging, and about 50 percent of flushed birds flew elsewhere (Burger 1981). In addition, the foraging time of sanderlings decreased and avoidance (e.g., running, flushing) increased as the number of humans within 100 meters increased (Burger and Gochfeld 1991). Nest predation for songbirds (Miller et al. 1998), raptors (Glinski 1976), colonial nesting species (Buckley and Buckley 1976), and waterfowl (Boyle and Samson 1985) tends to increase in areas more frequently visited by people. In addition, for many passerine species, primary song occurrence and consistency can be impacted by a single visitor (Gutzwiller et al. 1994). In areas where primary song was affected by disturbance, birds appeared to be reluctant to establish nesting territories (Reijnen and Foppen 1994).

Depending on the species (especially migrants vs. residents), some birds may habituate to some types of recreation disturbance and either are not disturbed or will immediately return after the initial disturbance (Hockin et al. 1992; Burger et al. 1995; Knight and Temple 1995; Madsen 1995; Fox and Madsen 1997). Rodgers and Smith (1997) calculated buffer distances that minimize disturbance to foraging and loafing birds based on experimental flushing distances for 16 species of waders and shorebirds. They recommended 100 meters as an adequate buffer against pedestrian traffic, however, they suggest this distance may be reduced if physical barriers (e.g., vegetation screening) are provided, noise levels are reduced, and traffic is directed tangentially rather than directly toward birds. Screening may not effectively buffer noise impacts, thus visitors should be educated on the effects of noise and noise restrictions should be enforced (Burger 1981, 1986; Klein 1993; Bowles 1995; Burger and Gochfeld 1998). Seasonally restricting or prohibiting recreation activity may be necessary during spring and fall migration to alleviate disturbance to migratory birds (Burger 1981, 1986; Boyle and Samson 1985; Klein et al. 1995; Hill et al. 1997).

Of the wildlife observation techniques, wildlife photographers tend to have the largest disturbance impacts (Klein 1993, Morton 1995, Dobb 1998). While wildlife observers frequently stop to view species, wildlife photographers are more likely to approach wildlife (Klein 1993). Even slow approach by wildlife photographers tends to have behavioral consequences to wildlife species (Klein 1993). Other impacts include the potential for photographers to remain close to wildlife for extended periods of time, in an attempt to habituate the wildlife subject to their presence (Dobb 1998) and the tendency of casual photographers, with low-power lenses, to get much closer to their subjects than other activities would require (Morton 1995), including wandering off trails. This usually results in increased disturbance to wildlife and habitat, including trampling of plants. Klein (1993) recommended that refuges provide observation and photography blinds to reduce disturbance of waterbirds when approached by visitors.

Education helps make visitors aware that their actions can have negative impacts on birds, and will increase the likelihood that visitors will abide by restrictions on their actions. For example, Klein (1993) demonstrated that visitors who had spoken with refuge staff or volunteers were less likely to disturb birds. Increased surveillance and imposed fines may also help reduce visitor caused disturbance (Knight and Gutzwiller 1995). Monitoring is recommended to adjust management techniques over time, particularly because it is often difficult to generalize about the impacts of specific types of recreation in different environments. Local and site-specific knowledge is necessary to determine effects on birds and to develop effective management strategies (Hockin et al. 1992; Klein et al. 1995; Hill et al. 1997).

The construction and maintenance of boardwalks/trails and parking lots will have minor impacts on soils and vegetation around the trails. This could include an increased potential for erosion, soil compaction (Liddle 1975), reduced seed emergence (Cole and Landres 1995), alteration of vegetative structure and composition, and sediment loading (Cole and Marion 1988). However, the construction of boardwalks will concentrate the foot traffic, allowing the vegetation surrounding them to remain undisturbed.

Disturbance of wildlife is the primary concern regarding these uses. Disturbance to wildlife, such as the flushing of feeding, resting, or nesting birds, is inherent to these activities. There is some temporary disturbance to wildlife due to human activities on trails (hiking, bird watching) however, the disturbance is generally localized and will not adversely impact overall populations. Increased facilities and visitation would cause some displacement of habitat and increase some disturbance to wildlife, although this is expected to be minor given the size of the Refuges and by avoiding or minimizing intrusion into important wildlife habitat.

The wildlife observation and photography programs are designed to avoid or minimize impacts anticipated to the Refuges' resources and visitors. The Refuges have requested Section 7 consultation with USFWS and NOAA-Fisheries on the Draft CCP/EA (USFWS 2008) and its effects on any of the special status species/designated critical habitat occurring on the Refuges including: palmate-bracted bird's beak, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, giant garter snake, western yellow-billed cuckoo, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, fall-run Chinook salmon, and late fall-run Chinook salmon.

Anticipated Impacts of Uses on future lands within the approved boundary: The following conditions must be met before allowing existing uses to occur on newly acquired lands: (1) There is no indirect, direct, or cumulative threat anticipated to human health or safety; (2) There is no indirect, direct, or cumulative threat anticipated to natural or cultural resources; (3) The use is consistent with management of existing Sacramento, Delevan, Colusa, and Sutter Refuge lands and would contribute to achieving the Refuges' goals. In particular, existing Refuge regulations would not be compromised; (4) The newly acquired lands represent a meaningful unit within which to manage the activity; and (5) There are no anticipated conflicts with priority public uses.

Public Review and Comment: Public review and comments will be solicited in conjunction with distribution of the Draft CCP/EA for the Sacramento, Delevan, Colusa, and Sutter Refuges (USFWS 2008).

Determination:

_____ Use is Not Compatible

__X__ Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

- Adequate areas are designated as wildlife sanctuary with no or limited public use activities to provide high quality habitat for feeding, resting, and nesting.

- Regulations and wildlife friendly behavior (e.g., requirements to stay on designated trails, dogs must be kept on leash, etc.) are described in brochures and posted at the visitor center.

- Refuge visitors are required to remain in vehicles while on the auto tour routes except at designated park and stretch locations.

- Visitor Services Assistants routinely monitor the auto tour route and walking trail on Sacramento Refuge for refuge regulation compliance.

- Refuge biologists and public use specialists conduct regular surveys of public activities on the Refuges. The data is analyzed and used by the refuge manager to develop future modifications if necessary to ensure compatibility of the wildlife observation and photography programs.

- Access to the Refuges is allowed from one hour before sunrise to one hour after sunset.

- Regulatory and directional signs clearly mark designated routes of travel and areas closed to the public.

- Visitors are required to obtain a Refuge Day Pass (currently $3 per vehicle) or Refuge Commercial Day Pass (currently $20 per commercial vehicle) for public use activities on Sacramento Refuge unless in possession of a Refuge Annual Pass, Federal Duck Stamp, valid Golden Eagle, Age or Access Passport, National Parks Pass with Hologram, or America the Beautiful Pass.

- Maps and public use information are available at the Refuge Headquarters, kiosks, and the Complex's website http://sacramentovalleyrefuges.fws.gov.

- Two photography blinds on Sacramento Refuge and a blind on Colusa Refuge are available by reservation from October through March. A universally accessible blind will be constructed at Delevan Refuge and be available by reservation. The photography blinds may be reserved only one day each week, on Wednesdays through Sundays. The current fee for photo blind use is $10 per visit. Photographers may request up to three total reservations during October through March and unlimited visits during the spring and summer if habitat conditions allow.

- Visitors must obtain a special use permit if the request includes access to closed areas of the Refuges or other special considerations (e.g. access to the Refuges after normal public visitation hours, setting up temporary photography blinds, etc.) (16 USC 460I-6d, Refuge Manual 8 RM 16). A standard fee of $50 per year for noncommercial photography and wildlife observation will be charged for issuing the SUP. The standard fee for commercial photographers is $100 per year. The standard fee for commercial tours is $150 (USFWS 1992). Unless otherwise stated on the permit, in addition to the permit fee, a daily Refuge entrance fee of $3 per vehicle or $20 per commercial vehicle is charged on Sacramento Refuge. Areas used will be closely monitored to evaluate the impacts on the resource; if adverse impacts appear, the activity may be moved to secondary locations or curtailed entirely. Specific conditions may apply depending upon the requested activity and will be addressed through the SUP.

- Additional requirements for commercial photography activities are covered in the Compatibility Determination for Commercial Photography for Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges.

Justification: These wildlife-dependent uses are priority public uses of the National Wildlife Refuge System. Providing opportunities for wildlife observation and photography would contribute toward fulfilling provisions of the National Wildlife Refuge System Administration Act, as amended in 1997, and one of the goals of the Sacramento Refuge (Goal 3, Chapter 4, CCP). Wildlife observation and photography provide an excellent forum for allowing public access and increasing understanding of the Refuges' resources. The stipulations outlined above should minimize potential impacts relative to wildlife/human interactions. Based upon impacts described in the Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2008), it is determined that wildlife observation and photography within the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges as described herein, will not materially interfere with or detract from the purposes for which the Refuges were established or the mission of the Refuge System. In our opinion, implementing the wildlife observation and photography programs and associated stipulations will not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the Refuges.

Mandatory Re-Evaluation Date (2023):

__X__ Mandatory 15-year Re-Evaluation, Date will be provided in Final EA/CCP (for priority public uses)

_____ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

_____ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

__X__ Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

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Refuge Determination

Prepared by: ______________________________ __________

(Signature) (Date)

Wildlife Refuge Manager/
Project Leader
Approval: ______________________________ __________

(Signature) (Date)

Concurrence

Refuge Supervisor: ______________________________ __________

(Signature) (Date)

Assistant Regional
Director, Refuges: ______________________________ __________

(Signature) (Date)

Appendix C. Hunt Plan

Table of Contents

Figures

Tables

I. Introduction

Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges (Refuges) are part of the Sacramento National Wildlife Refuge Complex (Complex) located approximately ninety miles north of the city of Sacramento, California. The Complex contains critically important habitats for a great diversity of wildlife, particularly migratory birds of the Pacific Flyway. Forty-four percent of the Pacific Flyway waterfowl population winters in the Sacramento Valley. An abundance and diversity of other migratory birds also winter or migrate through the area. A total of sixteen Federal and/or State listed threatened or endangered species occur on the Refuges. A variety of wetland and upland habitats on the Refuges supports these and many other species.

The purpose of this Hunt Plan is to outline how the hunting program will be managed on the Refuges. The Hunt Plan documents how the Refuges will provide safe, quality hunting opportunities, while minimizing conflicts with other priority wildlife-dependent recreational uses (Service Manual, 605 FW 2). The Hunt Plan will discuss the following topics: compatibility, the effect of hunting on Refuge objectives, assessment of target species, description of the hunting areas, avoiding biological and public conflicts, and the procedures to conduct the daily hunt.

II. Conformance with Statutory Authorities

National Wildlife Refuges are guided by the mission and goals of the National Wildlife Refuge System and the purposes for which individual Refuges were established, as well as other policies, laws and international treaties. Relevant guidance includes the National Wildlife Refuge System Administration Act of 1966 (Administration Act), as amended by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act), the Refuge Recreation Act of 1962, and selected portions of the Code of Federal Regulations and Service Manual. The Refuge Recreation Act of 1962, as amended, authorized the Secretary of the Interior to administer refuges, hatcheries, and other conservation areas for recreational use when such uses did not interfere with the area's primary purpose.

A. Refuge System Mission and Goals

The Administration Act, as amended by the Improvement Act, states: "The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

The following Refuge System goals guide the development of comprehensive conservation plans (CCPs) and the administration, management, and growth of the Refuge System:

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges.

- Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).
- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

B. Refuge Purposes

The official purpose or purposes for a refuge are specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit. The Service defines the purpose of a refuge when it is established or when new land is added to an existing refuge.

The Refuge purposes are:

Sacramento Refuge Purposes

> "... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February. 27,1937.
>
> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).
>
> "... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ..." 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).
>
> "... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. 742f(a)(4) "... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

Delevan Refuge Purpose

> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

Colusa Refuge Purposes

> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... for the management and control of migratory waterfowl and other wildlife ..." 16 U.S.C. 695 (Lea Act of 1948).
>
> "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).

Sutter Refuge Purposes

> "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).
>
> "... for the management and control of migratory waterfowl and other wildlife ..." 16 U.S.C. 695 (Lea Act of 1948).
>
> "... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ..." 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).
>
> "... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. 742f(a)(4) "... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

In general, the Refuges' purposes are to provide:

- wetland habitat management for migratory birds;
- habitat protection for endangered, threatened, or sensitive species;
- priority wildlife-dependent recreation opportunities;
- compatible, management-oriented research; and
- crop depredation prevention.

C. Refuge System Improvement Act

The Improvement Act identified a new mission statement for the Refuge System; established six priority wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, environmental education, and interpretation); emphasized conservation and enhancement of the quality and diversity of fish and wildlife habitat; stressed the importance of partnerships with Federal and State agencies, Tribes, organizations, industry, and the general public; mandated public involvement in decisions on the acquisition and management of refuges; and required, prior to acquisition of new refuge lands, identification of existing compatible wildlife-dependent uses that would be permitted to continue on an interim basis pending completion of comprehensive conservation planning.

The Improvement Act establishes the responsibilities of the Secretary of the Interior for managing and protecting the Refuge System; requires a CCP for each refuge by the year 2012; provides guidelines and directives for the administration and management of all areas in the Refuge System, including wildlife refuges, areas for the protection and conservation of fish and wildlife threatened with extinction, wildlife ranges, game ranges, wildlife management areas, and waterfowl production areas.

D. Compatibility Determination

The Improvement Act also establishes a formal process for determining compatibility of uses. Before any uses, including wildlife-dependent recreational uses, are allowed on refuges, Federal law requires that they be formally determined compatible. A compatible use is defined as a use that, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from the fulfillment of the purposes of the refuge or mission of the Refuge System. Sound professional judgment is defined as a finding, determination, or decision that is consistent with the principles of sound fish and wildlife management and administration, available science and resources (funding, personnel, facilities, and other infrastructure), and applicable laws. The Service strives to provide wildlife-dependent recreational uses when compatible. If financial resources are not available to design, operate, and maintain a priority use, the refuge manager will take reasonable steps to obtain outside assistance from the State and other conservation interests.

The Service has determined hunting of waterfowl, coot, common moorhen, snipe, and pheasant to be a compatible wildlife-dependent recreational use on the Complex (Hunting Compatibility Determination, Appendix C, Comprehensive Conservation Plan (CCP) (USFWS 2008a). Based upon biological impacts described in the Hunting Compatibility Determination (CD), Draft CCP and Environmental Assessment (USFWS 2008b), which are incorporated by reference, hunting within the Refuges is a compatible use and will not materially interfere with or detract from the purposes for which the Refuges were established. Stipulations within the Hunting CD to ensure compatibility include: Refuge-specific regulations; monitoring of hunting activities, habitat conditions, public use activities, and wildlife population levels; and routine law enforcement patrols.

E. Compliance with Endangered Species Act

The Refuges have requested Section 7 consultation with USFWS and NOAA-Fisheries on the Draft CCP/EA (USFWS 2008b) and its effects on any of the special status species/designated critical habitat occurring on the Refuges including: giant garter snake, winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, western yellow billed cuckoo, fall-run Chinook salmon, late fall-run Chinook salmon, palmate-bracted bird's beak, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

F. Appropriate NEPA Documents

See EA (Appendix A in CCP (USFWS 2008b))

III. Statement of Objectives

The Refuges' management goals, objectives, and strategies (CCP, Chapter 4) are designed to achieve the Refuges purposes, which are listed previously in Section II, Conformance with Statutory Authorities. The Refuges' hunting objective is to "implement a high quality hunting program including opportunities for approximately 22,000 annual hunting visits on 8,525 acres by 2023" (Goal 3, Objective 3.1).

The strategies for implementing the hunting objective (CCP, Chapter 4) and to create the Refuge hunting program were developed using the Refuge System's guiding principles for hunting programs (Service Manual, 605, FW2):

- Manage wildlife populations consistent with Refuge System-specific management plans approved after 1997 and, to the extent practicable, State fish and wildlife conservation plans;
- Promote visitor understanding of, and increase visitor appreciation for, America's natural resources;
- Provide opportunities for quality recreational and educational experiences consistent with criteria describing quality found in 605 FW 1.6;
- Encourage participation in this tradition deeply rooted in America's natural heritage and conservation history; and
- Minimize conflicts with visitors participating in other compatible wildlife-dependent recreational activities.

The Refuge developed and manages the program in consultation with the California Department of Fish and Game (CDFG) and stakeholders input based on the following Service quality criteria (Service Manual, 605, FW2):

- Promote safety of participants, other visitors, and facilities;
- Promote compliance with applicable laws and regulations and responsible behavior;
- Minimize or eliminate conflict with fish and wildlife population or habitat goals or objectives in an approved plan;
- Minimize conflicts with other compatible wildlife-dependent recreation;
- Minimize conflicts with neighboring landowners;
- Promote accessibility and availability to a broad spectrum of the American people;
- Promote resource stewardship and conservation;
- Promote public understanding and increase public appreciation of America's natural resources and our role in managing and conserving these resources;
- Provide reliable/reasonable opportunities to experience wildlife;
- Use facilities that are accessible to people and blend into the natural setting; and
- Use visitor satisfaction to help define and evaluate programs.

The hunting program will be conducted in a safe and cost-effective manner, and will be carried out consistent with State regulations. This Hunt Plan was developed to provide safe hunting opportunities, while minimizing conflicts with other priority wildlife-dependent recreational uses. Hunting will be permitted in accordance with State and Federal regulations and seasons to ensure that it will not interfere with the conservation of fish and wildlife and their habitats. Therefore, the sport hunting of waterfowl, coot, common moorhen, snipe, and pheasant on the Refuges is in compliance with State regulations and seasons, the National Wildlife Refuge System

Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd-ee), and the Refuge Recreation Act of 1962 (16 U.S.C. 460k).

IV. Assessment

A. Are wildlife populations present in numbers sufficient to sustain optimum population levels for priority refuge objectives other than hunting?

Yes, wildlife populations are present in sufficient numbers for priority Refuge objectives for wildlife management and for the other priority wildlife-dependent recreational uses (wildlife observation and photography, environmental education, and interpretation). The Refuges adopt harvest regulations set by the State, which uses concepts of density dependant compensatory mortality and adaptive harvest management to ensure sustained game species populations (See Section V. C. Species to be taken).

The Refuges are evaluated to determine the best public use strategy for providing high quality wildlife-dependent public use opportunities. Approximately 8,525 acres on the Refuges is open to hunting of waterfowl, coot, common moorhen, snipe, and pheasant. Approximately 11,152 acres of the Refuges are closed to all public uses, including hunting. Approximately 6,571 acres provide opportunities for other wildlife-dependent opportunities (wildlife observation, photography, environmental education, and interpretation). In addition, approximately 2,275 acres in the hunting area will be open February-June for wildlife observation and photography.

B. Is there competition for habitat between target species and other wildlife?

Possibly; while each species occupies a unique niche, there is only a finite amount of space available to satisfy various habitat requirements of water, food, cover, breeding, and roosting areas.

C. Are there unacceptable levels of predation by target species on other wildlife forms?

No, target species (waterfowl, coot, common moorhen, snipe, and pheasant) generally do not prey on other species at unacceptable levels.

V. Description of Hunting Program

A. Areas of the refuge that support populations of the target species

Target game species commonly occurring on the Refuges include waterfowl, coot, common moorhen, snipe, and pheasant. Descriptions of wetland, upland, vernal pool, and riparian habitats and their associated plant and wildlife species are described below, and in further detail in Chapter 3 of the CCP (USFWS 2008b). A list of animal and plant species occurring on the Refuges can be found in Appendix K of the CCP (USFWS 2008b). An overview of hunted target wildlife species is also described in Section 2.

1. Habitats

The Refuges consist mostly of managed wetlands and uplands, with much smaller amounts of unmanaged wetlands (mostly vernal pools) and riparian forest (Table 1). The majority of the managed wetlands are seasonally flooded with 10-20 percent managed as summer wetlands (Figures 6-9 in the CCP).

Table 1. Acreage and habitats of Refuges within the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges.

	Acreage							
Refuge	**Total[1]**	**Managed Wetlands[2]**		**Unmanaged Wetlands[2]**	**Vernal Pool/Alkali Meadow[2]**	**Grasslands[2, 5]**	**Riparian Forest[2,6]**	**Other[2,7]**
		SFW[3]	**Summer Wetlands[4]**					
Sacramento	10,819	6,305	781	163	2,941	139	117	373
Delevan	5,877	3,939	661	13	461	464	46	290
Colusa	4,686	2,957	390	119	619	438	15	148
Sutter	2,591	1,708	173	45	0	226	403	36
TOTAL	**23,973**	**14,909**	**2,005**	**340**	**4,021**	**1,267**	**581**	**847**

[1] Official refuge acres.
[2] Acres calculated with GIS from 2006-07 annual habitat management plans.
[3] Includes irrigated and non-irrigated.
[4] Includes semi-permanent and permanent wetlands.
[5] Includes annual and perennial grasslands
[6] Includes willow scrub, valley oak, and mixed riparian forest.
[7] Includes roads, facilities, and other miscellaneous areas.

1.1. Wetlands

The Central Valley has lost 90-95 percent of its original wetlands that existed in the late 1800's, (Holland 1978, Gilmer et al. 1982, Frayer et al. 1989, Kempka and Kollasch 1990). Many of the original wetlands in the Sacramento Valley occurred along rivers and creeks, where over bank flooding during major rain events and runoff during the spring seasonally inundated large expanses of wetlands. In areas farther away, isolated vernal pools were also filled directly from precipitation, creating significant wetland landscapes.

Most of the remaining wetlands in the Sacramento Valley are intensively managed, including those on the Sacramento Refuge Complex. Because of historic losses of wetlands, they are managed to maximize resources to support the annual abundance of migratory birds, endangered and threatened species, and other wetland-dependent wildlife. This has been accomplished through restoration and management of wetlands with delivered water for ponding ("managed wetlands"), while maintaining and restoring natural wetland habitats (vernal pools, vernal pool/alkali meadow complex, riparian scrub and forests) when appropriate (Mensik and Paveglio 2004).

1.2. Seasonal Flooded Wetlands

Seasonally-flooded wetlands (SFW) include both irrigated and non-irrigated wetlands and comprise the majority of the habitat on all four of the Refuges (Table 1). These wetlands are intensively managed, with the timing and depths of water controlled and vegetation species composition and density manipulated to meet resource management objectives. In general, they are wet from fall through spring and dry during the summer. SFW provide the greatest density and diversity of food and cover for waterfowl and other migratory wetland-dependant species. Consequently, it supports the greatest abundance and diversity of wildlife over the course of a year. Characteristic plants include emergent species such as cattail and hardstem, alkali and tuberous bulrush. Wildlife forage species include swamp timothy, smartweeds, and watergrass. The ratio of open water to emergent plants often determines the species that will use a particular area. For example, pintail, shoveler, wigeon, most geese, and shorebirds are species attracted to marshes, which have more open water and less emergent cover. When SFW are dry, bulrushes and other vegetation function as habitat for ground-nesting birds.

Some SFW receive an irrigation during the spring or early summer. This results in a large volume of seed production, which is especially sought-after by waterfowl early and late in the season. Among other seasonal wetlands, watergrass dominated units play a role in providing alternate food resources in the early fall to help prevent crop depredation on private agricultural lands.

1.3. Summer Wetlands

Permanent and semi-permanent wetlands (often referred to as “permanent ponds” and “summer water,” respectively) provide wetland habitat during all or part of the summer, as well as most of the rest of the year (Table 1). These units provide nesting and brood habitat for waterfowl and other wetland-dependent species such as egrets, bitterns, ibis, grebes, coots, rails, and tricolored blackbirds. They are also important water sources for all wildlife when most seasonal marshes are dry.

1.4. Vernal Pool/Alkali Meadow

Vernal pools are depressions found on ancient soils with an impermeable layer (duripan) such as a hardpan or claypan, which perches rainwater above the water table. They are generally filled and maintained with rainwater in the winter and early spring, then evaporate as temperatures warm and north winds blow in late spring. While temporary wetlands such as vernal (spring) pools occur throughout the earth, those of California are unique. Thus, the flora and some of the fauna of vernal pools are unique to California (Holland and Jain 1988). Since vernal pools support a significant amount of endemic and rare flora and fauna, they add significantly to the biotic diversity of the Refuges (Thorp and Leong 1995; Eriksen and Belk 1999; Silveira 2000). As a result, vernal pools are a high conservation priority.

These vernal pool-alkali meadow habitat complexes occur most commonly at Sacramento, Delevan, and Colusa Refuges (Table 1). They are a remnant of the original “Colusa Plains” identified by early settlers as the area west of the Sacramento River in the Colusa Basin. The habitat was also referred to historically as “alkali gooseland,” as thousands of geese used to and continue to seek out these areas for grazing. Vernal pools and alkali meadows are technically wetlands, but have been historically considered part of the overall “uplands” habitat group.

1.5. Grasslands

True upland habitats are relatively uncommon on the Refuges (Table 1), and include annual and perennial grasslands. Perennial grasslands include some recently restored natives adapted to the less alkali soils, and introduced non-native species of tall wheatgrass and Harding grass or perla-grass. These introduced species are invasive and pose a threat to alkali meadow vegetation and the rare, endemic and native species that grow there. Upland cover provides nesting habitat for ducks, pheasants, meadowlarks, and other grassland species. During the winter and spring, short grass uplands provide green browse for geese, wigeon, and coots. Uplands also support significant populations of insects, rodents, and reptiles, which, in turn, are important forage items for raptors and other birds.

1.6. Riparian Habitats

Riparian habitats comprise a relatively small proportion of these four Refuges (Table 1). Narrow bands of Goodding’s black willow, and sometimes narrow-leaved willow, form willow scrub stands along Logan and Stone Corral Creeks, the Colusa Basin Drain, and several other water delivery and drainage canals of the Refuges. At Sacramento Refuge, a stand of mature cottonwoods, known locally as “Sherwood Forest,” forms a woodlot on the south half of the Refuge. At Colusa Refuge valley oak riparian forest occurs along Powell Slough, a small area along the Colusa Basin Drain. Mixed riparian forest occurs along the Sutter Bypass Canals at Sutter Refuge.

Due to the dense canopy and understory, a large variety of Neotropical migrant bird species use this habitat, such as the yellow-billed cuckoo, yellow-rumped warbler, black-headed grosbeak, and spotted towhee. Because of their close proximity to water, riparian scrub and forest habitats attract a large array of “wetland-dependant” species such as the northwestern pond turtle, great blue heron, great egret, wood duck, common yellowthroat, song sparrow, beaver, and river otter.

2. Target Species

2.1. Migratory Game Birds

The Central Valley of California has always been a major wintering area for Pacific Flyway waterfowl. Presently, peak wintering populations in the Central Valley occur during late November through January, when 3-4 million ducks and over a million geese have been surveyed in recent years (USFWS 1989-2007). For perspective, the four Refuges together have an average peak population of over one million ducks and 300,000 geese. In some years, populations can exceed 1.5 million ducks and 300,000 geese. The most common wintering duck species include northern pintail, mallard, American wigeon, green-winged teal, gadwall, northern shoveler, and ring-necked duck. The most common goose species include lesser snow, Ross’s, and Pacific and tule greater white-fronted geese. At certain times of the fall and winter, the majority of the Flyway’s population of Pacific greater white-fronted geese will be present on the four Refuges (USFWS, unpub. reports). In addition, the Sacramento, Delevan, and Colusa Refuges comprise the core wintering area for the tule greater white-fronted goose subspecies (Hobbs 1999).

Some waterfowl reproduction occurs on the Refuges throughout the spring and summer months. Species include mostly mallards, wood ducks, cinnamon teal, and gadwall, with fewer redheads, and ruddy ducks. A small number of Western Canada goose pairs will remain to nest as well. Depending on habitat conditions, an estimated 2,000-3,000 ducks are produced on the Refuges annually.

Habitat use by waterfowl, coot, common moorhen, and snipe on the Refuges varies by species and includes many other factors such as water depth, ratio of open water to emergent vegetation, food availability, access to loafing sites, level of human disturbance, and tradition. Over 95 percent of waterfowl that occur on the Refuges are dabbling ducks and geese, which all prefer relatively shallow water. Species including pintail, wigeon, green-winged teal, and shoveler prefer more open water, whereas mallards and gadwall, will use wetlands with denser cover (Heitmeyer and Raveling 1988). Seasonal wetlands (including watergrass units) contain abundant seeds and other vegetative food items (leaves, stems, tubers, etc.) and invertebrates (insects, spiders, crustaceans, etc.). They are diverse in the amount and distribution of emergent vegetation (bulrushes, cattails) they provide, and also contain bare islands, levees, and open shorelines that provide excellent waterfowl loafing sites. Not surprisingly, the majority of wintering waterfowl select this habitat type above all other managed wetlands. Vernal pools are also heavily used, especially by mallard, wigeon, green-winged teal and shoveler, once they fill during the winter and spring (Bogiatto and Karnegis 2006; Silveira 1998). In addition, geese and wigeon will readily forage in alkali meadows and short grass uplands as soon as green browse is available in the fall (Silveira 1998, USFWS 1989-2007).

2.2. Upland Game Birds

Upland game birds occupy various habitats on the Refuges. Ring-necked pheasant are resident species that use a variety of grassland, riparian, and wetland habitats throughout the year. Grasslands are used for nesting and foraging, and riparian forest and wetlands provide roosting sites and escape cover.

B. Areas to be opened to the public

1. Hunt Program Background Information

The hunting program is administered by the Service in cooperation with the CDFG. The Service manages the Refuges' land, habitat and facilities; and the CDFG selects and processes the Refuge hunters and operates the Refuge check stations.

The hunting areas are physically separated from non-hunted lands and are opened to only migratory bird and upland game bird hunters. These hunting program parameters help minimize conflicts with visitors engaged in other priority wildlife-dependent recreational activities (i.e. wildlife observation, photography, environmental education, and interpretation). After the hunting season, designated portions of the hunt area (2,275 acres) will be open February-June for wildlife observation and photography (see Figures 11-14 in the CCP).

Hunting of waterfowl, coot, common moorhen, snipe, and pheasant on Sacramento, Delevan, Colusa, and Sutter Refuges are highly regulated. Hunting takes place in designated areas and occurs only on Wednesdays, Saturdays, and Sundays. Hunting areas are divided into free roam, spaced blind, spaced hunt site (island), or assigned pond (Figures 1-4). Pheasant and snipe may only be hunted in the free roam areas. A Special Monday Pheasant Hunt, which is held the first Monday after the opening day of the pheasant season on Sacramento, Delevan, and Colusa Refuges, opens the entire hunt areas to pheasant hunting, including the spaced blind and assigned pond areas.

Initially the Refuges offered only free roam hunting opportunities. Free roam hunting allows unrestricted hunter movement, with variable hunting locations selected daily. Originally, a 10 acre per free roam hunter quota was established based on a similar existing State hunter quota. This hunter quota was based on a hunting area that was configured differently than the Refuges' hunting areas; however, it was a starting point. Free roam was the most common type of hunting offered on the Refuges from the 1950s through the 1980s.

Free roam hunting requires the hunter to have a knowledge and understanding (most often based on specific refuge experience) of the Refuge habitats and corresponding cover types, bird use, and flight patterns given certain weather conditions, in order to be successful. Often firing lines, where hunters lined up along a closed area boundary and pass shoot birds, would occur. Pass shooting birds is not encouraged, since it does not require calling or decoying skills and often leads to "sky busting" (shooting out of range) that often results in excessive crippling loss. In addition, the freedom to choose a hunting location can lead to hunter confrontations, as they try to "hold" a hunting spot that others may attempt to use. Refuge free roam hunters can sometimes have feelings of ownership, which has resulted in verbal aggression or other unethical behavior.

It became evident that the Refuges needed to eliminate firing lines, crowding, and extreme competition among some hunters in order to provide a better quality hunting experience. In addition, due to the dynamic and ever-changing characteristics of the hunting program it was critical to adjust hunter quotas, procedures, and hunting area configuration to accommodate these changes in order to provide a quality hunting program.

Over time, a 15 flooded acre per free roam hunter quota was adopted by the Refuges. In addition, in the late 1970s, the spaced blinds were established on a portion of the Sacramento Refuge hunt area. In the early 1990s, hunt sites (islands) were added on a portion of Delevan Refuge. The blinds and hunting sites were spaced 250-400 yards apart taking into account the shot distance and path of travel. Assigned pond areas were introduced on Colusa Refuge in 2004 and have been added to both Delevan and Sacramento Refuges since that time. Collectively, this "assigned hunting" provides an opportunity to hunt with less interference or competition from other hunters. It also allows for increased effectiveness of decoys and calls.

Hunter quotas are currently based on acres of available wetland habitat and are adjusted depending upon water conditions. In addition to quotas, hunter distribution is influenced by habitat management, pond size, daily weather conditions, and waterfowl flight patterns.

Hunters may retain their blind, hunt site or assigned pond (site) for the full day, even if they leave temporarily. The hunting sites also offer new, less frequent or less experienced hunters a better chance of having a quality hunting experience. The reserved sites, site descriptions, bird harvest averages and directional signs assist hunters in choosing, and then accessing their selected location.

With the number of waterfowl hunters declining in California, it is important to offer opportunities for new hunters to experience quality refuge hunting. In the early 1990s the Service began hosting a one-day, in-season junior waterfowl hunt on Sacramento and Delevan Refuges. The spaced hunt site areas were reserved for junior hunters (age 16 and younger). These hunts resulted in up to 145 junior hunt visits annually. In the late 1990s, post season youth only hunts (age 15 and younger) began on Sacramento and Colusa Refuges and were later added to Delevan Refuge. These hunts have resulted in up to 372 annual youth hunter visits. Many local partners (i.e. California Waterfowl Association, Willows Rotary, Willows Kiwanis, and National Wild Turkey Federation) have also assisted by providing free morning beverages, barbecue lunches, raffles, and educational displays and activities.

The Refuge Hunting Program Working Group was established in 1991 to exchange ideas and information regarding the Complex's hunting program. The Disabled Access Working Group was established in 1999 to discuss disabled hunting access issues on the Complex. In 2006, the groups were combined to form the Complex Hunting Program Working Group. State game wardens and Federal law enforcement officers also routinely attend the annual Working Group meeting to provide information.

2. Harvest Information

The Refuges have approximately 22,000 annual hunting visits, including up to 500 annual visits by hunters with disabilities. The overall harvest success, as measured by the number of birds per hunter per day, has remained relatively constant (approximately 2.0 birds per hunter) since the hunting programs were established in the 1950s. This has occurred despite rather significant fluctuations in total birds harvested annually on the Complex, and trends on individual Refuges. Harvest data indicates that ducks make up 95 percent of the take. The top six species of ducks harvested are mallard (22.3 percent), gadwall (18.5 percent), green-winged teal (14.5 percent), northern shoveler (13.5 percent), American wigeon (12.6 percent), and northern pintail (7.5 percent) (Table 2). Geese harvested include snow (53.8 percent), white-fronted (30.2 percent), and Ross's (13.4 percent) (Table 3). The majority of the goose harvest occurs on Sacramento and Delevan Refuges.

Table 2. Primary Duck Species Harvested on the Sacramento Complex (2004-06 Season).

	Mallard	Gadwall	GWTeal	Shoveler	Wigeon	Pintail
Sacramento						
2006-07	2,992	3,324	2,029	3,294	2,015	1,688
2005-06	3,053	2,184	2,094	2,340	1,770	1,519
2004-05	3,392	2,237	1,995	1,794	1,373	1,112
Average	**3,146**	**2,582**	**2,039**	**2,476**	**1,719**	**1,440**
Delevan						
2006-07	2,991	4,332	2,518	3,959	2,304	1,553
2005-06	4,037	3,001	2,504	2,200	2,257	1,412
2004-05	3,319	2,854	2,117	1,776	1,808	655
Average	**3,449**	**3,396**	**2,380**	**2,645**	**2,123**	**1,207**
Colusa						
2006-07	1,287	2,774	1,770	1,468	868	720
2005-06	2,912	1,736	1,538	716	814	678
2004-05	2,625	2,067	1,639	734	1,248	381
Average	**2,275**	**2,192**	**1,649**	**973**	**977**	**593**
Sutter						
2006-07	2,182	564	1,138	792	1,481	665
2005-06	1,558	227	587	176	613	263
2004-05	1,875	1,469	1,026	299	1,469	249
Average	**1,872**	**753**	**917**	**422**	**1,188**	**392**
Average Total	**10,742**	**8,923**	**6,985**	**6,516**	**6,077**	**3,632**
Percent of Grand Total[1]	**22.3**	**18.5**	**14.5**	**13.5**	**12.6**	**7.5**

[1] The Grand Total includes other duck species that were harvested (48,233=Grand Total).

Table 3. Primary Goose Species Harvested on the Sacramento Complex (2004-06 Season).

	Snow	Ross's	White-front
Sacramento			
2006-07	1,614	295	652
2005-06	985	220	317
2004-05	835	196	285
Average	**1,145**	**237**	**418**
Delevan			
2006-07	1,344	229	736
2005-06	1,061	204	364
2004-05	461	176	354
Average	**955**	**203**	**485**
Colusa			
2006-07	435	221	88
2005-06	227	84	45
2004-05	149	90	84
Average	**270**	**132**	**72**
Sutter			
2006-07	204	90	834
2005-06	73	14	203
2004-05	44	37	208
Average	**107**	**47**	**415**
Average Total	**2,477**	**619**	**1,390**
Percent of Grand Total[1]	**53.8**	**13.4**	**30.2**

[1] The Grand Total includes other goose species that were harvested (4,599=Grand Total).

3. Refuge Hunting Area Descriptions

The Refuges currently consist of 23,126 acres of wetland, alkali meadow/vernal pool, grassland, and riparian habitats (Table 1). Approximately 8,525 acres are open to hunting of waterfowl, coot, common moorhen, snipe, and pheasant (Figures 1-4). These acres are not open to other wildlife-dependent recreational uses during the hunting season to allow for separation of the user groups spatially on the Refuges.

It is important to note that the Refuges' hunting program operations, procedures and hunting area designations (blind, hunt site, assigned pond and free roam) may change annually in order to provide a safe and quality Refuge hunting program. The Refuges' maintain an open two-way communication (e.g. meetings, events, personal conversations, web site, electronic mail, postal mail and the telephone) with the CDFG and refuge hunters so that hunting program concerns, ideas, and comments can be discussed.

3.1. Sacramento Refuge

Sacramento Refuge is the headquarters for the Complex and is located in the northern Sacramento Valley of California. The Refuge is situated about 90 miles north of the metropolitan area of Sacramento and six miles south of the town of Willows, population 6,000. The Refuge consists of 10,819 acres in Glenn and Colusa counties.

The Refuge was established as a refuge for migratory birds and other wildlife. Major objectives are to: provide feeding and resting habitat for wintering waterfowl; provide habitat and manage for endangered, threatened, or sensitive species of concern; preserve a natural diversity and abundance of flora and fauna; provide an area for compatible, management-oriented research; alleviate crop depredation; and provide wildlife-dependent recreation such as wildlife observation, photography, interpretation, environmental education and hunting.

The Refuge is divided into approximately 117 management units, and managed wetlands comprise about 65 percent of the total acreage (Table 1). The managed wetlands consist of summer wetlands (permanent and semi-permanent wetlands) and seasonally flooded wetlands (irrigated and non-irrigated seasonally flooded wetlands). The remaining acreage is comprised of unmanaged wetlands, alkali meadows, vernal pools, grasslands, riparian forests, and other habitats.

The wetlands of the Central Valley are critical to waterfowl of the Pacific Flyway (USFWS et al. 1986, 1998). Currently, about 44 percent of the Pacific Flyway waterfowl population winters in the Sacramento Valley. The Refuge typically supports wintering populations in excess of 680,000 ducks and 178,000 geese. As wetlands of the Central Valley have been lost, the waterfowl resource has become increasingly dependent upon the refuges of the Sacramento Valley. To help support the abundance of waterfowl and other wetland-dependent wildlife, the Refuge Complex's habitat management program is one of the most intensive in the National Wildlife Refuge System.

In addition to wintering waterfowl and associated resident, migratory and breeding wildlife species, habitats of the Sacramento Refuge support eight federally-listed threatened, endangered, or candidate species. Sacramento Refuge is considered a priority 1 core area for recovery of vernal pool plants and animals (USFWS 2005). The Refuge manages the largest relatively intact remnant of vernal pool and vernal pool-alkali meadow complexes in the Colusa Basin.

The visitor services program offers a six-mile auto tour route; a two-mile walking trail; environmental education activities, presentations, guided tours, videos/DVDs, a bookstore, and a wildlife exhibits at the visitor center; interpretive kiosks with brochures; two photography blinds; teacher assistance; a volunteer program; and waterfowl/pheasant hunting. The visitor center, auto tour route, and wetlands walking trail accommodate more than 86,000 annual visits. Waterfowl, coot, common moorhen, snipe, and pheasant hunting are permitted on Saturdays, Sundays, and Wednesdays and account for about 7,600 visits annually. Approximately 1,473 acres of the hunting area will be open February-June for wildlife observation and photography.

Sacramento Refuge Hunting History

In 1963, in cooperation with the CDFG, the Sacramento Refuge was opened to hunting. Slightly over 3,500 acres of the southern portion of the Refuge was opened to a maximum of 250 adult hunters. The initial fee was $2.50 per day per hunter. Hunters were largely dependent on a mail-in reservation system and a first come, first served system for obtaining a permit to hunt. Hunters leaving the area were usually quickly replaced by others waiting to hunt. As a result, the number of hunters on any given day was sometimes twice the actual capacity allowed at any one time (quota).

In 1978, the spaced blind program was initiated to improve the quality of the hunt and to meet regional and National Service policies. This involved the elimination of firing lines, crowding, and extreme competition among hunters. The blinds were either two in-ground, two-person, metal pits, or above-ground platforms that could accommodate up to four hunters. The blinds were spaced to improve hunter safety and to promote a hunting experience that emphasized decoys and calls. Hunters were only allowed to hunt waterfowl in the blind area and were required to hunt from within their assigned blinds until 1991. Since many of the metal blinds has become unavailable due to corrosion/leaking, the regulation was relaxed to allow hunting within 100 feet of the blind. During 1997-2003, concrete pit blinds were installed to replace all the metal pit and platform blinds. The first two replacement blinds, Blinds 9 and 13, were contributed by Safari Club International.

In 1991, the Refuge eliminated the requirement that non-reservation hunters remain in the check station parking lot after receiving their sweat line number. In addition, an on-site lottery draw system for non-reservation numbers was implemented to reduce overnight camping and provide a more equitable system of hunter access. A new check station was constructed in 1999, and an information kiosk was installed near the check station in 2004. The first assigned pond, replacing Blind 55, was established in 2006.

A Special Monday Pheasant Hunt was added to the hunt program in 1981. In addition, in 1991 an annual in-season, one-day Junior Waterfowl Hunt in the spaced blind area was implemented. Youth Hunts (either pre-season or post-season) were added beginning in 1996.

In 1997, as the result of an accessibility evaluation, Blinds 23D and 27D were constructed for hunters with disabilities.

Sacramento Current Hunting Conditions

Hunting is allowed on 3,566 acres south of Road 68 (Table 4, Figure 1).

Table 4. Hunt area acreage and hunter quotas for Sacramento Refuge.

	Spaced Blind Area	Assigned Pond Area (# parties)	Free Roam Area	Pheasant Only
Acres dry	220	48	336	127
Acres flooded	1,233	428	1,146	
Total acres	1,453	476	1,482	127
Number of blinds	37			
Number of assigned ponds		9		
Maximum adult hunter quota	148	36 (9)	75	
Wetland acre/hunter or hunt site	33.3	47.5	15.3	

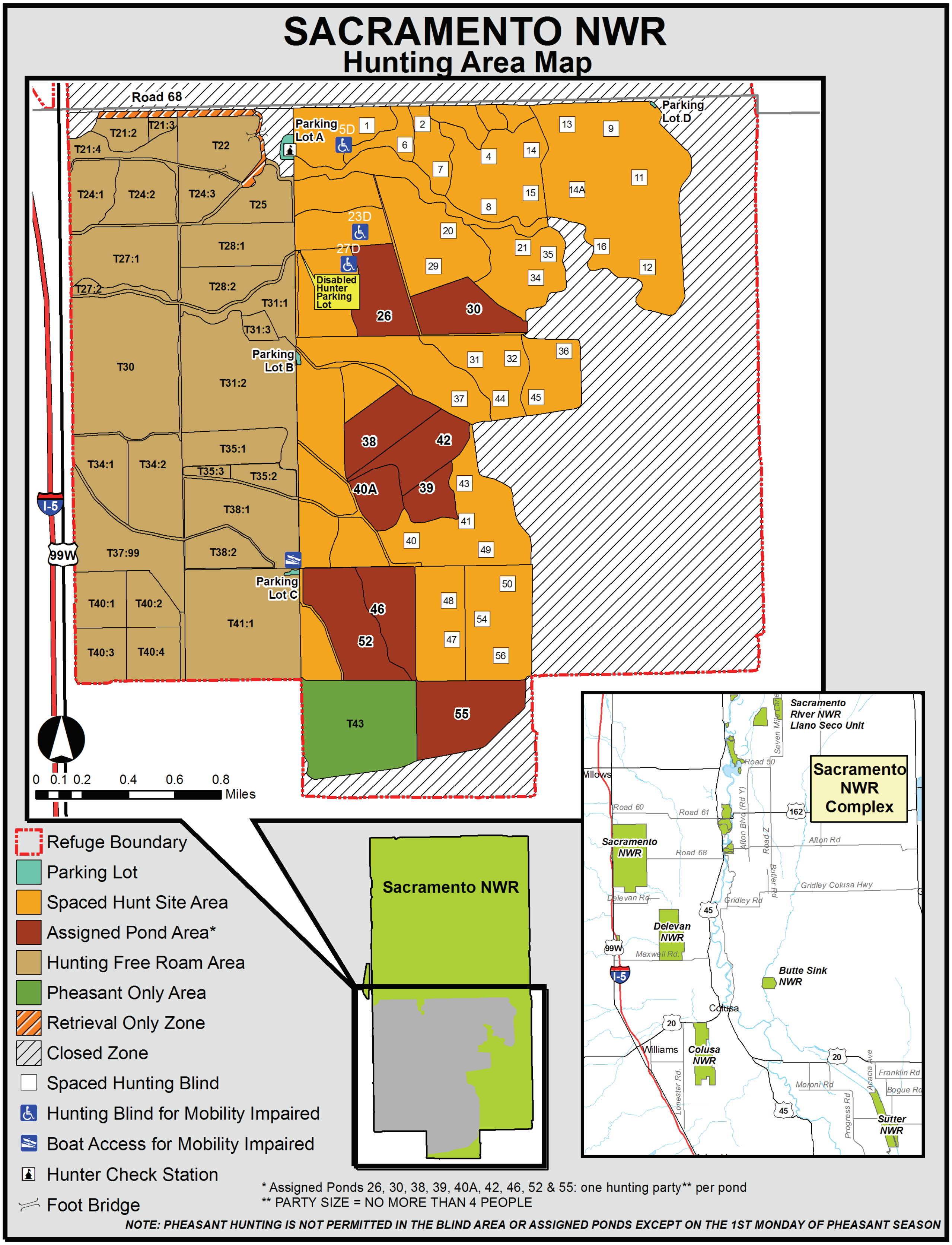
Sacramento Refuge has spaced blind, assigned pond, and free roam areas (Figure 1) that consist of managed wetland, watergrass, permanent pond, grassland, and vernal pool/alkali meadow habitats. Blinds are in-ground, concrete pits spaced 250-400 yards apart. Hunters must remain within 100 feet of their assigned blind. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas, while additional reflective stakes direct hunters to their assigned blind. The hunting areas are accessible by foot only from four parking areas.

Pheasant and snipe may be hunted on waterfowl hunt days in the free roam and pheasant only areas. Pheasant may also be hunted on the first Monday of the season in free roam, spaced blind, and assigned pond areas. Maximum quota for this day is 100 hunters.

Hunter quotas are based on acres of available wetland habitat and are adjusted depending upon water conditions. Fully-flooded conditions provide up to 37 blinds (up to four people per blind), nine assigned ponds (up to four people per pond), and up to 75 free roam hunters (15.3 wetland acres/hunter) (Table 4). In addition to quotas, hunter distribution is influenced by habitat management, pond size, daily weather conditions, and waterfowl flight patterns.

Sacramento Refuge has three spaced blinds (Blinds 5D, 23D, and 27D) designated for hunters with mobility impairments (Figure 1). These sites may be accessed by motor vehicle or an all-terrain-vehicle (ATV) from the parking areas. Additionally, a parking area to access Blinds 23D and 27D and a designated accessible boat launch in the free roam area (Tract 38) is available (Figure 1). In 2006-07, there were 212 visits by 62 individual hunters with disabilities.

Figure 1. Sacramento Refuge Hunting Area Map



3.2. Delevan Refuge

Delevan Refuge is situated about 80 miles north of the metropolitan area of Sacramento and four miles east of the town of Maxwell, population 1,500. The Refuge consists of 5,877 acres in Colusa County.

Delevan Refuge was established in 1962 as a refuge and breeding ground for migratory birds and other wildlife. Major objectives are to provide feeding and resting habitat for wintering waterfowl; provide habitat and manage for endangered, threatened, or sensitive species of concern; preserve a natural diversity and abundance of flora and fauna; alleviate crop depredation; and provide public use activities such as hunting and wildlife observation.

Delevan Refuge is divided into approximately 67 management units, and managed wetlands comprise about 78 percent of the total acreage. They consist of summer wetlands and seasonally flooded wetlands. The remaining acreage is comprised of unmanaged wetlands, alkali meadows, vernal pools, grasslands, riparian forest, and other habitats. The Refuge typically supports wintering populations in excess of 415,000 ducks and 150,000 geese.

The Refuge supports one of the largest known populations of palmate-bracted birds-beak (Federal-listed endangered species) and significant breeding colonies of tricolored blackbirds. Some of the units on the Refuge form one of the largest relatively intact remnants of the vernal pool and vernal pool-alkali meadow habitats that remain in the Colusa Basin.

A limited visitor services program on Delevan Refuge, offers wildlife observation and photography from adjacent county roads, including a primitive Watchable Wildlife site on Maxwell Road adjacent to the Refuge's south boundary. Waterfowl, coot, common moorhen, snipe, and pheasant hunting are permitted on Saturdays, Sundays, and Wednesdays and account for about 6,900 visits annually.

Delevan Refuge Hunting History

In cooperation with the CDFG, the hunt program began in 1963 with the opening of 2,000 acres to free roam hunting. In 1989, a portion of the free roam area was converted to accommodate 26 spaced hunting sites or islands. These sites could accommodate up to four hunters and were spaced to improve hunter safety and promote a hunting experience that emphasized decoys and calls. Hunters selecting such sites were required to remain within 100 feet of a marker stake designating the assigned hunting site, and were limited to waterfowl hunting only. A replacement hunter check station was completed in 1997, and a new hunter information kiosk was installed in 2003. In 2004, assigned ponds were added, with Hunt Site 11 and 12A being the first to become assigned ponds, followed by Hunt Site 17 in 2005.

The first Special Monday Pheasant Hunt was started in 1989, in conjunction with the new hunt sites. In 1991, the Delevan Refuge eliminated the sweat line system, and implemented an on-site lottery draw system for non-reservation hunters followed by a first-come first-served list. In 1992, an annual one-day Junior Waterfowl Hunt in the spaced hunt site area began. The first Youth Waterfowl Hunt was hosted "post-season" in January of 1998.

In 1994, facilities for physically impaired hunters were provided by developing a new hunting blind easily accessible from the check station. After considering other areas that would not impact the able-bodied hunt program and still be a quality hunting site for disabled hunters, the blind was constructed in Tract 27.2. The site was in a small pond close to the check station and was open to disabled hunters only. In 1997, as the result of an accessibility evaluation, Blind 13D was constructed as an additional disabled site, and the original disabled blind was renamed as Blind 29D. Able-bodied hunters were allowed to refill both blinds after 3:00 p.m.

In 1998, the Disabled Access Working Group (DAWG) requested that the Service construct Blind 30D. The Service was concerned that if both Blinds 30D and 29D were filled with four hunters, a firing line might result. In 2001, the CDFG check station manager reported that Blind 30D was cutting off the natural flyway from the north closed area into the free roam area south of Blind 30D. Since that time, the Service, Refuge Hunting Program Working Group, and DAWG have studied various proposals to locate an alternate site for Blind 30D. A flyer was distributed at the check stations, but no suggestions were received. The Service is now considering leaving Blind 30D at the present location. Since Blinds 29D and 30D are located in small ponds, there is no refill by able-bodied hunters after 3:00 pm.

In 2004, the Refuge introduced a floating pontoon blind in Tract 34.3 of the free roam area for mobility impaired hunters. The pontoon boat was purchased with a grant from Safari Club International and was modified to meet ADA standards.

Delevan Current Hunting Conditions

Hunting is allowed on 1,922 acres within the south half of Delevan Refuge (Table 5, Figure 2).

Table 5. Hunt area acreage and hunter quotas for Delevan Refuge.

	Spaced Hunt Area	Assigned Pond Area (# parties)	Free Roam Area
Acres dry	22	0	192
Acres flooded	746	129	*833
Total acres	768	129	1,025
Number of blinds	26		
Number of assigned ponds		3	
Maximum adult hunter quota	104	12 (3)	**58
Wetland acre/hunter or hunt site	28.7	43.0	14.4

* Does not include acres for T41.2 when it gets flooded in December-January.
**Increased to 62 during December-January when T41.2 is flooded.

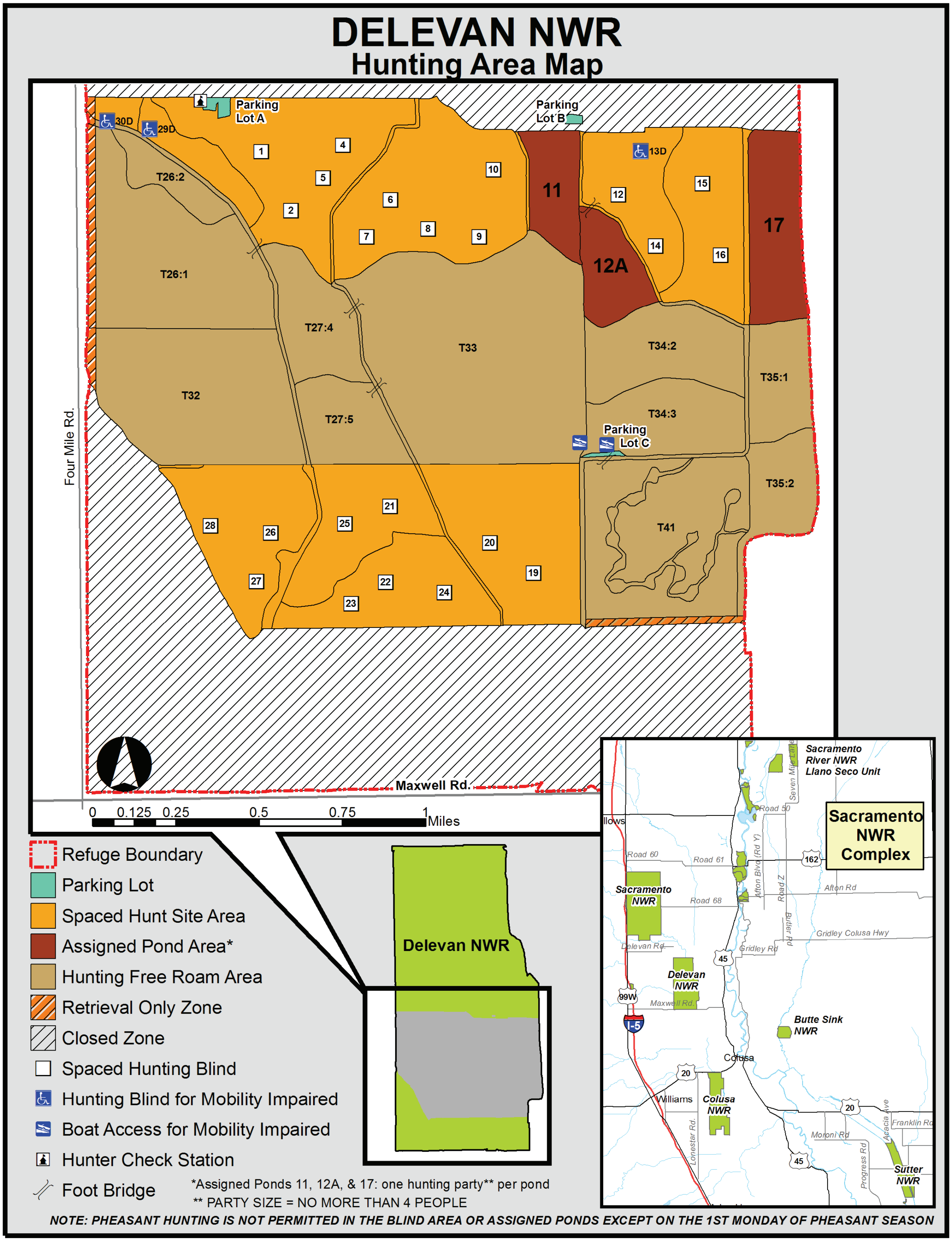
Delevan Refuge has spaced hunt sites, assigned pond, and free roam areas (Figure 2) that consist of managed wetland, watergrass, permanent pond, grassland, and vernal pool/alkali meadow habitats. Hunt sites consist of a dirt island (approximately 10'x20') surrounded by cattail or bulrush. Hunters must remain within 100 feet of their assigned hunt site. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas, while additional reflective stakes direct hunters to their assigned hunt site. The hunting areas are accessible by foot only from three parking areas.

Pheasant and snipe may be hunted on waterfowl hunt days in the free roam area. Pheasant may also be hunted on the first Monday of the season in free roam, spaced hunt sites, and assigned pond areas. Maximum quota for the special Monday hunt is 50 hunters.

Hunter quotas are based on acres of available wetland habitat and will be adjusted depending upon water conditions. Fully-flooded conditions provide up to 26 hunt sites (up to four people per hunt site), three assigned ponds (up to four people per pond) and up to 58 free roam hunters (14.4 wetland acres/hunter) (Table 5). In addition to quotas, hunter distribution is influenced by habitat management, pond size, daily weather conditions, and waterfowl flight patterns.

Delevan Refuge has three spaced blinds (Blinds 13D, 29D, and 30D) designated for disabled hunters (Figure 2). These blinds may be accessed by motor vehicle or ATV from the parking areas. A floating pontoon blind is located in Tract 34.3 as a free roam hunting opportunity. Additionally, there are designated accessible boat ramps in the free roam area of Tract 33 and Tract 34.3 (Figure 2). In 2006-07, there were 223 visits by 53 individual hunters with disabilities.

Figure 2. Delevan Refuge Hunting Area Map



3.3. Colusa Refuge

Colusa Refuge is situated about 70 miles north of the metropolitan area of Sacramento and one mile southwest of the town of Colusa, population 5,500. The Refuge consists of 4,686 acres in Colusa County.

Colusa Refuge was established in 1945 as a refuge and breeding ground for migratory birds and other wildlife and to reduce damage of agricultural crops caused by waterfowl. Major objectives are to provide feeding and resting habitat for wintering waterfowl; provide habitat and manage for endangered, threatened, or species of concern; preserve a natural diversity and abundance of flora and fauna; alleviate crop depredation; and provide public use activities such as hunting, wildlife observation, photography, environmental education, and interpretation.

Colusa is divided into approximately 59 management units, and managed wetlands comprise about 71 percent of the total acreage. They consist of summer wetlands and seasonally flooded wetlands. The remaining acreage is comprised of unmanaged wetlands, alkali meadows, vernal pools, grasslands, riparian, and other upland habitats. The Refuge typically supports wintering populations in excess of 218,000 ducks and 113,500 geese.

The Refuge supports one of the largest known populations of giant garter snakes (Federal-listed threatened species), and palmate-bracted birds-beak (Federal-listed endangered species). Some of the units on the Refuge form one of the largest relatively intact remnants of the vernal pool and vernal pool-alkali meadow habitats that remain in the Colusa Basin.

The visitor services program offers wildlife observation and photography from a three-mile auto tour route, one mile walking trail and one photography blind, and supports 16,300 annual visits. Waterfowl, coot, common moorhen, snipe, and pheasant hunting are permitted on Saturdays, Sundays, and Wednesdays and account for about 3,700 visits per year. Approximately 430 acres of the hunting area will be open February-June for wildlife observation and photography.

Colusa Refuge Hunting History

In cooperation with the CDFG, the Refuge was opened to free roam hunting in 1950. The hunt area acres have ranged from 1,100 in the 1960's to the current 1,921 acres. The lottery draw was implemented in 1998. Also in 1998, a boat ramp and disabled parking area were constructed. The Colusa check station was relocated with the completion of a new building in 1999, and an information kiosk was installed in 2004. In 2004, eight assigned ponds were established on Colusa Refuge and in 2005; the first blind for disabled hunters was constructed in the northeast corner of Pool 2. The first Youth Hunt was hosted pre-season in October of 1996. Thereafter, Youth Hunts have been hosted during the weekend after the end of the waterfowl hunting season.

Colusa Refuge Current Hunting Conditions

Hunting is allowed on 1,921 acres south of Abel Road (Table 6, Figure 3).

Table 6. Hunt area acreage and hunter quotas for Colusa Refuge.

	Assigned Pond Area (# parties)	Free Roam Area - Westside	Free Roam Area - Eastside
Acres dry	1	488	126
Acres flooded	386	292	491
Total acres	387	780	617
Number of assigned ponds	10		
Maximum adult hunter quota	30 (15)	14	36
Wetland acres/hunter or hunt site	25.7	20.8	13.6

Colusa Refuge has assigned pond and free roam areas (Figure 3) that consist of managed wetland, watergrass, permanent pond, grassland, and vernal pool/alkali meadow habitats. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas. The hunting areas are accessible by foot only from four parking areas.

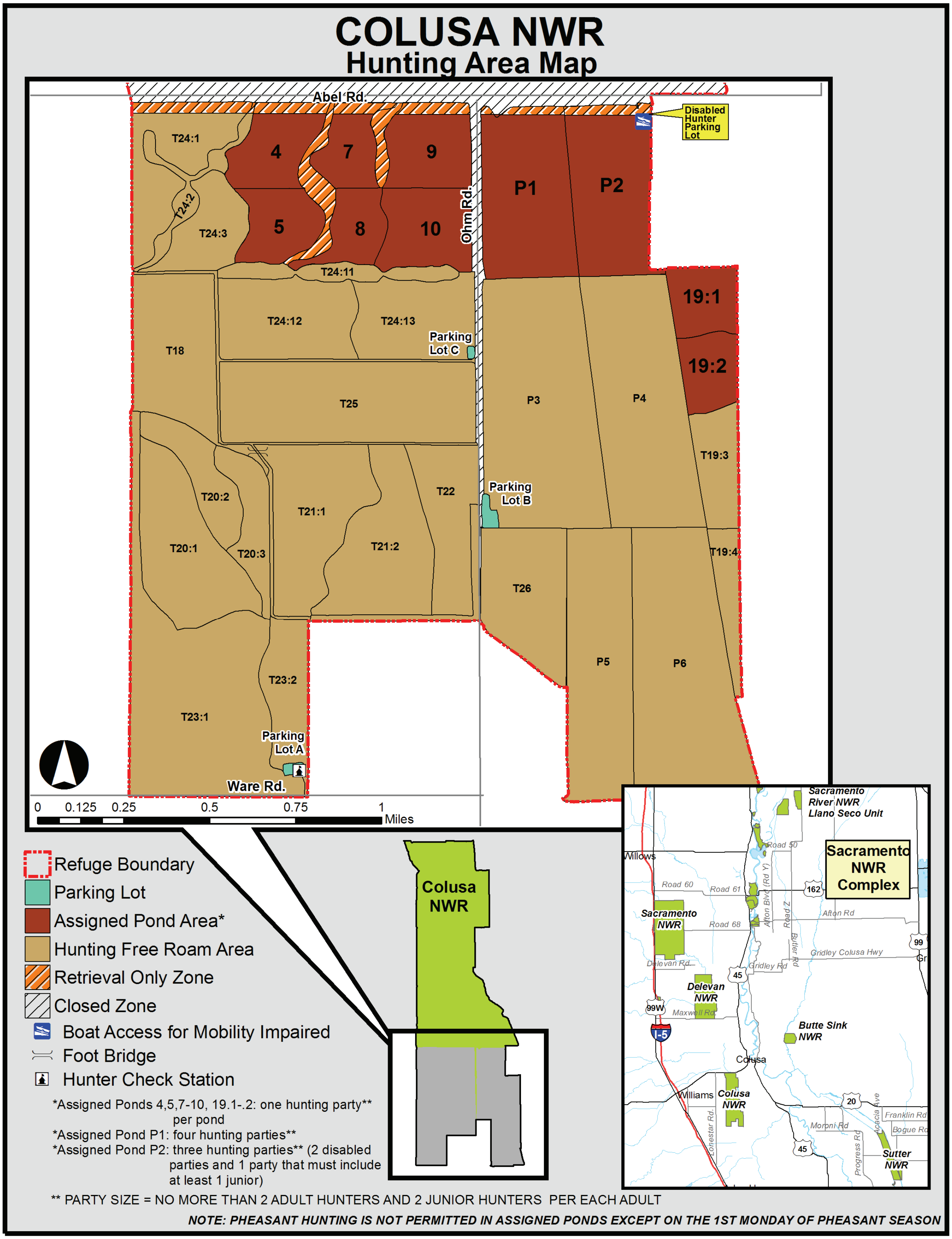
Disabled hunters may access Pool 2 from the disabled parking area via a boat ramp or access a blind in the northeast corner (Figure 3). In 2006-07, Pool 2 had 236 hunter visits and hunters reported using the accessible blind on 10 days resulting in 22 visits.

Pheasant and snipe may be hunted on waterfowl hunt days in the free roam areas only. Pheasant may also be hunted on the first Monday of the season in free roam and assigned pond areas. Maximum quota for this day is 10 hunters on the east side and 35 hunters on the westside.

Hunter quotas are based on acres of available wetland habitat and are adjusted depending upon water conditions. Fully-flooded conditions provide up to 10 assigned ponds (two adult hunters per party) and up to 50 free roam hunters (Table 6). Assigned ponds T24.4- 5, T24.7-10, and T19.1-2 allow one party per pond, Pool 1 allows up to four parties per pond. Pool 2 allows up to three parties: two disabled and one party, which must have a junior hunter. In addition to quotas, hunter distribution is influenced by habitat management, pond size, daily weather conditions and waterfowl flight patterns.

The eastside free roam area has one hunter per 13.6 wetland acres at its maximum quota of 36 hunters (Table 6). The westside free roam area has one hunter per 20.8 wetland acres at its maximum quota of 14 (Table 6). The westside free roam area is not in as strong of a flight path and thus the hunter density allowed is lower.

Figure 3. Colusa Refuge Hunting Area Map



3.4. Sutter Refuge

Sutter Refuge is situated about 50 miles north of the metropolitan area of Sacramento, 10 miles southwest of Yuba City, population approximately 60,000, and five miles south of Sutter, population approximately 2,900. The Refuge consists of 2,591 acres in Sutter County.

The majority of the Sutter Refuge is located within the Sutter Bypass of the Sacramento River Flood Control Project; an area dedicated to flood water conveyance. The eastern levee of the Sutter Bypass is managed by the Department of Water Resources. The western levee is managed by Reclamation District 1660. Both levees are part of the Sutter Bypass Wildlife Area managed by the CDFG. The State of California Reclamation Board holds easements within the Bypass portion of the Refuge. The easements allow for the flowage of floodwaters over the land and for the removal of vegetation that may be impeding floodwaters. Copies of the specific easements are available for review at the Refuge Headquarters.

Sutter Refuge was established in 1945 as a refuge and breeding ground for migratory birds and other wildlife, and to reduce damage of agricultural crops caused by waterfowl. Major objectives are to: provide feeding and resting habitat for wintering waterfowl; provide habitat and manage for endangered, threatened, or species of concern; preserve a natural diversity and abundance of flora and fauna; alleviate crop depredation; and provide public use activities such as hunting and wildlife observation.

Sutter Refuge is divided into approximately 27 management units, and managed wetlands comprise about 73 percent of the total acreage. They consist of summer wetlands and seasonally flooded wetlands. The giant garter snake (Federal-listed threatened species) occurs on the Refuge primarily in the portion outside the Bypass. In recent years, the Refuge has supported large white-faced ibis nesting colonies (5,000-15,000 birds). The Refuge typically supports wintering populations in excess of 73,000 ducks and 100,000 geese.

The remaining acres are in unmanaged wetlands, grasslands, riparian forest, and other habitats. The riparian habitat provides habitat for a variety of migratory songbirds, including the western yellow-billed cuckoo (Federal candidate species, State-listed threatened species), nesting Swainson’s hawks (State-listed species), and nesting rookeries for great blue herons and great egrets.

A limited public use program offers hunting for waterfowl, coot, common moorhen, snipe, and pheasant on Saturdays, Sundays, and Wednesdays and accounts for approximately 2,100 visits annually. Approximately, 372 acres of the hunting area will be open February-June to wildlife observation and photography.

Sutter Refuge Hunting History

In cooperation with the CDFG, the hunt program began in 1953 when 1,350 acres were opened to free roam hunting. Since that time, the annual hunt program has varied from a complete closure in 1978, to a maximum of 1,441 acres in 1987. The Refuge is located in the Sutter Bypass and consequently has suffered from flooding and resultant closures of the hunt program more frequently than any other Refuge on the Complex. A boat access ramp for disabled hunters was constructed in the southeast corner of Tract 17 in 1998. A new check station and information kiosk were constructed in 2006.

Sutter Refuge Current Hunting Conditions

Currently hunting is allowed on 1,116 acres on the south half of Sutter Refuge (Table 7, Figure 4).

Table 7. Hunt area acreage and hunter quotas for Sutter Refuge.

	Assigned Pond Area (# parties)	Free Roam Area	Pheasant Only Area
Acres dry	0	0	125
Acres flooded	540	*265	
Total acres	540	265	125
Number of assigned ponds	10		
Maximum adult hunter quota	44 (22)	20	10
Wetland acres/hunter or hunt site	24.5	13.2	

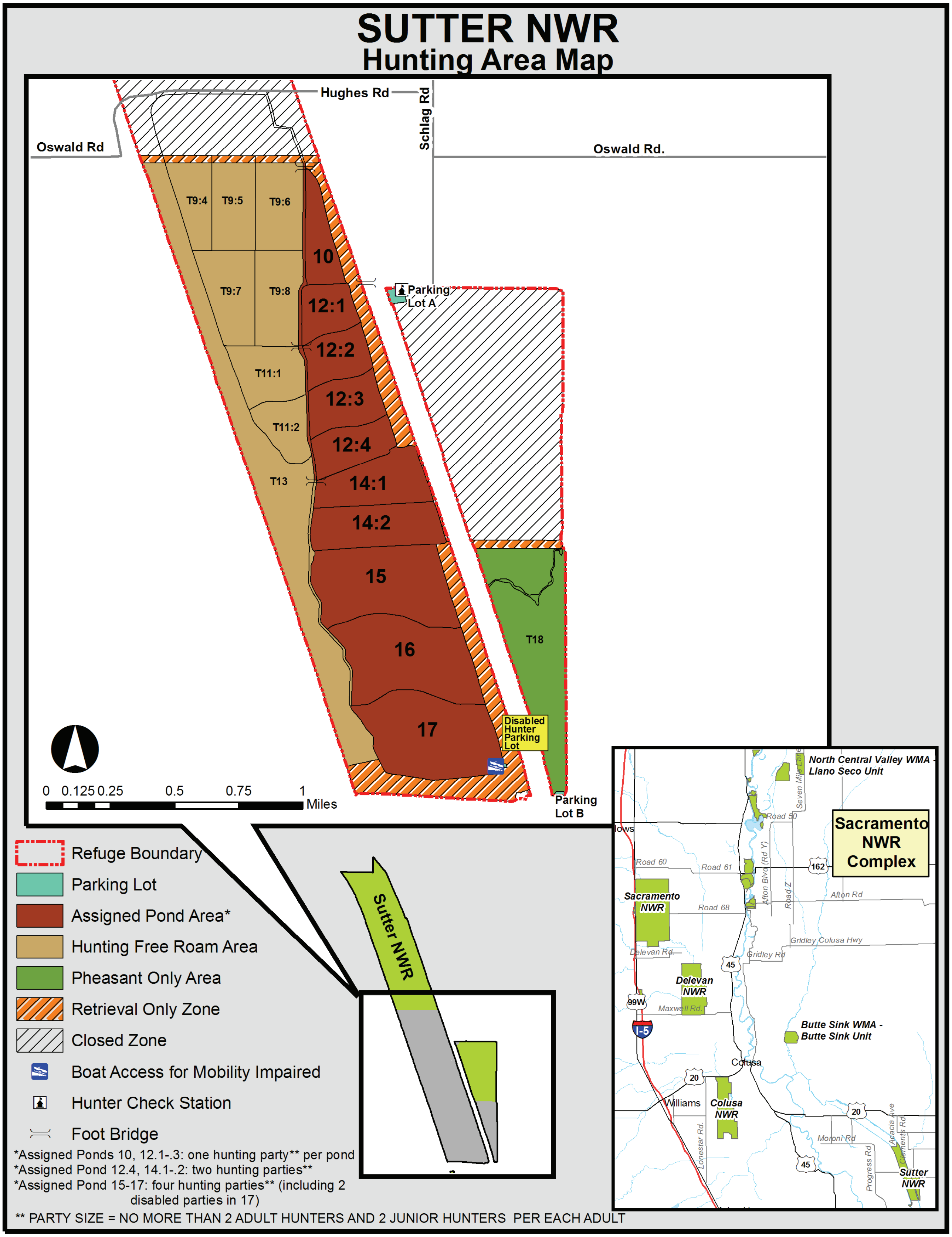
Sutter Refuge has assigned pond and free roam areas (Figure 4) that primarily consist of managed wetland, watergrass, and grassland habitats. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas. The hunting areas are accessible by foot only from two parking areas. In addition, there is a designated boat launch with a parking area available to hunters with disabilities, in the southeast corner of assigned pond T17 (Figure 4). There has been minimal visitation by hunters with disabilities.

Pheasant and snipe can be hunted in the free roam and pheasant only areas on the Refuge on waterfowl hunt days.

Hunter quotas are based on acres of available wetland habitat and are adjusted depending upon water conditions. Fully-flooded conditions provide up to 10 assigned ponds and up to 20 free roam hunters (Table 7). Assigned ponds T10 and T12.1-.3 allow one party per pond; T12.4, T14.1 and T14.2 allow up to two parties each and T15-17 allow up to four parties each, including two adult disabled hunting parties in T17. A hunting party may include up to two adults. A disabled hunting party must include at least one disabled hunter. In addition to quotas, hunter distribution is influenced by habitat management, pond size, daily weather conditions, and waterfowl flight patterns.

The free roam area has one hunter per 13.2 wetland acres at its maximum quota of 20 hunters (Table 7). Tract 18 will remain as a pheasant hunting only area and will have a quota up to 10 hunters (Table 7).

Figure 4. Sutter Refuge Hunting Area Map



3.5. Summary of Hunter Quota Changes

Below is a table that compares the 2006-07 hunting conditions with the hunting conditions proposed in this plan.

Table 8. Maximum Adult Hunter Quota in 2006-2007 Compared With Proposed Hunt Plan Changes.

	2006-07	Proposed	2006-07	Proposed	2006-07	Proposed	2006-07	Proposed
	Spaced Blinds (# blinds)	**Spaced Blinds (# blinds)**	**Assigned Ponds (# ponds)**	**Assigned Ponds (# ponds)**	**Free Roam**	**Free Roam**	**Total**	**Total**
Sacramento								
Maximum Adult hunter quota	180 (45)	148 (37)	4 (1)	36 (9)	75	75	**259**	**259**
Delevan								
Maximum Adult hunter quota	104 (26)	104 (26)	12 (3)	12 (3)	62	62	**178**	**178**
Colusa								
Maximum Adult hunter quota			26 (8)	30 (10)	54	50	**80**	**80**
Sutter								
Maximum Adult hunter quota				44 (10)	70	20	**70**	**64**
Total	**284**	**252**	**42**	**122**	**261**	**207**	**587**	**581**

C. Species to be taken, hunting periods

1. Hunting Season and Bag Limits Overview

Waterfowl populations throughout the United States are managed through an administrative process known as flyways, of which there are four (Pacific, Central, Mississippi and Atlantic). The review of the policies, processes and procedures for waterfowl hunting are covered in a number of documents identified below.

The National Environmental Policy Act (NEPA) considerations by the Service for hunted migratory game bird species are addressed by the programmatic document, "Final Supplemental Environmental Impact Statement: Issuance of Annual Regulations Permitting the Sport Hunting of Migratory Birds (FSES 88– 14)," filed with the Environmental Protection Agency on June 9, 1988. The Service published a Notice of Availability in the Federal Register on June 16, 1988 (53 FR 22582), and the Record of Decision on August 18, 1988 (53 FR 31341). Annual NEPA considerations for waterfowl hunting frameworks are covered under a separate Environmental Assessment and Finding of No Significant Impact. Further, in a notice published in the September 8, 2005 Federal Register (70 FR 53776), the Service announced its intent to develop a new Supplemental Environmental Impact Statement for the migratory bird hunting program. Public scoping meetings were held in the spring of 2006, as announced in a March 9, 2006 Federal Register notice (71 FR 12216).

Because the Migratory Bird Treaty Act stipulates that all hunting seasons for migratory game birds are closed unless specifically opened by the Secretary of the Interior, the Service annually promulgates regulations in Title 50 of the Code of Federal Regulations (50 CFR Part 20) establishing the Migratory Bird Hunting Frameworks. The frameworks are essentially permissive in that hunting of migratory birds would not be permitted without them. Thus, in effect, Federal annual regulations both allow and limit the hunting of migratory birds.

The Migratory Bird Hunting Frameworks provide season dates, bag limits, and other options for the States to select that should result in the level of harvest determined to be appropriate based upon Service-prepared annual biological assessments detailing the status of migratory game bird populations. In North America, the process for establishing waterfowl hunting regulations is conducted annually. In the United States, the process involves a number of scheduled meetings (Flyway Study Committees, Flyway Councils, Service Regulations Committee, etc.) in which information regarding the status of waterfowl populations and their habitats is presented to individuals within the agencies responsible for setting hunting regulations. In addition, public hearings are held and the proposed regulations are published in the Federal Register to allow public comment.

For waterfowl, these annual assessments include the Breeding Population and Habitat Survey, which is conducted throughout portions of the United States and Canada, and is used to establish a Waterfowl Population Status Report annually. In addition, the number of waterfowl hunters and resulting harvest are closely monitored through both the Harvest Information Program (HIP) and Parts Survey (Wing Bee). Since 1995, such information has been used to support the adaptive harvest management (AHM) process for setting duck-hunting regulations. Under AHM, a number of decision-making protocols render the choice (package) of pre-determined regulations (appropriate levels of harvest) which comprise the framework offered to the States that year. California's Fish and Game Commission then selects season dates, bag limits, shooting hours and other options from the Pacific Flyway package. Their selections can be more restrictive, but can not be more liberal than AHM allows. Thus, the level of hunting opportunity afforded each State increases or decreases each year in accordance with the annual status of waterfowl populations.

Each National Wildlife Refuge considers the cumulative impacts to hunted migratory species through the Migratory Bird Frameworks published annually in the Service's regulations on Migratory Bird Hunting. Season dates and bag limits for National Wildlife Refuges open to hunting are never longer or larger than the State regulations. In fact, based upon the findings of an environmental assessment developed when a refuge opens a new hunting activity, season dates and bag limits may be more restrictive than the State allows.

2. Refuge Hunt Seasons and Bag Limits

Hunting will be permitted in accordance with State and Federal regulations (Table 9 gives an example of annual State hunt seasons for areas within the Refuges) to ensure that it will not interfere with the conservation of fish and wildlife and their habitats. Therefore, the sport hunting of migratory and upland game birds on the Refuges is in compliance with State regulations and seasons, the National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd-ee), and the Refuge Recreation Act of 1962 (16 U.S.C. 460k).

Table 9. Sacramento, Delevan, Colusa, and Sutter Refuges, Hunting Season Bag Limit Summary for 2006-2007.

Species	Dates	Daily Bag Limits
Waterfowl – Ducks	Third Saturday in October extending for 100 consecutive days	Up to 7 ducks; see below; possession double the bag limit*
Waterfowl – Geese	October - concurrent with duck season	Up to 4 geese any species; possession double the bag limit
American Coot and Common Moorhen	October - concurrent with duck season	25/day, 25 in possession, either all of one species or a mixture of these species
Snipe	Third Saturday in October extending for 107 days	8/day; possession double the bag limit
Pheasants – General	Second Saturday in November extending for 44 days	2 – males first two days; 3 males thereafter; possession double the bag limit

*Duck Bag Limits: 7 ducks/ but not more than 2 hen mallards, 1 pintail, 1 canvasback, 2 redhead, 3 scaup, throughout the season

The Draft CCP (USFWS 2008b) identifies that limited spring turkey hunting opportunities on Sacramento, Delevan, and Colusa Refuges could be allowed based on sufficient wild turkey populations, habitat conditions, and the development of a turkey hunt management plan, as well as the appropriate National Environmental Policy Act compliance.

In order to promote interest in hunting and hunter recruitment, the Refuges will continue to coordinate in-season Junior Hunts and pre-season or post-season Youth Waterfowl Hunts in coordination with the CDFG and the California Waterfowl Association.

D. Justification for a permit if one is required

A valid California hunting license, including appropriate stamps, is required of all hunters. Permits are needed to track daily hunter quotas, hunter refill, and species harvested on the Refuges. To defray expenses connected with the operation and maintenance of the hunting program, the CDFG is authorized to charge and retain a fee from each adult hunter. Hunter fees are determined annually in advance of the hunting season by the California Fish and Game Commission. At present, the Refuge entry permit fees are: one-day $14.75, two-day $25.45, or a season pass with a one-time, base fee of $117.85. These fees are adjusted annually, as required under Fish and Game Code Section 713. Holders of valid junior hunting licenses and non-shooters are exempt from these fees.

E. Procedures for consultation and coordination with State

A Standard Agreement and a Cooperative Hunting Agreement enables the Service to administer the hunt program in cooperation with the CDFG. The Cooperative Agreement is renegotiated every 2-3 years. In general, the Service will manage the Refuges' land, habitat and facilities; and the State will manage the hunter selection and processing. Both agencies participate in enforcing applicable Federal and State laws and Refuge regulations. Additionally, annual pre and post-season meetings are held with the CDFG to discuss and coordinate the Refuges' hunting program procedures and operations.

To assure that hunted bird populations are sustainable, the California Fish and Game Commission, in consultation with the CDFG, annually reviews the population censuses to establish season lengths and harvest levels. In addition, refuge staff conducts habitat management reviews of each unit on the Complex to evaluate wildlife population levels, habitat conditions and public use activities. This information is shared and discussed with the CDFG.

Sometimes Delevan, Colusa, and Sutter Refuges need to be closed due to flood water events. The Service and the CDFG coordinate using the Procedures for Monitoring Flood Waters and Hunt Area Operations. The guidelines list notification contacts, timelines for decision-making, and suggested procedures for determining a closure. The Service also uses the Department of Water Resources, Division of Flood Management website to monitor flood stage forecasts in order to help determine a closure.

1. Check Station Operation

The CDFG provides annual training for check station staff that outlines check station procedures, operations, and changes. The Service hunting program coordinator attends this meeting. The CDFG, in coordination with the Service, provides and updates an in-depth Check Station Operations Manual for the Refuges. The Manual covers such topics as entry procedures to fill hunter quotas, checking lottery entries and generating a computer list, lottery and hunt day procedures, blind and free roam waiting, mobility impaired hunter access and blind filling, morning hunter orientation, boat blind operations and checklist, procedures for monitoring flood waters, and hunt day closing. The kiosks and check station alcoves provide the most current California waterfowl and upland game hunting on State and Federal areas booklet, hunting related brochures, hunting area maps, Refuge hunting results, blind averages, waterfowl surveys, and litter bags.

F. Methods of control and enforcement (identify check stations)

The hunting program is managed in strict accordance with all applicable Federal laws (Code of Federal Regulations, Title 50 subchapter C) and to the extent practicable, consistent with applicable State laws.

- Hunters are required to obtain a valid daily entry permit to access and exit the hunting area. The permit must be returned with the recorded bird harvest no later than within l ½ hours after sunset.
- Hunters must report their harvest at the check stations located at Sacramento Refuge south of Road 68, at Delevan Refuge east of Four Mile Road, at Colusa Refuge north of Ware Road, and at Sutter Refuge south of Hughes Road.
- Hunting visits, hunter quotas, and bird harvest will be monitored through entry permits issued at the check stations.
- Boundary, spaced blind, assigned pond, hunt site and free roam area signs will be maintained.
- Parking areas will be signed and gated to allow only pedestrian access.
- Information in the hunting kiosks will be maintained and updated.
- The CDFG State Area Manager is responsible for the check station operations and enforcement of the Operations Manual on each Refuge.
- The CDFG State Area Manager supervises the State check station day and night shift staff.
- The Service and State will coordinate monitoring and closing hunting areas during flood water events by following the Procedures for Monitoring Flood Waters and Hunt Area Operations.
- Field checks by refuge law enforcement officers will be planned and coordinated with staff and other agencies to maintain compliance with regulations and assess species and number harvested.
- Coordinated and frequent law enforcement patrols by refuge officers, special agents, game wardens, and deputy sheriffs will be conducted.

G. Funding and staffing requirements for the hunt.

The majority of the funding for the hunt program activities conducted by refuge personnel is provided from the Complex's annual budget with a smaller portion coming from a reimbursement via an agreement with the CDFG. One of the purposes of the Cooperative Agreement with the CDFG is to reimburse the Service for some of the operation and maintenance costs directly attributable to the administration of the hunting programs. The CDFG enters into this Agreement pursuant to the authority granted to the California Fish and Game Commission by the California Legislature under the provisions of sections 1528, 1530, and 10680 of the California Fish and Game Code. The Service is required to collect these funds pursuant to an audit by the Department of the Interior's Office of Inspector General. The CDFG has been conducting the public hunting program on these Refuges and collecting fees from hunters since the early 1950s. The Service is currently reimbursed with a payment that is based on the hunting season length.

In order to monitor and conduct the hunt program for the Complex, the estimated annual Service costs (printing, law enforcement, maintenance, other personnel services, etc.) are approximately $85,000 per year.

The following one-time and annual costs (FY 2006) would be required:

	One-Time Costs	Annual Costs
Install electric line to hunter check station (Delevan)	$172,000	
Replace hunter access bridges with culverts (Sacramento and Delevan)	$20,000	
Printing (brochures, signs, posters, etc) 3%		$3,000
Law Enforcement (permit compliance, access control, protection) 26%		$22,000
Maintenance (check stations, blinds, discing, mowing, etc.) 39%		$33,000
Personnel Services (managerial, biological, clerical, etc.) 32%		$27,000
TOTAL	**$192,000**	**$ 85,000**

H. Consideration of providing opportunities for hunters with disabilities

The Service, including the Office of Diversity and Civil Rights, strongly supports the Americans with Disabilities Act and Rehabilitation Act of 1967. Requirements that priority wildlife-dependent activities are to be managed in ways that promote integrated access for persons with disabilities, to the maximum extent possible where feasible and safe, are priority Refuge objectives. The Refuges will keep integration central, avoid exclusivity and continue encouraging persons with disabilities to hunt wherever they are individually capable of hunting. Hunters with disabilities participate in the Complex Hunting Program Working Group that meets annually to discuss, evaluate and improve Refuge hunting facilities and procedures.

Both the terms "disabled" which is used by the Service, and "mobility impaired" used by the CDFG, are used interchangeably. A mobility impaired (MI) hunter is defined by the CDFG as a person who has been issued a Department of Motor Vehicles (DMV) MI license plate or permanent parking placard identification card or a MI veteran license plate, or a valid MI persons motor vehicle hunting license. A blue plastic MI parking placard may not be substituted for the required identification card, which bears the name of the MI person. MI hunters must provide the registration certificate for the DMV issued MI license plates.

The Refuges provide the following facilities for hunters with disabilities:

- Sacramento Refuge has three spaced blind sites (Blinds 5D, 23D, and 27D) designated for hunters with mobility impairments. These sites may be accessed by motor vehicle or ATV. There is also a designated boat launch in the free roam area of Tract 38 for disabled hunter use.
- Delevan Refuge has three spaced blind sites (Blinds 13D, 29D, and 30D) designated for hunters with mobility impairments. These sites may be accessed by motor vehicle or ATV.

There is also a designated boat launch in Tract 33, and a designated boat launch and pontoon blind in Tract 34.3 of the free roam area for disabled hunter use.

- Colusa Refuge has a disabled access parking area that is available to disabled hunters assigned to Pool 2. There is a gravel boat ramp at the disabled parking area that allows for launching small boats and an accessible hunting blind.
- Sutter Refuge has a designated boat launch available to disabled hunters in the southeast corner of Tract 17.
- Mobility impaired hunters may use ATV's to access designated blinds and hunting sites on Sacramento and Delevan Refuges. A helmet must be worn while driving the ATV. A driver must provide proof of completion of ATV safety training.
- MI hunters who wish to use their non-motorized boats or boats with electric motors may gain entry to the free roam areas (except Colusa) by using accessible boat ramps through the standard reservation and lottery draw systems.
- MI hunters must abide by and sign the Safety and Operations Checklist when using the pontoon blind.
- If a non-hunting MI person is a member of a hunting party and the party would like to use a MI hunting blind, it is up to the discretion of the area manager.
- MI hunters desiring special accommodations should use the MI hunting application and processing procedures. The MI hunter who wants to hunt without any accommodations, and does not need assistance, may enter the hunting area under the standard procedures.

VI. Measures Taken to Avoid Conflicts With Other Management Objectives

The impacts addressed here are discussed in detail in the Environmental Assessment (Appendix A) for the CCP (USFWS 2008b) which is incorporated by reference.

A. Biological Conflicts

Biological conflicts will be minimized by the following:

- Proper zoning and regulations will be designated to minimize negative impacts to wildlife.
- The number of hunters will be limited by designated hunter quotas at each of the Refuges.
- Check stations will process the hunters' entry to and exit from the hunting areas.
- Federally approved non-toxic shot will be used for all hunting to help minimize the possibility of lead poisoning.
- No hunting will be allowed during the breeding season. Hunting will be allowed only during designated seasons for waterfowl and upland game birds.
- The hunting area is flooded-up beginning approximately 2½ months prior to the hunting season to allow bird use.
- The areas closed to hunting activities (11,152 acres of sanctuary, 15,448 acres closed to hunting) will provide adequate sanctuaries for wildlife.
- Law enforcement presence will help minimize excessive harvest and other infractions (illegal use of lead shot, take of non-game species, littering, etc.).
- Firearms are permitted on the Refuges for public hunting under the provisions of 50 CFR Part 32. Persons may carry unloaded firearms on the Refuges that are dismantled or cased in vehicles (50 CFR 27.42).

- Section 7 consultations with USFWS and NOAA-Fisheries will be completed to determine effect of the CCP (USFWS 2008b) on special status species/designated critical habitat occurring on the Refuges.
- The Refuges will provide information in kiosks about how to prevent the spread of invasive terrestrial and aquatic plant species.

B. Public Use Conflicts

Conflicts between hunting and other public uses will be minimized by the following:

- Physically separate non-hunting and hunting acres will be provided to spatially divide the activities.
- Hunting will be limited to Wednesdays, Saturdays, and Sundays during the established seasons.
- Boundary and hunting area signs will be maintained to clearly define the designated hunting areas.
- Vehicle traffic will be allowed only on designated roads and parking areas.
- Parking areas will be signed and gated to allow only pedestrian hunter access to hunting areas.
- The hunting program will be managed in strict accordance with all applicable Federal laws (50 CFR Subchapter C) and to the extent practicable, consistent with applicable State laws.
- Field checks by refuge law enforcement officers will be planned and coordinated with staff and other agencies to maintain compliance with regulations and assess species and number harvested.
- Information about the Refuge hunting program will be provided through signs, kiosks, brochures, and the Complex's website (http://sacramentovalleyrefuges.fws.gov)
- No camping or tents will be allowed on the Refuges.

C. Administrative Conflicts

There are no administrative conflicts with this proposal at this time. As the program expands (i.e. permit system), there may be conflicts associated with the cost of the program.

VII. Conduct of the Hunt

A. Refuge Specific Regulations

The following are the special regulations for Migratory Game Bird Hunting and Upland Game Hunting on the Sacramento, Delevan, Colusa, and Sutter Refuges. The regulations are noticed in the Federal Register and are incorporated into 50 CFR 32.24, California Refuge-specific regulations.

1. Hunting of Migratory Game Birds

We allow the hunting of geese, ducks, coots, moorhens, and snipe on designated areas of the refuge subject to the following conditions [for Sacramento Refuge (see regulations 1-13 below), Delevan Refuge (see regulations 1-13 below), Colusa Refuge (see regulations 4-13 below), and Sutter Refuge (see regulations 4-13 below)]:

1. You must unload firearms while transporting them between parking areas and spaced blind areas.
2. We do not allow snipe hunting in the spaced blind area.
3. We restrict hunters in the assigned blind unit to within 100 feet (30 m) of their assigned hunt site, except for retrieving downed birds, placing decoys, or traveling to and from the parking area.
4. You may possess only approved non-toxic shot while in the field.
5. You may possess no more than 25 shells while in the field.
6. Access to the hunt area is by foot traffic only. We do not allow bicycles and other conveyances. Mobility-impaired hunters should consult the refuge manager for allowed conveyances.
7. No person may build or maintain fires, except in portable gas stoves.
8. You may enter or exit only at designated locations.
9. Vehicles may stop only at designated parking areas. We prohibit the dropping off of passengers or equipment or stopping between designated parking areas.
10. We require dogs to be kept on a leash, except for hunting dogs engaged in authorized hunting activities and under the immediate control of a licensed hunter.*
11. We do not allow cutting or removal of vegetation for blind construction or for making trails.*
12. We allow only electric motors on boats used by hunters with disabilities.*
13. Consumption or possession of an open container of alcohol within public areas on the Refuges is prohibited.*

(* Indicates a new regulation.)

2. Upland Game Hunting

We allow hunting of pheasant on designated areas of the Refuge subject to the following conditions: [for Sacramento Refuge (see regulations 1-9 below), Delevan Refuge (see regulations 1-9 below), Colusa Refuge (see regulations 2-9 below), and Sutter Refuge (see regulations 2-9 below)]:

1. We do not allow pheasant hunting in the spaced blind and assigned pond areas except during a special 1-day pheasant-only hunt on the first Monday after the opening of the State pheasant hunting season.
2. You may possess only approved nontoxic shot while in the field.
3. Access to the hunt area is by foot traffic only. We do not allow bicycles and other conveyances. Mobility-impaired hunters should consult with the refuge manager for allowed conveyances.
4. You may possess no more than 25 shells while in the field.
5. No person may build or maintain fires, except in portable gas stoves.
6. You may enter or exit only at designated locations.
7. Vehicles may stop only at designated parking areas. We prohibit the dropping off of passengers or equipment or stopping between designated parking areas.
8. We require dogs to be kept on a leash, except for hunting dogs engaged in authorized hunting activities and under the immediate control of a licensed hunter.*
9. Consumption or possession of an open container of alcohol within public areas on the Refuges is prohibited.*

(* Indicates a new regulation.)

B. Anticipated public reaction to the hunt

Hunting is a traditional use in the Sacramento Valley. Hunting on the Refuges has been occurring since 1950. Most hunters would support the hunting program on Sacramento, Delevan, Colusa, and Sutter Refuges. During the comment periods and public scoping sessions for the CCP in 2005, a variety of opinions were heard. The majority of the comments received supported the hunting program on the Refuges (see Chapter 2 of the CCP). Anti-hunting individuals and organizations also voiced their objection to any hunting on the Refuges.

The Draft CCP's goal states that the Refuges will provide opportunities for approximately 22,000 annual hunting visits on 8,525 acres (Chapter 4, Goal 3.1). A total of 157,000 annual visits are estimated for all wildlife-dependent recreational uses (includes 22,000 hunting visits (Chapter 4, Goal 3.1), 100,000 wildlife observation visits (Chapter 4, Goal 3.2), 10,000 photography visits (Chapter 4, Goal 3.3), 5,000 environmental education visits (Chapter 4, Goal 3.4), and 20,000 interpretation visits (Chapter 4, Goal 3.5)).

C. Hunter application and registration procedures

Hunters may gain entry to hunt on the Refuges through the CDFG reservation system, an on-site lottery drawing, or sign-up on a first-come, first-served list on each Refuge. These systems establish the order of entry and permit sales.

1. Reservation Application Procedures:

- Resident, junior and non-resident licensed hunters may apply.
- Reservation applicants may purchase a one-day ($1.25), five-day ($6.25), or season-long application.
- Hunters may apply as many times per season as desired, but no more than once for each area for each shoot day.
- Application forms are available through the CDFG offices and licensed agents.
- The reservation application needs to be received 17 days prior to the requested hunt date.
- On Sacramento and Delevan Refuges, each reservation assures entry for up to four individuals, whether adult hunters, junior hunters, or non-shooters.
- On Colusa and Sutter Refuges, each reservation assures entry for up to two persons with adult licenses. Each adult (18 years of age or older) may be accompanied by up to two junior license holders, or two non-shooters, or one of each.

2. Lottery Draw Procedures:

The Refuges will hold an on-site, lottery drawing for non-reservation hunters.

- Non-reservation hunters may enter a lottery drawing on only one Refuge each hunt date. This applies to all members of the hunting party.
- Hunters who enter more than one lottery on a single shoot day shall not be issued a permit for that day, or will be ejected for that day if a permit has been issued, and may be denied entry to all the CDFG-operated areas for the remainder of the hunting season.
- A maximum of three additional names may be placed on the back of the card. This includes

adult hunters, junior hunters (no more than two juniors per adult) and non-shooters.

- A lottery draw fee is not required at this time.

3. First-come, first-served Procedure:

Hunters arriving at the Refuge check station after the lottery drawing may sign-up on a first-come, first-served list (FC, FS).

- A FC, FS fee is not required at this time.

D. Description of hunter selection process

The hunter selection process is a prioritized, three-tier system. The daily hunter quotas are filled through the check station in the following sequence: first the reservation card holders are processed, then the lottery card holders, and then first-come, first-served hunters. Refilling the hunting area quotas is accomplished using a waiting list.

1. Reservation Process

The reservations are numbered in the order in which they are randomly drawn by the computer at the CDFG License and Revenue Branch. Reservations will be mailed at least 7 days prior to the hunt day for which it is valid. Waterfowl reservations drawing results are also posted on the CDFG website (www.dfg.ca.gov).

- Applicants must enter at the appropriate check station on the assigned hunt date.
- On Sacramento Refuge, the reservation is valid from 2 ½ to 1 ½ hours before shoot time. On Delevan, Colusa, and Sutter Refuges the reservation is valid from 2 to 1 hour before shoot time.
- Mobility impaired (MI) hunters will be processed before other hunters in numerical sequence.
- If any reservation card holder is not present when a card number is called, they will be allowed to enter upon arrival, or until the end of the reservation period.
- A MI reservation holder may choose any available MI blind, hunting site, assigned pond (hunt site), enter free roam, or elect to be placed on a "MI Waiting" list in order to remain eligible to hunt.
- Reservation holders may choose any available non-MI hunt site or enter free roam. If these options are refused, the hunter may be placed on a waiting list in order to remain eligible to hunt (See Section 5 and 6, Waiting, below).
- Guests of the reservation holder need not have a lottery number to be eligible. Once formed, the party cannot add or substitute other individuals. The party may not split between the blind and free roam areas.
- If the reservation holder chooses a blind site or assigned pond and has a guest who has not arrived yet, the holder may request to have this person join him/her at his/her assigned blind site or assigned pond. The name must be given at the time of processing. This does not affect the quota.
- If the reservation holder chooses free roam, all hunters in the party must be present at the time of processing. Once the free roam hunting party has been processed and the next reservation number is called, additional hunters cannot be added to the card, as this would affect the free roam quota.

2. Lottery Draw Process

The CDFG will open the Refuge hunting area gates and check stations at 6:00 p.m. on Tuesdays and Fridays. The lottery will take place at 8:00 p.m. On Saturdays, hunters may enter the lottery for Sunday between 9:00 a.m. and 8:00 p.m. Lottery entry cards will be available at the check stations.

- After reservations and prior to calling lottery card holders, the CDFG State Area Manager may issue any vacant MI hunt sites to MI hunters in the "lottery line".
- A MI lottery card holder may choose any available MI blind, hunt site, assigned pond, enter free roam or elect to be placed on a "MI waiting" in order to remain eligible to hunt. (See waiting list below.)
- If a MI hunter selects a non-mobility impaired blind site, they must turn in their lottery number and drop down to the bottom of the first-come (sweat line) list and will then be processed in order of their number.
- The remaining lottery card holders may choose any available non-MI hunt site, enter free roam, or elect to be placed on a waiting list in order to remain eligible to hunt. (See Section 5 and 6, Waiting below).
- Hunters obtain a lottery card at the check station and fill out both halves. Only one hunter's name may appear on the front of a card. Hunting license number and vehicle license number must be written on the front.
- MI hunters wishing to use the MI hunting areas must mark the MI box.
- Hunter's names and hunting license numbers (actual license is not required at this time) are required on the back of the card. Hunters on the back of the card do not have to be present.
- Hunters who want to sign up other hunters but do not have their license numbers at the time may add license numbers any time before the draw.
- Any names recorded without hunting license numbers at time of the draw will not be eligible to hunt.
- Hunter's name may be placed on the front or back of only one Refuge lottery card per hunt day.
- A card number will be assigned to each card in the top right corner. It will take the place of individuals' name for the purpose of assigning lottery numbers.
- The right half of the lottery card will be filed at the check station. The hunter will keep the left half.
- Hunters may leave the area once the lottery card is filled out and turned in. They do not have to be present during the draw.
- On Tuesdays, Fridays, and Saturdays at 8:00 p.m., the total number of cards that have been issued are entered into the computer. The computer will randomly select the order of each card number.
- The card numbers (plastic tokens) are placed on a numbered board in the check station. The position of each card number designates the lottery number. The spaces between each card number are determined by the additional number of hunters that have been entered on the cards. Non-shooters are not counted in the quota.
- Lottery numbers determine the order that the hunters will be called the next morning. Only one lottery number will be issued per party. All names on a card must enter as a party. Once a party is formed, the party must hunt together. No splitting between blind and free roam areas.
- It is the hunter's responsibility to check the board to determine what their lottery number is before lottery numbers are called. Hunters will be called in sequence of their lottery number.

- If a lottery cardholder does not appear on the morning of the hunt, the other hunters on the back of the card are still eligible to hunt.
- Hunters must be present when their number is called, and will be eliminated from the list if they are not present.
- Waiting list numbers will become invalid at the end of refill time on Saturday, even if there was no opportunity to hunt.

3. First-come, first-served Process

Hunters arriving after the lottery drawing at 8:00 p.m. will be issued a first-come, first-served (FC, FS) number. This is also known as the "sweat line".

- FC, FS hunters will be processed after the last lottery card number.
- Each hunter must be physically present to sign-up.
- A FC, FS hunter may choose any available blind, hunt site, assigned pond or enter free roam. If these options are refused, the hunter may be placed on a waiting list in order to remain eligible to hunt.
- Saturday FC, FS numbers will be invalid at the end of shoot time on Saturday, even if there was no opportunity to hunt.

4. Mobility Impaired Waiting

If there are no vacant or desirable mobility impaired blinds, pontoon boat or mobility pond (Colusa Pool 2), hunters may be placed on the MI "blind waiting" or "pond waiting" list.

- The letters "MI" are placed after the name to indicate that the hunter has been placed on the "Mobility Impaired Waiting" list. This process begins the order of the "Mobility Impaired Waiting" list.
- As spaces become available for a refill, hunters on the "Mobility Impaired Waiting" list are called in numerical order and offered the available hunt site.
- The first name on the "Mobility Impaired Waiting" list will be given first option when refilling.
- Hunters must be present when their number is called. If a hunter does not respond within a reasonable amount of time, their name is omitted and the next number is called.

5. Hunt Site Waiting

The hunter entry process utilizing the reservation, lottery draw, and FC, FS systems continues until all hunters have had an opportunity to obtain a permit or the daily hunter quota for the area is reached, whichever comes first.

- If a hunter requests a particular hunting blind, site, pond (hunt sites) that is not available, or if they are filled, the hunter may request that they be placed on the waiting list. The hunter still retains their number and place in line.
- The letter "W" is placed after the name to indicate that the hunter has been placed on the "Hunt Site Waiting" list. This process begins the order of the "Hunt Site Waiting" list.
- As hunt sites become available for a refill, hunters on the "Hunt Site Waiting" list are called in numerical order and offered the available hunt site.

- The first name on the “Hunt Site Waiting” list will be given first option when refilling a hunt site each time there is a refill opportunity. Proceed through the “Hunt Site Waiting” list until it is filled. If not filled, continue to call hunters from remaining lottery and first-come lists.
- Hunters must be present when their number is called. If a hunter does not respond within a reasonable amount of time, their name is omitted and the next number is called.
- Hunters that have not been offered an opportunity to hunt must wait until their number is called before they will be added to the wait list.

6. Free Roam Waiting

If a hunter wishes to hunt free roam and it is at capacity when his number is called, the hunters name may be placed on “Free Roam Waiting” list. By doing so, the hunter gives up the option to take any assigned hunt site that may become available.

- The letters "FR" are placed after the name to indicate that the hunter has been placed on the “Free Roam Waiting” list. This process begins the order of the “Free Roam Waiting” list.
- As free roam spaces become available for refill, hunters on the “Free Roam Waiting” list are called in numerical order and offered the available space.
- The first name on the “Free Roam Waiting” list will be given first option.
- Hunters must be present when their number is called. If a hunter does not respond within a reasonable amount of time, their name is omitted and the next number is called.
- Hunters that have not been offered an opportunity to hunt must wait until their number is called before they will be added to the “Free Roam Waiting” list.

7. MI Blind and Assigned Pond Refill

Unfilled sites that are vacant at 3:00 p.m. and if no MI hunters appear at 3:00 p.m. the following procedures will be in effect:

- Sacramento Refuge – Blinds 5D, 23D and 27D may be refilled with able-bodied hunters at 3:00p.m.
- Delevan Refuge - Blinds 29D and 30D will not be refilled once vacated by the initial mobility impaired hunting party. Blind 13D may be refilled with able-bodied hunters at 3:00p.m.
- Colusa Refuge – The blind may be filled or refilled by the mobility-impaired hunters in Pool 2 at anytime before 3:00p.m. since it is part of the free roam area.

E. Media selection for announcing and publicizing the hunt.

The Complex has a standard list of local media contacts for news releases. The Service will utilize the Complex’s website, kiosks, brochures, and flyers to provide current and accurate information regarding the Refuges’ hunt program. A draft news release regarding the hunting program is attached. An Outreach Plan is also included below.

1. Outreach Plan

1.1. Issue

The Service intends to continue to manage designated areas for migratory bird and upland game bird hunting on Sacramento, Delevan, Colusa, and Sutter Refuges.

1.2. Basic facts about the issue

- The objective for the Refuges is to implement a high quality hunting program including opportunities for approximately 22,000 annual hunting visits on 8,525 acres by 2023, taking into account season length and climatic conditions.
- Hunting of waterfowl, coot, common moorhen, snipe, and pheasant will be allowed in accordance with State and Refuge-specific hunting regulations during the legal hunting seasons and shooting times.
- Hunting is allowed on limited designated areas of the Refuges, during the designated hunting seasons.
- Hunting will be permitted in accordance with State and Federal regulations and seasons to ensure that it will not interfere with the conservation of fish and wildlife and their habitats.
- Method of enforcement and control will take place through boundary and hunting signs, information kiosks, check stations, and routine patrol by the CDFG game wardens and refuge law enforcement officers.
- Biological conflicts will be minimized by use of federally approved non-toxic shot and providing sanctuary areas that are strategically dispersed on the Refuges.
- Measures taken to avoid Biological and Public Use conflicts are discussed under Section VI.
- Hunters are required to enter and exit through a staffed check station where hunter quotas are filled and bird harvest is recorded.
- The number of hunters using the Refuges is limited through daily hunter quotas and only during three days each week.

1.3. Communication goals:

Continue to:

- Solicit input from partners and keep lines of communication open.
- Participate or host the pre and post hunt meetings with the State.
- Solicit input from the Sacramento Refuge Complex Hunting Program Working Group.
- Host the annual Brush Up Day, including the hunter forum.
- Participate in CWA's annual hunter forum.
- Ensure accurate public information and provide news releases.
- Utilize the Complex's website (http://sacramentovalleyrefuges.fws.gov), kiosks, brochures and flyers to provide current and accurate information.

1.4. Message

A quality and safe hunting program is managed and maintained on the Sacramento, Delevan, Colusa, and Sutter Refuges with input and assistance from many partners.

1.5. Interested parties

State fish and wildlife agencies; tribes; nongovernmental organizations; conservation groups; hunting, fishing, and wildlife observation groups; educators; farmers and ranchers; other Federal agencies; members of Congress; State and county representatives; news media; and many members of the public.

F. Description of hunter orientation, including pre hunt scouting opportunities

Maps and hunting information will be provided on the Complex's website, in the California State hunting regulations, and in the Refuges' kiosks. The hunting areas of the Refuges are not open year-round, therefore pre-hunt scouting will not be allowed.

A morning orientation announcement will be provided at the check station by the CDFG State Area Manager over a loud speaker system approximately 20 minutes before reservation process time. The following topics are included: a welcome to the Refuge, purchase of season pass and stamps, cash only, shooting hours, daily bag limits, species, and closures, 25 shell limit, steel or federally approved non-toxic shot, 100 foot of the blind or hunt site restriction (Sacramento and Delevan Refuges only), possession of alcohol while in the field is not allowed, bicycles are not allowed, pull carts are allowed, hunters must enter and exit at designated locations, stopping between designated parking areas to drop off passengers or equipment is not allowed and is a citable offense, trailers are allowed in the check station parking area only and must be removed at the end of the hunt day on Wednesdays and Sundays, observe all regulatory signs, MI boat access, parking and registration, and available harvest information in the kiosk.

G. Hunter requirements

1. State determined age requirement

- Junior and youth hunters, 15 years of age or younger, must be accompanied by an adult.
- Minor hunter, 16-17 years of age, may hunt alone but may not accompany a junior and youth hunter or non-shooter.
- Adult hunter, 18 years of age or older, may accompany a junior, youth, or minor.

2. Allowable equipment

- Method of take: Federally approved non-toxic shot required for all species. No shot shell larger than 12 gauge and no shot size larger than "T" is permitted. Shotguns only are allowed. No rifles, pistols, or archery equipment may be used or possessed on the Refuges.
- Dogs are required to be kept on a leash, except for hunting dogs engaged in authorized hunting activities and under the immediate control of a licensed hunter.
- Hunters must remove from the field all personal property, including decoys, at the end of each day.

3. Licensing and permits

- A State hunting license is required for taking any bird. Hunters must carry licenses and be prepared to show them upon request.

- Federal Duck Stamps are required for hunters 16 and older to take migratory waterfowl.
- State Duck Stamps are required for all hunters, except junior hunters, to take migratory waterfowl.
- Upland Game Bird Stamps are required for all hunters, except junior hunters, to take pheasants.

4. Reporting harvest

- Hunters are required to obtain a valid daily entry permit at the check station to access and exit the hunting area. The permit must be returned before leaving the hunting area with the recorded bird harvest.
- The total daily bird harvest is recorded by the check stations.
- The daily blind harvest averages and/or Refuge bird harvest totals are posted on the Complex and State websites, Refuge telephone information line, and in the hunting kiosks.
- The season totals are recorded in the States Operations Report for each Refuge. The reports are discussed at the post hunting season coordination meeting with the State and Service.

5. Hunter training and safety

The Refuge Systems' guiding principles for hunting programs is to provide quality recreational experiences. The Service's criteria for quality are to promote safety for participants, visitors, and facilities (see Section III).

- Hunters are required to successfully complete a hunter education course in order to purchase a State hunting license.
- The Refuge-specific regulations 1-3, 6, 8, 10, and 12 (see Section VII A) are enforced to address hunter safety.

6. Other information

- Waterfowl and upland game bird hunting: trained retrieving dogs are allowed and encouraged.
- Falconry is not allowed.
- Dog trials are not allowed.

VIII. Evaluation

A. Monitoring and reporting use levels and trends

Each Refuge has a single entry point with a staffed check station. All hunters are required to enter and exit through the check station. Hunters are also required to record their birds harvested. Therefore, accurate, in-depth monitoring including daily hunting visits and bird harvest can be recorded at the Refuge check stations.

Hunter use levels, trends, and needs will be evaluated through hunters' harvest, contact in the field, comments during the annual Working Group meeting, agencies, public meetings, e-mails and letters. The visitor use will be recorded annually in the Refuge Annual Performance Plan.

B. Surveying needs of the hunting visitor

Hunting visitor needs will be surveyed through hunter contacts in the field, discussions during the annual Working Group meeting, pre and post meetings with the State, public meetings, e-mails and letters.

C. Are we meeting program objectives?

The hunting program objective to "provide high quality hunting opportunities on 8,525 acres by 2023," taking into account season length and climatic conditions, will be met through the CCP strategies (Chapter 4, Goal 3). Monitoring will determine if we are meeting program objectives.

D. Do we need to resolve any conflicts?

Not at this time. The hunting program and outreach plans are written to minimize future conflicts.

NEWS RELEASE

U.S. FISH & WILDLIFE SERVICE
Sacramento NWR Complex
752 County Road 99 W
Willows, CA 95988

FOR IMMEDIATE RELEASE
Contact: Denise Dachner
530/934-2801

Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges Open to Hunting

The Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges (Refuges) will provide opportunities for migratory and upland game bird hunting on 8,525 acres beginning on XXXX. Take of waterfowl, coot, common moorhen, snipe, and pheasant will be allowed in accordance with the State of California and Refuge-specific hunting regulations during the legal hunting seasons. Brochures and posted public use signs will assist hunters in determining the Refuges' hunting areas. For further information and Refuge-specific hunting regulations see http://sacramentovalleyrefuges.fws.gov or call 530-934-2801.

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Appendix D. Visitor Services Plan

Table of Contents

Figures

Tables

Summary

The purpose of the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges (Refuges) (Figure 1) visitor services program is to foster understanding and instill appreciation of the fish, wildlife, and plants and their conservation by providing the public with safe, high quality, appropriate, and compatible wildlife-dependent recreational and educational programs and activities. In 1997, Congress passed the National Wildlife Refuge Improvement Act (Improvement Act) which clearly states, that on national wildlife refuges, wildlife comes first. The Improvement Act also identified six priority wildlife-dependent public use activities and programs that are compatible with the mission of the National Wildlife Refuge System. These uses include hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation.

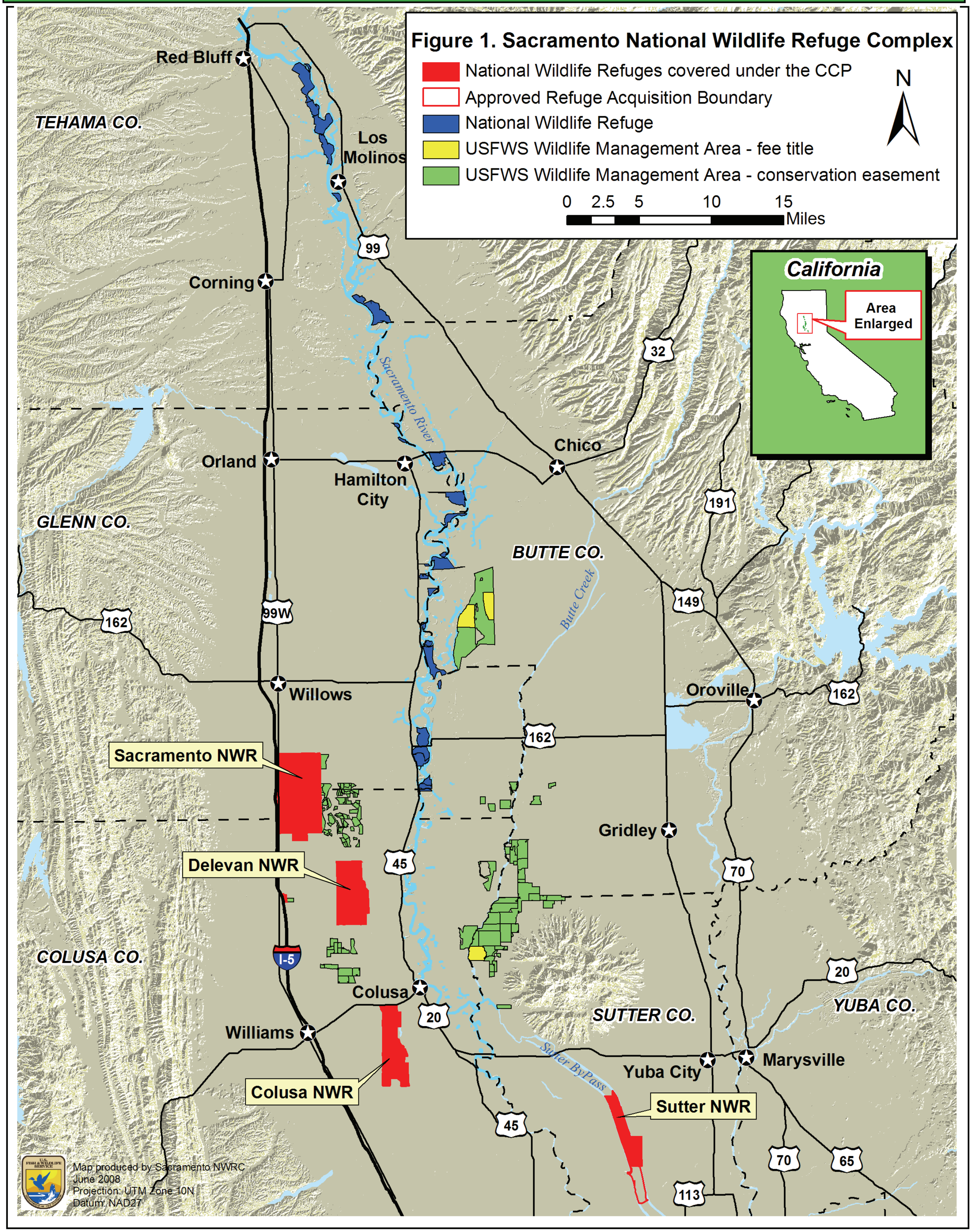
This Visitor Services Plan (VSP) was prepared based upon these guidelines. With the adoption and implementation of the Comprehensive Conservation Plan (CCP) (USFWS 2008a) and this step-down plan, all visitor service activities and programs on the Refuges would be in conformance with national guidelines and would insure that all visitor activities are compatible with the Refuges overarching wildlife mission and purposes.

The purpose of the VSP is to establish priorities and identify improvements, which will guide the Refuges visitor service program over the next fifteen years. A visitor services goal, objectives, and strategies have been identified within the Chapter 4 of the CCP for Sacramento, Delevan, Colusa, and Sutter Refuges (USFWS 2008a). A Hunt Plan, which is a step-down plan from this VSP, has also been prepared (Appendix C of the CCP). This VSP addresses compatible wildlife-dependent recreational uses on the Refuges including hunting, wildlife observation, photography, environmental education, and interpretation (Appendix B of the CCP). Bicycling, a form of non-wildlife dependant recreation, in designated areas has also been determined to be compatible (Appendix B of the CCP). The VSP also addresses the volunteer, Youth Conservation Corps (YCC) programs and the partnership and resource protection goals from Chapter 4 of the CCP (USFWS 2008a).

Introduction

The U. S. Fish and Wildlife Service (Service) manages the Sacramento National Wildlife Refuge Complex (Complex) located in the Sacramento Valley of California (Figure 1) approximately ninety miles north of the city of Sacramento. Five national wildlife refuges (Sacramento, Delevan, Colusa, Sutter, and Sacramento River) and three wildlife management areas (North Central Valley, Willow Creek – Lurline, and Butte Sink) are included in the Complex. The Complex contains critically important habitats for a great diversity of wildlife, particularly migratory birds of the Pacific Flyway. A variety of wetland and upland habitats on the Refuges supports these and many other species.

Sacramento National Wildlife Refuge Complex



Brief History

In 1937, when Sacramento National Wildlife Refuge was established, managers and biologists worked to transform many of the Refuge's dry, alkaline lands into productive managed marshes. Some of the areas were used for growing grain crops to attract waterfowl away from those on private lands. Three additional Refuges were created in the 1940s through the 1980s, forming the Sacramento National Wildlife Refuge Complex. These Refuges, including Delevan, Colusa, and Sutter, were established to provide wintering habitat for waterfowl and in some cases to reduce crop damage. They consist of approximately 23,000 acres of wetland, grassland, and riparian habitats. Seasonal marshes, the Refuges most common habitat type, are drained during spring and remain dry over the summer to encourage plant growth on the moist, exposed soil. Re-flooding in the fall makes seeds and plants available for wildlife. Water management, prescribed burns, disking, and mowing are some of the techniques used to manage wetland habitats.

The fifth refuge, Sacramento River Refuge, was established in 1989 to help protect and restore riparian habitat along the Sacramento River as it meanders through the Sacramento Valley from Red Bluff to Colusa. The Sacramento River Refuge Final CCP (USFWS 2005a) was completed in 2005 and a separate VSP will be completed for this Refuge.

The Complex's three wildlife management areas: North Central Valley, Willow Creek – Lurline, and Butte Sink, except where noted in the CCP, are closed to the public and therefore are not included in this VSP.

For more information, see Chapter 1 of the CCP (USFWS 2008a).

Significant Features

Sacramento, Delevan, Colusa, and Sutter Refuges provide a significant amount of the wintering habitat that supports waterfowl and many other migratory birds in the Sacramento Valley. Forty-four percent of the Pacific Flyway waterfowl population winters in the Sacramento Valley. An abundance and diversity of other migratory birds also winters or migrates through the area. The Refuges currently support nearly 300 species of birds. A total of sixteen Federal and/or State listed threatened or endangered species occur on the Refuges.

Primary Refuge Resource Management Goals

The CCP (USFWS 2008a) contains the primary goals that will define the management direction of the Refuges for the next 15 years. In addition, as part of the CCP, the Refuges developed objectives and strategies that, together, will help achieve the goals.

The five goals of the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges are outlined below. The objectives and strategies can be found in Chapter 4 of the CCP (USFWS 2008a).

Goal 1: Wildlife and Habitat Goal

Conserve, manage, restore, and enhance habitats and associated plant and wildlife species, with an emphasis on supporting an abundance and natural diversity of wintering and migrating waterfowl, shorebirds, birds of prey, and songbirds.

Goal 2: Threatened and Endangered Species Goal
Conserve, manage, restore, and enhance threatened and endangered species and their habitats including vernal pool plants and invertebrates, and giant garter snakes.

Goal 3: Visitor Services Goal
Provide visitors of all ages and abilities with quality wildlife-dependent recreation (hunting, wildlife observation, photography, environmental education, and interpretation), and volunteer opportunities to enhance public appreciation, understanding, and enjoyment of fish, wildlife, habitats, and cultural resources.

Goal 4: Partnership Goal
Promote partnerships to preserve, restore, and enhance a diverse, healthy, and productive ecosystem in which the Refuges play a key role.

Goal 5: Resource Protection Goal
Adequately protect and maintain all natural and cultural resources, staff and visitors, equipment, facilities, and other property on the Refuges.

Local Setting

Community Description

Sacramento Refuge is the headquarters of the Sacramento Refuge Complex and is located in the Sacramento Valley of north-central California (Figure 1). The Refuge is situated about 90 miles north of the metropolitan area of Sacramento and six miles south of the town of Willows, population 6,000. The Refuge consists of 10,819 acres in Glenn and Colusa counties.

Delevan Refuge is located about 80 miles north of the metropolitan area of Sacramento and four miles east of the town of Maxwell, population 1,500 (Figure 1). The Refuge consists of 5,877 acres in Colusa County.

Colusa Refuge is situated about 70 miles north of the metropolitan area of Sacramento and one mile southwest of the town of Colusa, population 5,500 (Figure 1). The Refuge consists of 4,686 acres in Colusa County.

Sutter Refuge is situated about 50 miles north of the metropolitan area of Sacramento, 10 miles southwest of Yuba City, population approximately 60,000, and five miles south of Sutter, California (Figure 1). The Refuge consists of 2,591 acres in Sutter County.

For additional information, see Chapter 3 of the CCP (USFWS 2008a).

Local Economy

Agriculture is the dominant economic enterprise in the northern Sacramento Valley and provides nearly 20 percent of the jobs in the Central Valley. The diversity of crops grown in the Sacramento Valley reflects the diversity of soils, climate, cultural and economic factors. Glenn County's major crops include rice, almonds, prunes, and corn; Colusa County's include rice, tomatoes, and almonds; and Sutter County's include rice, plums, peaches, walnuts, and tomatoes.

Countywide agricultural production values are $280.9 million for Glenn County, $346 million for Colusa County, and $343 million for Sutter County (California Department of Finance 2002).

The 2005-2025 County-Level Economic Forecast (California Department of Transportation 2005) reported that Glenn County's per capita income is $21,210, and the average salary per worker is $30,780. Colusa County's per capita income is $27,690, and the average salary per worker is $31,450. Sutter County's per capita income is $26,940, and the average salary per worker is $32,150.

For additional information, see Chapter 3 of the CCP (USFWS 2008a).

Demographics

In the first 150 years of statehood, California grew from fewer than 100,000 citizens in 1850 to almost 34 million in 2000 (California Department of Finance 2002). Between 1950 and 2000 alone, California's population increased by 200 percent (California Department of Finance 2002). If California continues to add nearly 500,000 persons each year, by 2012, the population could easily exceed 40 million. The 50-million mark will be passed sometime between 2030 and 2040 if current growth rates persist (California Department of Finance 2002).

The Central Valley has been one of the fastest growing areas in California during the last few decades. As of July 1997, the Central Valley had seventeen percent of the State's population (Munroe and Jackman 1999).

In 2005, Glenn County's population was 28,197 and is expected to increase to 32,000 residents by 2020 (California Department of Finance 2005). The racial makeup of the county was 71.8 percent white, 29.6 percent Hispanic, 3.4 percent Asian, 2.1 percent Native American, 0.6 percent African American, with the remaining percentage from other races (percentage total can be greater than 100 percent because Hispanics can be counted in multiple races, US Census Bureau 2000). The estimated median family income was $32,107.

Colusa County is home to 20,800 residents and is projected to increase to 26,000 residents by 2020 (California Department of Finance 2005). The racial makeup of the county was 64.3 percent white, 46.5 percent Hispanic, 2.3 percent Native American, 1.2 percent Asian, 0.5 percent African American, with the remaining percentage from other races (percentage total can be greater than 100 percent because Hispanics can be counted in multiple races, US Census Bureau 2000). The estimated median family income was $35,062.

Sutter County's population was 88,945 people and is expected to increase to 112,000 people by 2020 (California Department of Finance 2005). The racial makeup of the county was 67.5 percent white, 22.2 percent Hispanic, 11.3 percent Asian, 1.9 percent African American, 1.6 percent Native American, with the remaining percentage from other races (percentage total can be greater than 100 percent because Hispanics can be counted in multiple races, US Census Bureau 2000). The estimated median family income was $38,375.

The Sacramento River Public Recreation Access Study (EDAW 2003) was conducted to assess existing and potential public recreation uses, accesses, needs, and opportunities along the Sacramento River between Red Bluff and Colusa. This study indicates a substantial public interest in recreational activities of boating, fishing, and hunting. Additionally, other uses such as bird watching, wildlife viewing, and other nature observation activities are expected to increase 65 percent over the next 40 years. EDAW (2003) depicts a profile of the potential local refuge visitor as predominately Caucasian, 31-50 years of age with some college education/trade school education. As the population in the region grows, demand for recreation activities will increase. Planning will need to strike a balance between recreation use and conservation goals.

The report "Banking on Nature 2006: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation" (USFWS 2007) detailed the findings from 80 national wildlife refuges, including Sacramento Refuge. The Banking on Nature 2006 study included money spent for food and refreshments, lodging at motels, cabins, lodges or campgrounds, and transportation when it calculated the total economic activity related to refuge recreational use. Sacramento Refuge had over 137,430 visits in 2006. Refuge visitors enjoyed a variety of activities, including wildlife viewing, hiking, and migratory bird hunting. Non-residents accounted for about 127,408 or 93 percent of recreation visits and almost all of the visits were for non-consumptive recreations (129,257). Sacramento Refuge generated an estimated $2.4 million in total economic activity related to refuge recreational use with associated employment of 25 jobs, $773,500 in employment income and $391,100 in total tax revenue. Total expenditures were $1.8 million with non-residents accounting for $1.7 million or 96 percent of total expenditures. Expenditures on hunting accounted for 57 percent of all expenditures, and non-consumptive activities accounted for 43 percent. Sacramento Refuge generated $2.78 of recreation-related benefits for every $1 of budget expenditure during 2006.

For additional information, see Chapter 3 of the CCP (USFWS 2008a).

Visitor Data

The Complex utilizes a variety of methods for estimating the number of annual wildlife-dependent visits. The types of estimation methods used are direct observation, traffic counters, hunter permits, surveys, and estimation based on professional judgment. From these estimates, the numbers of visitors and visits are used to manage and improve the Refuges' visitor services program.

The National Wildlife Refuge System Visitation Estimation Workbook (USFWS 2005b) provides basic principles and definitions that have been used to describe the Refuge visitation estimation program.

Refuge recreational or educational activities that are allowed and monitored include wildlife observation, environmental education, interpretation, photography, and hunting. Wildlife observation has been more specifically reported as auto tour and hiking trail visits.

A Refuge visitor (visitor) is a person that participates in at least one of the wildlife-dependent activities (e.g. wildlife viewing, hunting, environmental education, interpretation, or photography). Visitors do not include staff, volunteers, researchers, contractors, special use permittees, or people who are traveling through the refuge to reach another non-refuge location. A single visitor may make several visits to the refuge during the year by participating in one or more activities.

A visitor is not the same as a Refuge visit (visit). A single visitor can make several visits to the Refuge on a single day by participating in several different activities. The total amount of visits on a given day is a count of only individuals. The amount of time for each individual visit is not accounted for; whether it be minutes to hours.

It should be noted that there is not a 100 percent accurate method of counting all visitors or visits. Therefore, the numbers of visitors or visits reported are only estimates. The Refuge strives for consistency and quality of estimation monitoring methods to improve the accuracy of the information collected. Unfortunately, the reporting systems Refuge Management Information System (RMIS) and the Refuge Annual Performance Plan (RAPP) change annually, making it more difficult to accurately compare annual visitation.

Table 1 depicts the number of Refuge visitors and visits for some of the primary wildlife-dependent Refuge activities over the last five years. The environmental education, interpretation and photography blind visits were collected from reservation forms. Hunting visit information was collected from hunting permits and professional estimations of hunting activities (e.g. a hunter in the free roam area may hunt several species during waterfowl and pheasant season). The auto tour and hiking trail visits are a percentage of the vehicle counts that are recorded by a traffic counter at the Refuge entrance. The vehicle counts are multiplied by three due to a Refuge survey that documented an average of three people per vehicle. It should be noted that the 2002-2004 data is based on RMIS reports and 2005-06 is based on RAPP. The data management systems are not directly comparable, since they each used a different reporting methodology to determine activity visits. The annual visitors are comparable, since the same formula was used. On Sacramento and Colusa Refuges, the formula is: Annual Visitors = Vehicle Counts X 3 + Interpretation + EE + Hunting + Photo Blind Visitors. On Delevan and Sutter Refuges, the annual visitors equal the hunting visits.

Table 1. Refuge Visitation Trends FY 2002-2006

	2002	2003	2004	2005	2006	Five Year Average
Sacramento						
Annual Visitors	**67,619**	**75,528**	**71,617**	**89,138**	**86,165**	**78,103**
Auto Tour Visits	48,345	53,842	51,646	73,149	60,616	**57,520**
Hiking Trail Visits	8,566	8,418	8,064	9,443	8,735	**8,645**
Hunting Visits	8,203	7,052	6,851	7,386	7,683	**7,435**
Environmental Education Visits	2,851	3,027	2,799	3,032	2,528	**2,847**
Interpretation Visits	807	1,065	630	125	150	**555**
Photo Blind Visits	20	33	39	34	33	**32**
Delevan						
Annual Visitors	**6,073**	**5,660**	**5,881**	**5,678**	**6,386**	**5,936**
Hunting Visits	6,073	5,660	5,881	5,678	6,386	**5,936**
Colusa						
Annual Visitors	**24,308**	**31,135**	**26,364**	**20,426**	**16,284**	**25,311**
Auto Tour Visits	16,246	21,847	18,084	16,547	13,027	**17,150**
Hiking Trail Visits	4,185	5,610	4,496	4,127	3,256	**4,335**
Hunting Visits	3,877	3,678	3,784	3,879	3,910	**3,826**
Environmental Education Visits	168	60	65	39	24	**71**
Interpretation Visits	0	0	88	0	0	**18**
Photo Blind Visits	NA	NA	NA	NA	12	**12**
Sutter						
Annual Visitors	**3,058**	**1,241**	**2,620**	**2,870**	**2,152**	**2,388**
Hunting Visits	3,058	1,241	2,620	2,870	2,152	**2,388**
TOTAL ANNUAL VISITORS	**96,924**	**108,135**	**101,869**	**118,112**	**110,999**	**107,208**

Travel Links

Major transportation routes in the vicinity of the Refuge include Interstate 5, State highways 99, 45, 162 and 20, and county route 99W. Many small paved county roads provide for local transportation, offering service access to local agricultural activities. These, and the large interstate and highways, provide access to Refuge visitor contact stations and parking lots. There are no alternative transportation systems that provide access to the Refuges.

Visitor Services Opportunities (off-refuge)

Sacramento River National Wildlife Refuge

Established in 1989, the fifth Refuge in the Complex, Sacramento River Refuge, is composed of 27 units along a 77-mile stretch of the Sacramento River between Red Bluff and Princeton. As of 2006, Refuge lands comprise approximately 10,000 acres of riparian habitat, wetlands, uplands, and intensively managed walnut, almond, and prune orchards.

Sacramento River Refuge has 18 units that are open to public access offering wildlife observation, photography, interpretation, and environmental educational opportunities. In addition, hunting and fishing are allowed on selected units of the Refuge. Gravel bars also continue to be open for hunting, fishing, and camping.

Mendocino National Forest

The Mendocino National Forest straddles the eastern spur of the Coastal Mountain Range in northwestern California, just a three-hour drive north of San Francisco and Sacramento. Some 65 miles long and 35 miles across, the Forest's 913,306 federally owned acres of mountains and canyons offer a variety of recreational opportunities: camping, hiking, backpacking, boating, fishing, hunting, nature study, photography, and off-highway vehicle travel. The Forest’s office is located in Willows.

California Department of Fish and Game

Located approximately 60 miles north of Sacramento, the 9,100 acre Gray Lodge Wildlife Area’s (WA) diversity and location along the Pacific Flyway make this a heaven for wildlife. Wildlife viewing is available all year. In the fall and winter, a vast number of migratory waterfowl fill the sanctuary with lively chatter and incredible sights. For the more avid photographers and viewers, two viewing hides are available. Hunters enjoy many species of wildlife they may take during the regulated hunting seasons. Fishing is also a highlight in the spring and summer. Educational programs, informative exhibits, a self-guided nature trail and seasonal guided tours are used by thousands of visitors every year.

Upper Butte Basin WA includes Howard Slough, Little Dry Creek, and Llano Seco units encompassing 9,376 acres. The WA provides local recreational opportunities including hunting, wildlife observation, and photography.

Sacramento River WA consists of 3,737 acres of riparian woodland, meadows, and gravel bars. Most areas are accessible only by boat and provide local recreation opportunities including hunting, fishing, wildlife observation, and photography.

Oroville WA is located west of Oroville adjacent to the Feather River. It consists of 11,870 acres of riparian forest, bordered by 12 miles of river channels. Local recreation opportunities include fishing, camping, hunting, and wildlife observation.

Other Areas

The Bureau of Land Management, Army Corps of Engineers (Black Butte Lake), California State Parks, and various city and county agencies all provide additional recreation opportunities near the Refuges.

Visitor Services Standards

The Service Manual (605 FW 1-7) provides Service policies, strategies, and requirements for management of wildlife-dependent recreation programs within the National Wildlife Refuge System (Refuge System).

The Service Manual (605 FW 1, Section 1.6) states: the Refuge System provides a unique opportunity to ensure that we approach our compatible wildlife-dependent recreation programs from the perspective of the Refuge System mission and goals. We believe wildlife-dependent recreation that comports well with the following criteria will continue to meet the needs and desires of refuge visitors. To ensure continued visitor satisfaction with our wildlife-dependent recreation programs, we incorporate public input using visitor satisfaction surveys or other instruments, including input during the development of a CCP or VSP, that help us define and evaluate wildlife-dependent recreation programs at each refuge. We develop our wildlife-dependent recreation programs in consultation with State fish and wildlife agencies and stakeholder input based on the following criteria:

- Promotes safety of participants, other visitors, and facilities;
- Promotes compliance with applicable laws and regulations and responsible behavior;
- Minimizes or eliminates conflict with fish and wildlife population or habitat goals or objectives in an approved plan;
- Minimizes or eliminates conflicts with other compatible wildlife-dependent recreation;
- Minimizes conflicts with neighboring landowners;
- Promotes accessibility and availability to a broad spectrum of the American people;
- Promotes resource stewardship and conservation;
- Promotes public understanding and increases public appreciation of America's natural resources and our role in managing and conserving these resources;
- Provides reliable/reasonable opportunities to experience wildlife;
- Uses facilities that are accessible to people and blend into the natural setting; and
- Uses visitor satisfaction to help define and evaluate programs.

In 2007, the Service declared that "connecting people with nature" is among the agencies highest national priorities (USFWS 2008b). A connection with nature, whether it's hiking, fishing, camping, hunting, or simply playing outside, helps children develop positive attitudes and behaviors towards the environment. Positive interactions with the environment can lead to a life-long interest in enjoying and preserving nature. People's interest in nature is crucial to the Service mission of conserving, protecting, and enhancing fish, wildlife, plants, and their habitats.

When U.S. Fish and Wildlife Service employees were asked to describe a childhood experience where they felt a connection with nature, the answers ranged from memories of riding on the laps of loved ones while mowing the lawn, to family vacations along a lake, beach, or forest, to hiking, climbing trees, and discovering insects, frogs, and birds. Many employees credit these memorable moments for placing them in the career that they are in today. Those experiences were the spark that led to a lifetime of stewardship and conservation. The Service wants to capture that spark and share it with the next generation of conservationists. The Connecting People with Nature Program goals for Region 8 include 1) rekindle the spark, 2) share the spark and 3) ignite the spark. Currently, these goals are being implemented on the Refuges.

Welcome and Orient Visitors

We will assure that our Refuges are welcoming, safe, and accessible. We will provide visitors with clear information so they can easily determine where they can go, what they can do, and how to safely and ethically engage in recreational and educational activities. Facilities will meet the quality criteria defined in 605 FW 1, Section 1.6 of the Service Manual. We will treat visitors with courtesy and in a professional manner.

Our Visitors Services goal, as stated in the CCP (USFWS 2008a), is to:

> *Provide visitors of all ages and abilities with quality wildlife-dependent recreation (hunting, wildlife observation, photography, environmental education, and interpretation), and volunteer opportunities to enhance public appreciation, understanding, and enjoyment of fish, wildlife, habitats, and cultural resources.*

Provide Quality Hunting Opportunities

Hunting is a wildlife-dependent recreational use and, when compatible, an appropriate use of resources in the Refuge System. Hunting programs will meet the quality criteria defined in the Visitor Services Standards above and, to the extent practicable, be carried out consistent with State laws, regulations, and management plans.

Hunting Objective

Implement a high quality hunting program including opportunities for approximately 22,000 annual hunting visits on 8,525 acres by 2023, depending on season length and climatic conditions.

Rationale: Hunting is identified in the Improvement Act as a priority public use that can be allowed when compatible with other Refuge purposes. As a result, the Refuge proposes waterfowl, coot, common moorhen, snipe, and pheasant hunting, all of which are currently hunted on the Refuges. The hunting program will be conducted in a safe and cost-effective manner and will be carried out consistent with State regulations. The Hunting Plan (Appendix C of the CCP) was developed to provide safe hunting opportunities, while minimizing conflicts with other priority wildlife-dependent recreational uses. Other visitor uses occur on different areas, thereby minimizing potential conflicts with hunters (Figures 2-5, or 11-14 from the CCP). The Refuge hunting program complies with the Code of Federal Regulations Title 50, 32.1 and is managed in accordance with Service Manual 605 FW 2, Hunting.

Figure 11. Sacramento Refuge - Visitor Services

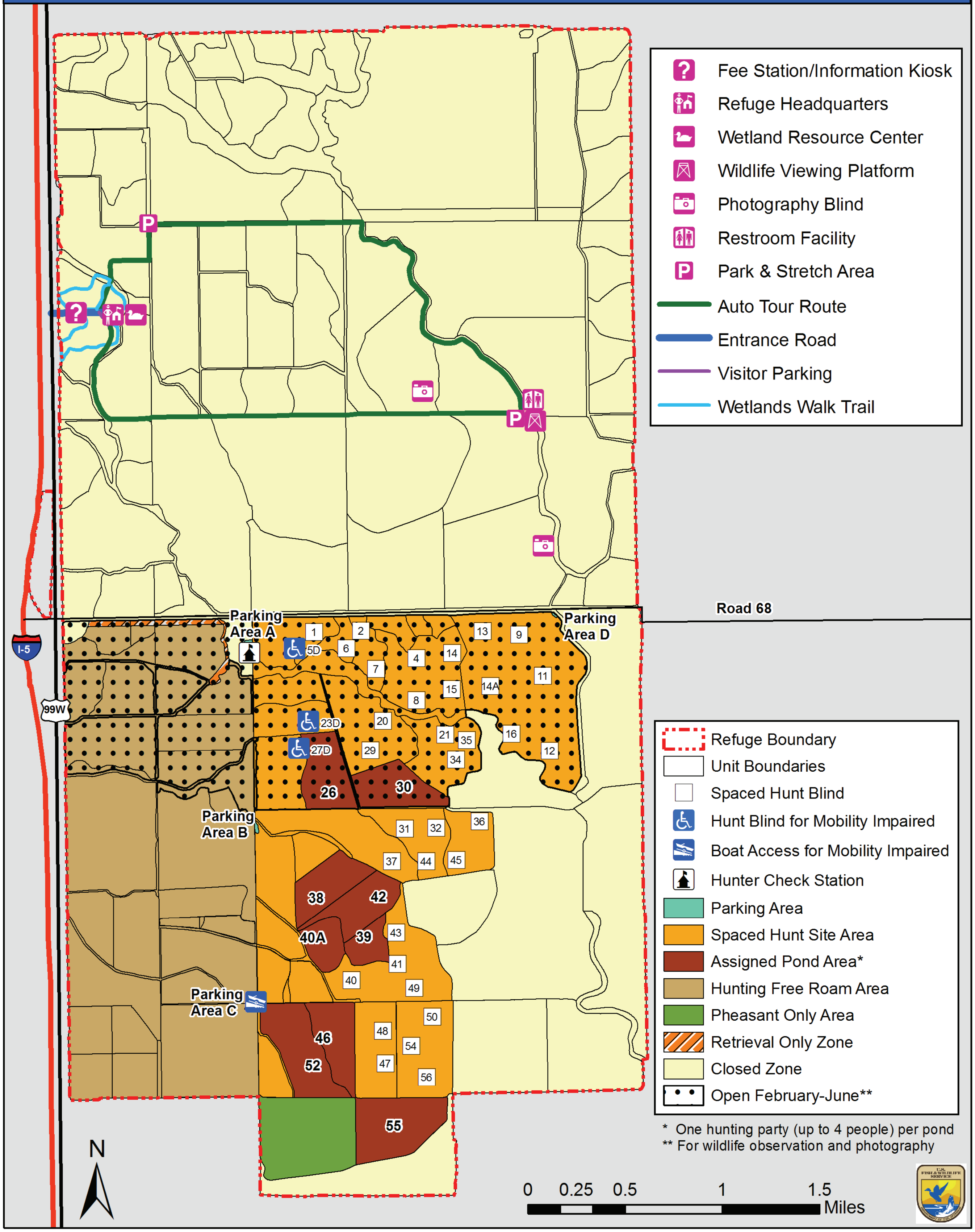
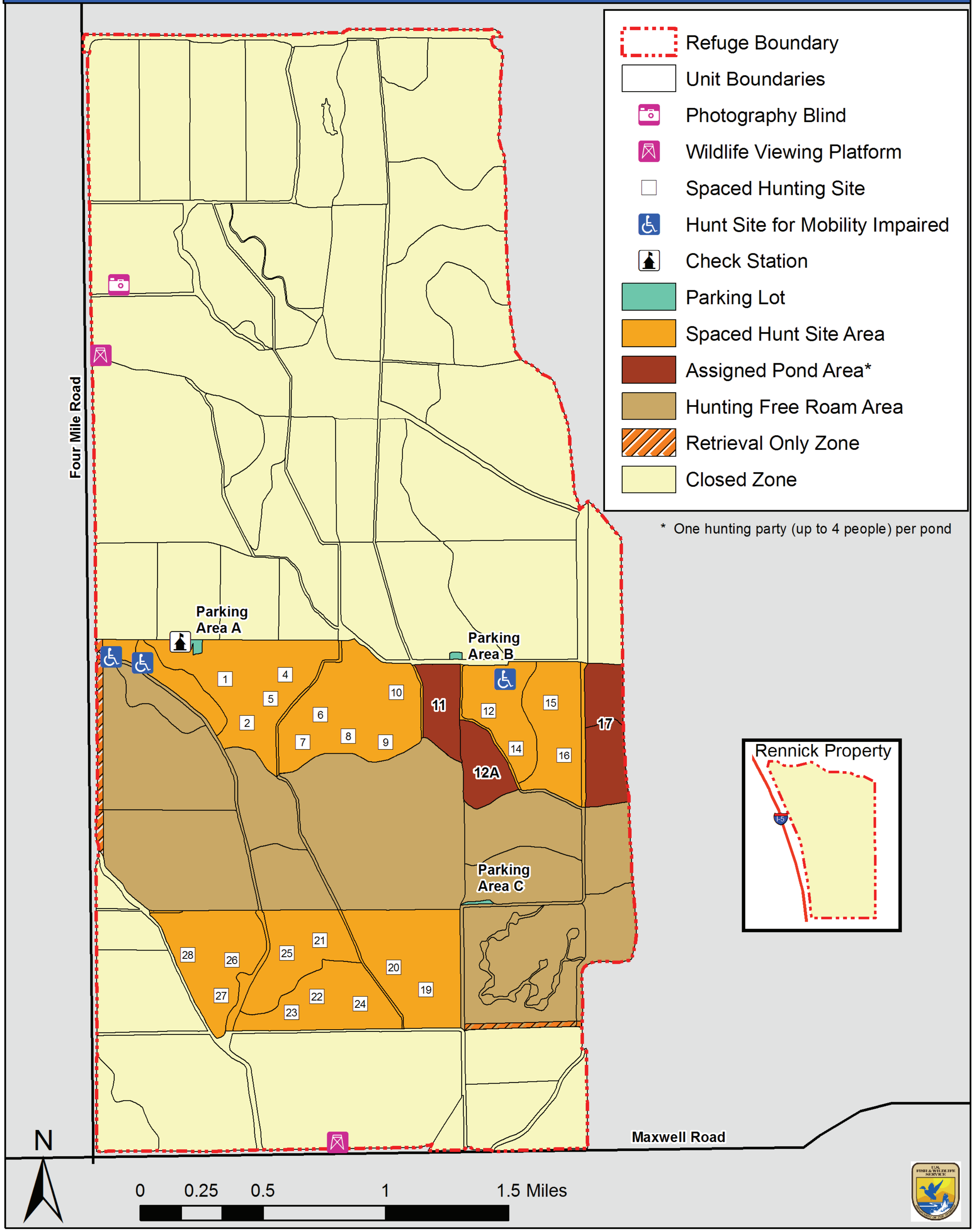


Figure 12. Delevan Refuge - Visitor Services



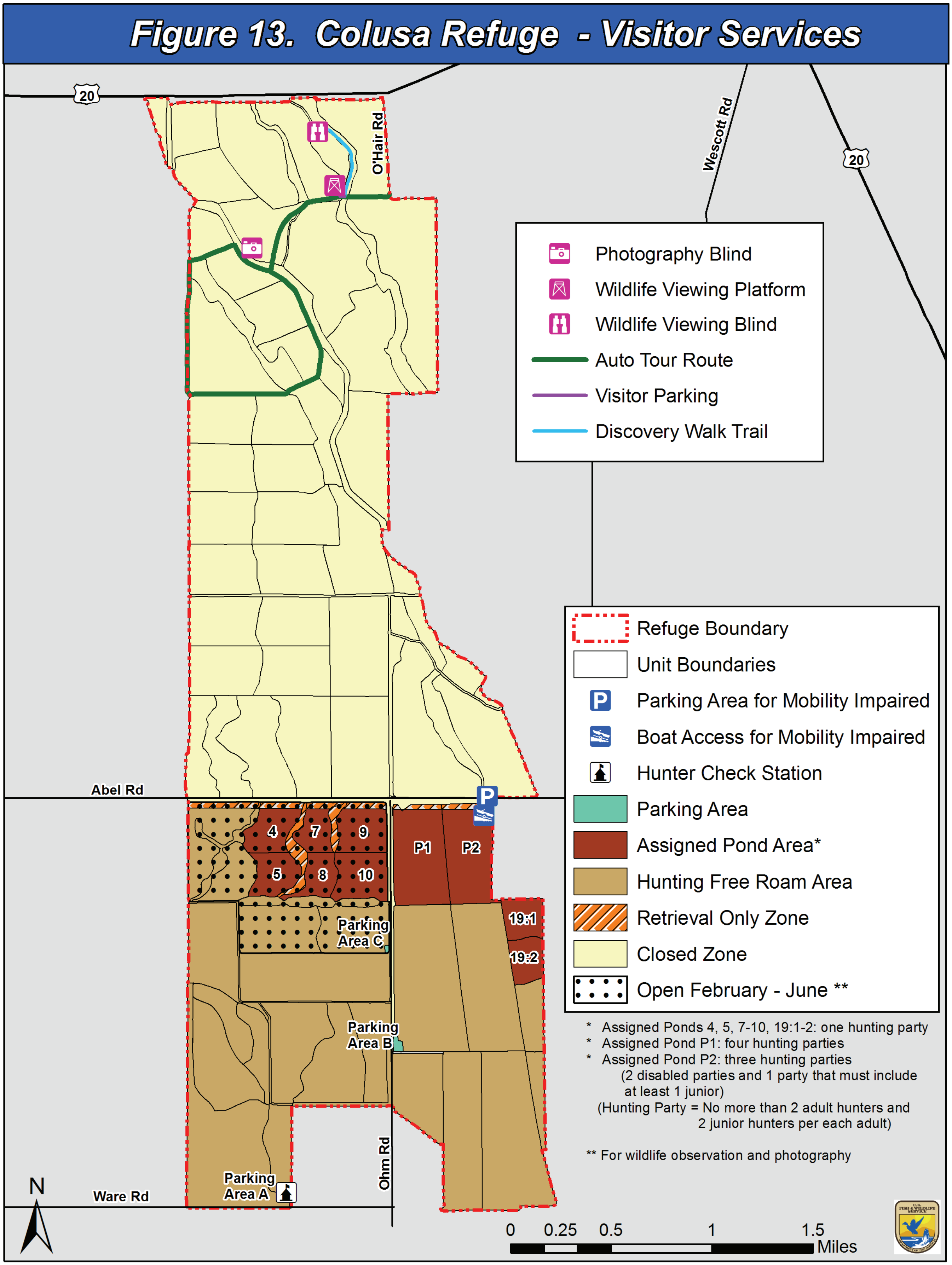
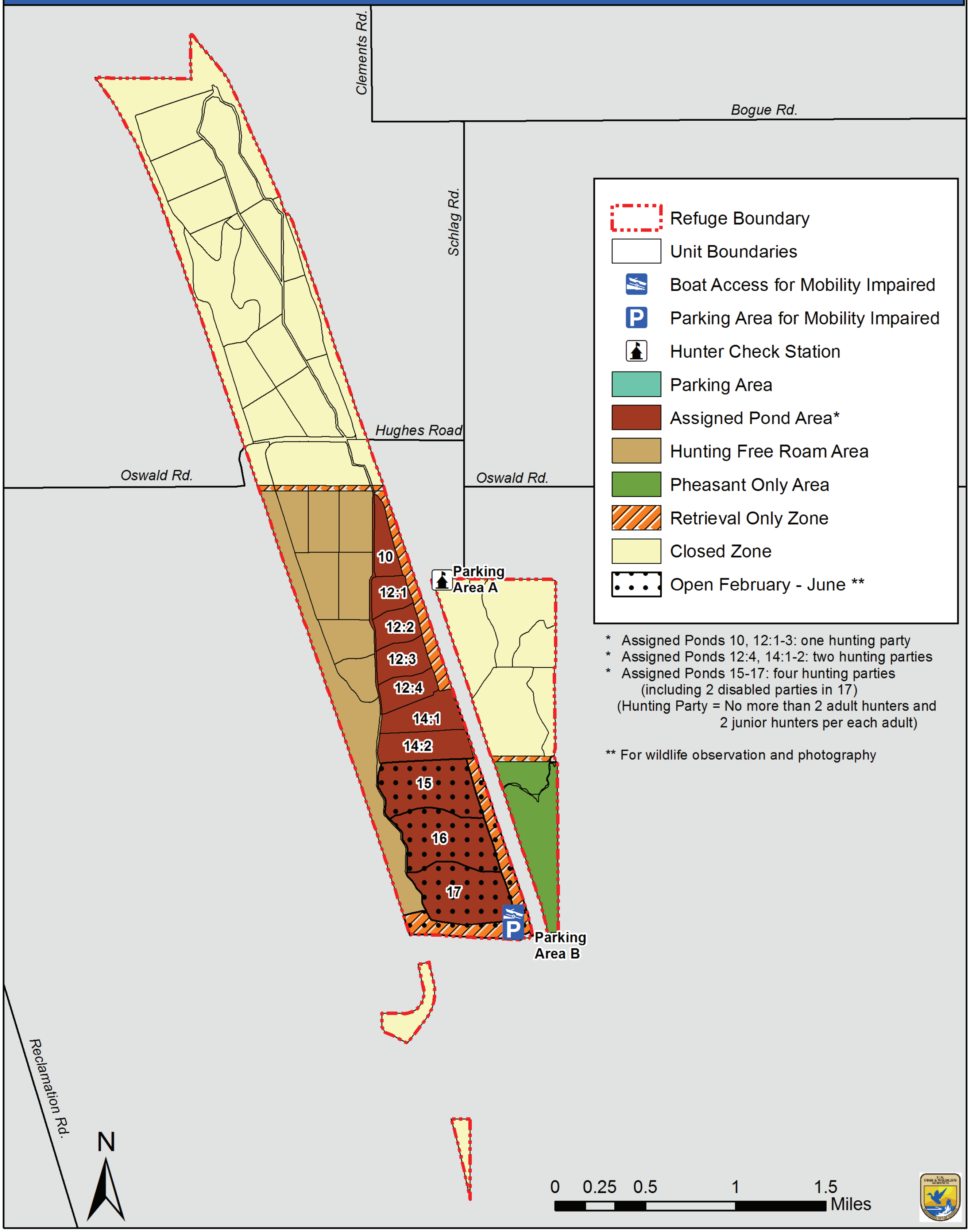


Figure 13. Colusa Refuge - Visitor Services
20
O'Hair Rd
Wescott Rd
20
Photography Blind
Wildlife Viewing Platform
Wildlife Viewing Blind
Auto Tour Route
Visitor Parking
Discovery Walk Trail
Refuge Boundary
Unit Boundaries
Parking Area for Mobility Impaired
Boat Access for Mobility Impaired
Hunter Check Station
Parking Area
Assigned Pond Area*
Hunting Free Roam Area
Retrieval Only Zone
Closed Zone
Open February - June **
Abel Rd
4
7
9
5
8
10
P1
P2
19:1
19:2
Parking Area C
Parking Area B
Parking Area A
Ohm Rd
Ware Rd
N
0 0.25 0.5 1 1.5 Miles
* Assigned Ponds 4, 5, 7-10, 19:1-2: one hunting party
* Assigned Pond P1: four hunting parties
* Assigned Pond P2: three hunting parties
(2 disabled parties and 1 party that must include at least 1 junior)
(Hunting Party = No more than 2 adult hunters and 2 junior hunters per each adult)
** For wildlife observation and photography

Figure 14. Sutter Refuge - Visitor Services



* Assigned Ponds 10, 12:1-3: one hunting party
* Assigned Ponds 12:4, 14:1-2: two hunting parties
* Assigned Ponds 15-17: four hunting parties (including 2 disabled parties in 17)
(Hunting Party = No more than 2 adult hunters and 2 junior hunters per each adult)

** For wildlife observation and photography

Hunting Strategies:

1. Implement the Hunting Plan for the Refuges.

2. Coordinate hunt program operations with California Fish and Game Department (CDFG) including the annual pre and post hunting meetings.

3. Add hunt program changes to CDFG regulations and 50 CFR annually.

4. Provide the Complex's hunting brochure at the hunter check station, interpretive kiosks, and the visitor center.

5. Disseminate hunting information packet at the Complex visitor center.

6. Provide and update hunting information on the Complex's 24-hour telephone information line and on the website.

7. Continue to coordinate the Junior and Youth Waterfowl Hunts on Sacramento, Delevan, and Colusa Refuges with California Waterfowl Association and CDFG.

8. Monitor hunting visits and bird harvest every hunt day.

9. Work with the Complex's Refuge Hunting Program Working Group to develop and improve the Refuge hunting program, including access and facilities for hunters with disabilities.

10. Work cooperatively with CDFG wardens to enforce State Fish and Game hunting laws and Refuge-specific regulations to provide a quality experience for all visitors.

11. Maintain hunter check stations and kiosks to effectively process hunters and provide hunter-related information.

12. Convert a portion of the free roam area to assigned ponds at Sutter and Colusa Refuges and convert some spaced blinds to assigned ponds at Sacramento Refuge.

13. Consider allowing limited spring turkey hunting opportunities on Sacramento, Delevan, and Colusa Refuges based on sufficient populations, habitat conditions, and the development of a turkey hunt management plan, as well as appropriate National Environmental Policy Act compliance.

14. Hire one full-time clerk position to implement the hunting program and support other Refuge programs.

Current Program

See Chapter 3 of the CCP (USFWS 2008a).

Proposed Change

See Hunt Plan (Appendix C of the CCP) (USFWS 2008a).

Monitoring and Evaluation

See Hunt Plan (Appendix C of the CCP) (USFWS 2008a).

Provide Quality Fishing Opportunities

Fishing is a wildlife-dependent recreational use and, when compatible, an appropriate use of resources in the Refuge System. Fishing programs will meet the quality criteria defined in the Visitor Services Standards above and, to the extent practicable, be carried out consistent with State laws, regulations, and management plans.

Current Program

Currently there is no public fishing access on Sacramento, Delevan, Colusa, and Sutter Refuges.

Proposed Change

None.

Monitoring and Evaluation

None.

Provide Quality Wildlife Observation

Visitors of all ages and abilities will have an opportunity to observe key wildlife and habitat on the Refuges when it is compatible with the refuges' purpose(s). Viewing wildlife in natural or managed environments should foster a connection between visitors and natural resources. The wildlife observation program will meet the quality criteria defined above.

Wildlife Observation Objective

Provide quality opportunities for 100,000 wildlife viewing annual visits on 8,575 acres by 2023.

Rationale: Wildlife observation is identified in the Improvement Act as a priority public use that can be allowed when compatible with other Refuge purposes. As a result, the Refuges' encourage first-hand opportunities to observe wildlife in their habitats. This activity will be managed to ensure that people have opportunities to observe wildlife in ways that minimize wildlife disturbance and damage to Refuge habitats. Wildlife viewing will be managed to foster a connection between visitors and natural resources. This Visitor Services Plan was developed to provide guidance for the Refuges' public use program. The wildlife observation program will be managed in accordance with Service Manual 605 FW 4, Wildlife Observation.

Wildlife Observation Strategies:

1. Maintain and enhance auto tour routes on Sacramento and Colusa Refuges to provide viewing opportunities of wildlife and their habitats.

2. Expand the hours on all Refuges to one hour before sunrise to one hour after sunset.

3. Maintain the wildlife viewing facilities on Sacramento, Delevan, and Colusa Refuges.

4. Upgrade walking trails on Sacramento and Colusa Refuges to provide for universal access.

5. Construct a walking trail on Sutter Refuge and provide guided tours from April-June.

6. Continue to plan and integrate universal access, facilities and programs to provide and enhance a quality wildlife observation program, including replacement of the wildlife observation blind at Colusa with an accessible blind and boardwalk.

7. Open selected portions of the hunt area (2,275 acres) and modify parking areas to provide wildlife observation from February through June (post waterfowl season) on Sacramento, Colusa, and Sutter Refuges.

8. Add wildlife-viewing platforms along Maxwell Road and Four Mile Road on Delevan Refuge.

9. Install a remote camera on an eagle nest or a view of the Butte Sink WMA to facilitate viewing via the Complex's website and the Refuge Headquarters.

10. Increase the Refuge Day and Annual Pass fees.

11. Hire a full-time tractor operator and maintenance worker to implement the wildlife observation and support other Refuge programs.

Current Program

Sacramento Refuge is open to the public for wildlife observation daily along the auto tour route and trails from sunrise to sunset year-round. The visitor center, auto tour route, and wetlands walking trail currently accommodate approximately 66,165 annual visits (Table 1). The six-mile auto tour route meanders along marshes and riparian areas of Logan Creek. There are two park and stretch areas on the auto tour route where visitors are encouraged to get out of their vehicles to view wildlife. At the first park-and-stretch area halfway along the auto tour route, there is a three-tier wildlife-viewing platform with two spotting scopes. The two-mile walking trail also meanders along marshes and riparian areas of Logan Creek. Using the new Wetlands Walk Guide, groups may stroll by the fourteen stops for an hour-long adventure. If time is limited, visitors may take alternate trail shortcut routes. Binoculars are loaned to visitors using the auto tour and walking trail on Sacramento Refuge to enhance their viewing opportunities.

Delevan Refuge is open to the public for wildlife observation and photography along perimeter roads only. A primitive off-Refuge parking area is currently available for visitors along the Maxwell Road on the southern boundary of the Refuge.

On Colusa Refuge, visitors enjoy wildlife viewing as they drive the three-mile, graveled auto tour route adjacent wetlands. A universally accessible wildlife viewing platform is located at the beginning of the auto tour route. A one-mile walking trail is located along a lush riparian slough. The auto tour route and trail are open sunrise to sunset year-round. The Refuge receives an average of 21,485 annual auto tour and hiking trail visits (Table 1).

Roads adjacent to Sutter Refuge provide the public with opportunities for wildlife observation throughout the year.

Proposed Change

The Refuges will be open from one hour before sunrise to one hour after sunset.

A portion of the hunt area (2,275 acres) will be open for photography from February through June on Sacramento, Colusa, and Sutter Refuges. Visitors would utilize the existing directional blind, directional assigned pond and free roam boundary signs to access the areas. Boundary closed signs would be added and taken down seasonally.

A primitive parking area along the Maxwell Road on Delevan Refuge is currently available for visitors. Construction of a viewing platform and other improvements to this site are planned. An additional parking area and viewing platform along Four Mile Road is also planned.

The walking trail on Colusa Refuge will be upgraded to provide for universal access and the wildlife viewing blind will be replaced with a universally accessible blind and boardwalk.

Scheduled guided tours on the southern portion of the Sutter Refuge will be conducted during February through June when staff and funding are available. In addition, a walking trail utilizing the existing roads will be available.

Monitoring and Evaluation

Vehicle counters on Sacramento and Colusa Refuges assist in monitoring the number of visitors monthly. Visitors are also encouraged by Refuge staff to sign their name and address in a registration book located in the visitor center. This information helps determine visitor group size and travel distance. Visitor Service Assistants (VSA) staff the visitor center seven days a week November through February. During this time, the VSAs engage visitors in conversations that help evaluate the wildlife viewing facilities and program. Walking trail use is periodically observed for use and effectiveness. In addition, our questions and comments from our website visitors help assess our wildlife-viewing program.

Provide Quality Photographic Opportunities

Visitors of all ages and abilities will have an opportunity to photograph key wildlife and habitat on the refuges when it is compatible with the refuges' purpose(s). Photographing wildlife in natural or managed environments should foster a connection between visitors and natural resources. The photography program will meet the quality criteria defined in the Visitor Services Standards above.

Wildlife Photography Objective

Provide quality opportunities for 80 photography blind visits and 10,000 wildlife photography annual visits on 8,758 acres by 2023.

Rationale: Wildlife photography is identified in the Improvement Act as a priority public use that can be allowed when compatible with other Refuge purposes. As a result, the Refuges' encourage first-hand opportunities to observe and photograph wildlife in their habitats. This activity will be managed to ensure that people have opportunities to photograph wildlife in ways that minimize wildlife disturbance and damage to Refuge habitats. Wildlife photography will be managed to foster a connection between visitors and natural resources. The wildlife photography program will be managed in accordance with Service Manual 605 FW 5, Wildlife Photography.

Wildlife Photography Strategies:

1. Maintain and enhance auto tour routes on Sacramento and Colusa Refuges to provide photographic opportunities from a vehicle.

2. Maintain two wildlife photography blinds on Sacramento Refuge and one wildlife photography blind on Colusa Refuge.

3. Construct and maintain a universally accessible photography blind on Delevan Refuge. Replace one of the Sacramento Refuge wildlife photography blinds with a universally accessible blind.

4. Open selected portions of the hunt area (2,275 acres) and modify parking areas to provide wildlife photography from February through June (post waterfowl season) on Sacramento, Colusa, and Sutter Refuges.

5. Update photographer guidelines, maps, and photography blind reports annually.

6. Evaluate photography blind reports and implement changes annually.

7. Maintain the Complex's website to provide information about current photographer guidelines and facilities.

8. Offer photography workshops and guided field trips on Sacramento Refuge utilizing the Wetlands Resource Center.

Current Program

The auto tour and walking trail on both Sacramento and Colusa Refuges provide excellent photographic opportunities. Sacramento Refuge receives an average of 32 annual photo blind visits and Colusa Refuge receives an average of 12 annual photo blind visits (Table 1). The best time of year for photography occurs from November through February, when a variety of waterfowl and shorebirds are present.

Additionally, there are two photography blinds on Sacramento Refuge and one on Colusa Refuge. The blinds may be reserved one day each week only on Wednesdays through Sundays for a small fee (currently $10). Limiting use promotes continued bird use of the surrounding areas, and thereby improving the potential for good photography opportunities. They are typically available October through March depending on habitat conditions. When habitat conditions are suitable, the blinds are available for use during the spring and summer months. Photographers may request up to three reservations each season and may be placed on a waiting list if the blind or day requested is filled. Photographers also complete an evaluation that reports photographed species, time spent, and comments.

Photographers must be in the blind at least one hour before sunrise. They must park in the designated parking area and proceed directly to the assigned blind on foot. Stakes with reflective tape mark the route from the parking area to the blind. The route is designed to minimize disturbance; therefore, deviation from the staked route is not allowed. Photographers may leave the blind at any time, but once the blind has been vacated, returning to the blind is not permitted.

The blinds are approximately 300 yards within the wetlands, see map. They are 4½' x 6' wide and 5' high. They have adjustable camera size openings in three sides. The blinds accommodate one person comfortably; however, two people at a time are allowed. There is one chair in each blind. Tree snags and islands have been placed to encourage birds to perch or rest about 40 feet from the blind.

Proposed Change

The Refuges will be open from one hour before sunrise to one hour after sunset.

A portion of the hunt area (2,275 acres) will be open for photography from February through June on Sacramento, Colusa, and Sutter Refuges. Visitors would utilize the existing directional blind, directional assigned pond and free roam boundary signs to access the areas. Boundary closed signs would be added and taken down seasonally. The in-ground, concrete hunting blinds on Sacramento Refuge will be available for photographic use from February through June with no user fees or reservations required.

Photography Blind 2 on Sacramento Refuge will be replaced with a universally accessible blind and boardwalk. A universally accessible photography blind will be constructed at Delevan Refuge with access via Four Mile Road. The viewing blind at Colusa Refuge will also be replaced with a universally accessible blind and boardwalk.

Lottery:
Photographers may apply through a lottery system, for up to three reservations annually. Photographers will be assigned up to three reservations in an August lottery. Then, depending on availability, reservations will be assigned by a first-come, first-serve process.

Lottery Process:

- The lottery is held in August (applications must be received between August 1-31).
- Photographers may select up to 10 date/blind combinations in priority order [e.g. Choice 1: Dec. 17, 2008 – Blind 1, Choice 2: Dec. 17 – Blind 3, Choice 3: Nov. 12 – Blind 1, etc.], including the option to be on a blind waiting list (indicate which week or month and blind is desired).

- All reservation applications are randomly drawn and assigned a number, which indicates the order in which the reservations will be processed.
- The reservations are then processed in numerical order by reserving the remaining highest priority of date/blind choice available for all of the reservation applicants.
- After all of the applicants have received one reservation, the blind assignment continues until all applicants receive their next priority date of choice.

First come, first serve process:
Photographers that missed the lottery will fill any remaining dates by a first-come, first-serve process.

Waiting list:
In addition, a blind waiting list that is used to refill blinds when there are reservation cancellations.

Fees:
The photography blind fee has two required components:

- Purchase of a Refuge entrance pass (Refuge Day Pass or Refuge Annual Pass is required by all photographers who do not possess either a federal duck stamp, Golden Eagle, Golden Age, Golden Access or America the Beautiful Pass).
- A non-refundable $15 fee per photography blind visit.

For photographers participating in the lottery, the fee is due by October 1.

For photographers participating in the first come, first serve or in the waiting list, the reservations are confirmed when the photography blind fee is paid prior to the visit.

Some of the photography blinds may also be available for use from April through June when habitat is suitable. Inquiries about availability should be directed to Sacramento National Wildlife Refuge Complex, 752 County Road 99W, Willows, CA 95988 (530/934-2801).

Photographers also complete a blind evaluation that reports photographed species, time spent, and comments. Photographers must be in the blind at least one hour before sunrise. They must park in the designated parking area and proceed directly to the assigned blind on foot. Stakes with reflective tape mark the route from the parking area to the blind. The route is designed to minimize disturbance; therefore, deviation from the staked route is not allowed. Photographers may leave the blind at any time, but once the blind has been vacated, returning to the blind is not permitted.

Monitoring and Evaluation

The photography blind reservation process assists in monitoring the number of visits by each photographer and the day of the visit. The photographer completes photography blind reports for each visit. The forms request comments regarding name and number of bird species photographed, other wildlife observed/photographed, time of entrance and egress from the blind, and other suggestions and observations. The comments assist in our photography blind management decisions.

Develop and Implement Quality Environmental Education Programs

Through curriculum-based environmental education (EE) packages based on National and State education standards, we will advance public awareness, understanding, appreciation, and knowledge of key fish, wildlife, plant, and resource issues. Each Refuge will assist its potential to work with schools to provide an appropriate level of EE. We may support EE using facilities, equipment, educational materials, teacher workshops, programs and study sites that are safe, accessible, and conducive to learning. EE programs will meet the quality criteria defined in the Visitor Services Standards above.

Environmental Education Objective

Develop an environmental education program by 2023 to serve 5,000 students annually. Develop an environmental education program that promotes in-depth studies of the ecological principles that are associated with wetland and riparian ecosystems, and the Refuges' natural, cultural, and historical resources. The education activities will be designed to develop awareness and understanding for refuge resources and management activities.

Rationale: Environmental education is identified in the Improvement Act as a priority public use that can be allowed when compatible with other Refuge purposes. As a result, the Refuge encourages environmental education as a process of building knowledge in students. The Refuge staff will work with schools (K-12) to integrate environmental concepts and concerns into structured educational activities. These Refuge-lead or educator-conducted activities are intended to actively involve students or others in first-hand activities that promote discovery and fact-finding, develop problem-solving skills, and lead to personal involvement and action. Refuge staff will promote environmental education that: is aligned to the current Federal, State and local standards; is curriculum-based that meets the goals of school districts adopted instructional standards; and provides interdisciplinary opportunities that link the natural world with all subject areas. The environmental education program will be managed in accordance with Service Manual 605 FW 6 Environmental Education.

Environmental Education Strategies:

1. Construct and operate a Wetlands Resource Center at Sacramento Refuge.

2. Schedule and plan 100 school group field trips annually utilizing the Wetlands Resource Center and the visitor facilities at Colusa Refuge.

3. Offer the Discovery Pack containing environmental education activities and on-site information for use on walking trails on Sacramento and Colusa Refuges.

4. Annually assist schools who wish to implement an in-depth study of wetlands and riparian habitats on Sacramento Refuge utilizing the Wetlands Resource Center.

5. Facilitate after school programs involving activities such as habitat restoration, wetland analysis, and student mentor workshops.

6. Develop a partnership with the Girl Scouts: Linking Girls to the Land to assist habitat restoration projects.

7. Facilitate two annual resource-training workshops (e.g. Project Wild or Project Wet) about the Refuges' environmental education program for educators.

8. Annually disseminate current environmental education program guidelines and activities offered to teachers.

9. Maintain the Complex's website to promote current educational opportunities, provide reservation form, and update guidelines.

10. Update and provide Environmental Education Guide brochure.

11. Utilize interpretive specialists, interns, and volunteers to facilitate the environmental education program.

12. Hire one full-time interpretive specialist to implement environmental education activities and the visitor services program.

13. Hire one full-time custodian/maintenance worker to maintain visitor service facilities.

Current Program

The Environmental Education Guide for the Complex describes the activities, facilities and resources available. The environmental education program was restructured in 2005 to increase the involvement of teachers or leaders in conducting their pre-selected activities. The program offers several ways for the classes to experience the Refuge Complex. Specifically at the Sacramento Refuge, they are welcomed by visitor services staff and have access to the diorama, Discovery Room and Refuge videos. For the remainder of their visit, the teachers or leaders guide their group through their pre-planned tour using the two-mile walking trail, kiosk area and six-mile auto tour. Sacramento Refuge receives an average of 2,847 annual environmental education visits (Table 1). On Colusa Refuge, students use the new visitor facilities including restrooms, welcome kiosk, viewing platform. Colusa Refuge receives an average of 71 annual environmental education visits (Table 1).

Participants in the Refuge's environmental education and interpretation programs are restricted to established trails, the visitor center, the Wetland Resource Center, and other designated sites. All groups using the Refuge for environmental education are required to make reservations two-weeks in advance. They may call, fax, or visit the Complex's website to make reservations by a first-come, first serve system. This reservation process, allows refuge staff to manage the number and location of visitors for each day. A daily limit of up to one school participating in the education program is maintained through this reservation system. Efforts are made to spread out use by large groups, reducing disturbance to wildlife and over-crowding of the Refuges' facilities during times of peak demand. Educational groups are required to have a sufficient number of adults to supervise their groups, a minimum of one adult per 12 students. Currently, educational groups are not charged a fee or required to have a special use permit (SUP).

The Field Trip/Event Reservation Application allows the Refuges and groups to help plan their visit. Groups can request teacher's packets, discovery packs, scavenger hunt directions, a bird coloring book, bird mounts and videos for classroom use. The application also provides some activity time guidelines (e.g., 45 minutes to drive the auto tour, 1 1/2 hours to have lunch and drive the auto tour, 20 minutes to 1 ½ hours on wetlands walk depending on the trail section, and videos are about 20 minutes).

For an even more comprehensive environmental education experience, the fully equipped backpack or Discovery Pack provides items to teach as many as five activities along the Wetlands Walk. The Pack contains dip nets, field guides, plant mounts, bug boxes, lenses, and other written materials. A teacher's guide can be sent, upon request, prior to the visit. Binoculars and waterfowl guides are available on loan. The Environmental Education Guide and the Complex's website list many other resources available.

The Wetlands Walk trail is posted with "Short Cut" signs for school groups that are under a time constraint. Trail etiquette, including talk softly, move slowly, stay on the trail and leave only foot prints behind, is discussed with teachers during orientation workshops and with students upon arrival during their welcome session. On the Refuges, the teacher(s) is responsible for ensuring that students follow required trail etiquette.

Proposed Change

A Wetland Resource Center would be constructed and more teacher workshops would be held. The site area for the Wetlands Resource Center would be located on the east side of Logan Creek between the existing headquarters and easement buildings. A wetland could be created south of the Center for habitat viewing and EE activities. A footbridge would be constructed over Logan Creek so that the current parking area and Wetlands Walk may be used. The Center could be a one-story building with a covered viewing porch at roof height. Large picture windows would accommodate views to the south and west. Part of the entry area would descend below the pond surface to allow visitors to view aquatic organisms and soil profiles. An auditorium would provide seating for up to 100 and include a surround-sound system, High Definition (HD) television, and retracting screens for projectors, videos, and DVDs. Separate laboratory rooms would provide a secluded work area, storage and sinks. Computer workstations with internet/satellite access and a resource library would be available for students and teachers.

Monitoring and Evaluation

The reservation and application process for scheduling a visit assists Refuge staff in monitoring the EE program. The application (available in paper copy and on the Refuge web site) records the name of the school and teacher, date and reason of visit, arrival and departure time, number of students/adults, grade level, items requested for loan, and EE activities. Each teacher completes a teacher evaluation form for each Refuge visit. The forms allow the teachers to evaluate the activities and facilities they utilized (i.e. videos, wetlands walk, auto tour, viewing platform, wetland scavenger hunt, discovery room and the discovery pack). These comments assist with managing the EE program.

Provide Quality Interpretations of Key Resources

We will communicate fish, wildlife, habitat, and other resource issues to visitors of all ages and abilities through effective interpretation. We will tailor core recreational uses when we determine they are both appropriate and compatible. We will allow uses that are either legally mandated or occur due to special circumstances. Interpretive programs will meet the quality criteria defined in the Visitor Services Standards above.

Interpretation Objective

Refuge staff will develop an interpretive program to provide 20,000 annual visits. The program will promote public awareness and support of the Refuge resources and management activities by 2023.

Rationale: Interpretation is identified in the Improvement Act as a priority public use that can be allowed when compatible with other Refuge purposes. As a result, the Refuges encourage interpretation as both an educational and recreational opportunity that is aimed at revealing relationships, examining systems, and exploring how the natural world and human activities are interconnected. Participants of all ages can voluntarily engage in stimulating and enjoyable activities as they learn about the issues confronting fish and wildlife resource management on the Refuges. First-hand experiences with the environment will be emphasized, although presentations, audiovisual media, and exhibits will be necessary components of the Refuges' interpretive program. The Visitor Services Plan (Appendix D) was developed to provide guidance for the Refuges' public use program. The interpretive program will be managed in accordance with Service Manual 605 FW 7, Interpretation.

Effective outreach is an important component of the interpretive program. The Refuges will provide two-way communication between the Refuges and the public to establish a mutual understanding and promote involvement with the goal of improving joint stewardship of our natural resources. Outreach will be designed to identify and understand the issues and target audiences, craft messages, select the most effective delivery techniques, and evaluate effectiveness. Refuge outreach will follow the guidance of the National Outreach Strategy: A Master Plan for Communicating in the U.S. Fish and Wildlife Service (USFWS 1997).

In 2007, the Service declared that "connecting people with nature" is among the agencies highest national priorities (USFWS 2008b). A connection with nature, whether it's hiking, fishing, camping, hunting, or simply playing outside, helps children develop positive attitudes and behaviors towards the environment. Positive interactions with the environment can lead to a life-long interest in enjoying and preserving nature. People's interest in nature is crucial to the Service mission of conserving, protecting, and enhancing fish, wildlife, plants, and their habitats.

Interpretation Strategies:

1. Use the Complex's visitor center to provide presentations and exhibits.

2. Maintain interpretive kiosks, walking trails, auto tour routes, the visitor center, and Wetlands Resource Center for use by Refuge visitors.

3. Lead at least 20 tour groups on the Refuges annually.

4. Develop "Sense of Wonder Zones" or naturalized play areas for family-oriented activities on the Sacramento and Colusa Refuges where people of all ages can reconnect with nature.

5. Create interpretive geocaching opportunities on the Sacramento and Colusa Refuges where people of all ages can increase their awareness of fish and wildlife resources and outdoor activities that the Refuges provide.

6. Continue to participate in or provide information to local annual events (e.g. International Migratory Bird Day, National Wildlife Refuge Week, Snow Goose Festival, Pacific Flyway Decoy Association Wildlife Art Festival, California State Fair, International Sportsman's Expo, Return of the Salmon Festival and California Junior Duck Stamp Contest/Judging).

7. Participate in fire prevention education and outreach about the role of fire and its management uses.

8. Write news releases for local and State newspapers and articles for magazines. Conduct television and radio interviews upon request.

9. Maintain the Complex's website.

10. Maintain the Sacramento Refuge radio station (FM 93.1).

11. Provide interpretive brochures at kiosks and in the visitor center.

12. Maintain and upgrade the Discovery Room displays, videos, and activities.

13. Manage and stock the bookstore to provide relevant books and miscellaneous items that relate to the Refuge Complex.

14. Continue to coordinate and facilitate the California Junior Duck Stamp Contest and judging.

15. Continue to host and facilitate California Waterfowl Association's (CWA) Marsh Madness school events.

16. Utilize interpretive specialists, interns, and volunteers to coordinate annual events on and off Refuge, manage the bookstore, and coordinate the California Junior Duck Stamp Program.

17. Utilize interns to assist with Refuge programs (e.g. managing the visitor center on weekends, facilitating school groups).

Current Program

Interpretation involves participants of all ages who learn about the complex issues confronting fish and wildlife resource management as they voluntarily engage in stimulating and enjoyable activities. First-hand experience with the environment is emphasized although presentations, audiovisual media, and exhibits are often necessary components of the interpretive program.

Refuge brochures pertaining to information on the Complex, Watchable Wildlife, and the hunting program have been developed and revised over the years. The Wetlands Walk Guide and the

Northern Sacramento Valley birding trail guide were completed in 2006. A variety of videos is also available for viewing upon request. The Sacramento Valley Refuge: An Unfinished Symphony and America's National Wildlife Refuge System: Where Wildlife Comes First, are the most popular videos. As part of the Refuge System Centennial Celebration, the Unfinished Symphony was written and filmed on location in 2003.

A bookstore in the Sacramento Refuge Visitor Center (Headquarters Office) was created in 1990 via cooperative agreement with the San Francisco Bay Wildlife Society. Additional shelving was added in 1996 increasing the sales to a consistent $14,000 annually. The cooperative agreement was terminated with San Francisco Wildlife Society in 2001 and a new cooperative agreement was signed with Altacal Audubon Society in Chico, CA in 2002.

Refuge related information is provided at annual local festivals or during special events, such as the State Fair, International Migratory Bird Day, Snow Goose Festival, National Wildlife Refuge Week, Pacific Flyway Decoy Association, Coleman National Fish Hatchery Salmon Festival, Chico Endangered Species Fair, CWA Art Camp, and CWA Marsh Madness. During 2005, approximately 13,000 individuals attended the presentations and saw exhibits at these events. Sacramento Refuge receives an average of 555 annual interpretation visits and Colusa Refuge receives an average of 18 annual interpretation visits (Table 1).

Proposed Change

A Wetland Resource Center would be constructed and more teacher workshops would be held. The site area for the Wetlands Resource Center would be located on the east side of Logan Creek between the existing headquarters and easement buildings. A wetland could be created south of the Center for habitat viewing and EE activities. A footbridge would be constructed over Logan Creek so that the current parking area and Wetlands Walk may be used. The Center could be a one-story building with a covered viewing porch at roof height. Large picture windows would accommodate views to the south and west. Part of the entry area would descend below the pond surface to allow visitors to view aquatic organisms and soil profiles. An auditorium would provide seating for up to 100 and include a surround-sound system, High Definition (HD) television, and retracting screens for projectors, videos, and DVDs. Separate laboratory rooms would provide a secluded work area, storage and sinks. Computer workstations with internet/satellite access and a resource library would be available for students and teachers.

"Connecting people with nature" is among the agencies highest national priorities (USFWS 2008b). A connection with nature, whether it's hiking, fishing, camping, hunting, or simply playing outside, helps children develop positive attitudes and behaviors towards the environment. Positive interactions with the environment can lead to a life-long interest in enjoying and preserving nature. The Refuges are currently beginning to implement these goals by developing "Sense of Wonder Zones" or naturalized play areas for family-oriented activities on the Sacramento and Colusa Refuges where people of all ages can reconnect with nature. The Refuges will also create interpretive geocaching opportunities on the Sacramento and Colusa Refuges.

Monitoring and Evaluation

The reservation and application process for scheduling a visit assists Refuge staff in monitoring the interpretation program. The application (available in paper copy and on the Complex's website) records the name of the group, date and reason of visit, arrival and departure time, number of participants, age, items requested for loan, and activities. Annual on and off Refuge events are monitored by Refuge staff recording the event and number of participants on a calendar posted in the Visitor Services office. Refuge brochures and bookstore items are monitored in order to restock the inventory. The Junior Duck Stamp Contest including the judging is evaluated annually with California Waterfowl Association and other partners.

Manage for Other Recreational Use Opportunities

We may allow other recreational uses that support or enhance one of the wildlife-dependent recreational uses or minimally conflict with any of the wildlife-dependent recreational uses when we determine they are both appropriate and compatible. We will allow uses that are either legally mandated or occur due to special circumstances (605 FW 1).

Bicycling is currently allowed on the auto tour route on Sacramento Refuge.

Communicate Key Issues with Off-Site Audiences

Effective outreach depends on open and continuing communication and collaboration between the refuge and its many publics. Effective outreach involves determining and understanding the issues, identifying audiences, listening to stakeholders, crafting messages, selecting the most effective delivery techniques, and evaluating effectiveness. If conducted successfully, the results we achieve will further refuge purposes and the Refuge System mission.

Proposed Change

Bicycling would be allowed on the entrance road and auto tour routes on Sacramento and Colusa Refuges from May through August (see Bicycling Compatibility Determination, Appendix B). Other non-wildlife dependent uses (i.e. field dog trials, horseback riding, camping, etc) would not be allowed on the Refuges.

Monitoring and Evaluation

Refuge biologists and visitor services staff conduct regular surveys of public activities including bicycling on the Refuges. The data is analyzed and used by the refuge manager to develop future modifications if necessary to ensure compatibility bicycling.

Build Volunteer Programs and Partnerships with Refuge Support Groups

Volunteer and Friends organizations fortify refuge staffs with their gifts of time, skills, and energy. They are integral to the future of the Refuge System. Where appropriate, refuge staff will initiate and nurture relationships with volunteers and Friends organizations and will continually support, monitor, and evaluate these groups with the goal of fortifying important refuge activities. The National Wildlife Refuge System Volunteer and Community Partnership Enhancement Act of 1998 strengthen the Refuge System's role in developing effective partnerships with various community groups. Whether through volunteers, Friends organizations, or other important partnerships in the community, refuge personnel will seek to make the refuge an active community member, giving rise to a stronger Refuge System.

Volunteer Objective

Increase the number of volunteers to 120 in order to support a variety of Refuge programs by 2023.

Rationale: The National Wildlife Refuge System Volunteer and Partnership Enhancement Act of 1998 (P.L. 105-242) strengthens the Refuge System's role in developing relationships with volunteers. Volunteers possess knowledge, skills, and abilities that can enhance the scope of refuge operations. Volunteers enrich Refuge staff with their gift of time, skills, and energy. Refuge staff will initiate, support, and nurture relationships with volunteers so that they may continue to be an integral part of Refuge programs and management. The volunteer program will be managed in accordance with the Fish and Wildlife Service Manual, Part 150, Chapters 1-3, "Volunteer Services Program", and Part 240 Chapter 9 "Occupational Safety and Health, Volunteer and Youth Program".

Volunteer Strategies:

1. Utilize interpretative specialists and interns to coordinate the volunteer program.
2. Recruit interns through the California Waterfowl Association, California State University Chico (CSU/Chico) internship program, and other universities.
3. Recruit a variety of community groups and individuals (e.g. CSU/Chico, Butte College, Boy Scouts, Girl Scouts, Altacal Audubon Society).
4. Host an annual volunteer recognition dinner.
5. Facilitate volunteer training workshops.
6. Host an annual workday (Brush Up Day) to clean up Refuges' hunt areas.
7. Utilize the Girl Scout Council to recruit volunteers.
8. Provide Service volunteer uniform for all volunteers to wear when greeting the public or at special events.

Current Program

The Complex volunteer program consists of 69 individuals that assist with biological, environmental education, interpretive, wildlife observation, hunting, and maintenance events and activities. Additional individuals are signed up for one-time events such as Brush Up Day of the hunting areas and trail maintenance by Altacal Audubon Society. The Refuges support and participate in annual Eagle Scout and Girl Scout projects.

Proposed Change
Volunteer recruitment would take place in order to increase the number of current volunteers from 69 to 120.

Monitoring and Evaluation
Volunteers are monitored through an application process that enables Refuge staff to match requested volunteer projects by Refuge staff with volunteer interests and expertise. Volunteers may participate in specific work projects, special events or on specific days/hours. Each volunteer records their hours daily within one of four categories: recreation, habitat & wildlife, maintenance or cultural resources. The volunteer program is evaluated by work project completion and volunteer satisfaction.

Partnerships Goal
Promote partnerships to preserve, restore, and enhance a diverse, healthy, and productive ecosystem in which the Refuges play a key role.

Partnership Objective
Maintain and enhance at least 25 partnerships among Federal, State, local agencies, organizations, schools, corporations, and private landowners to promote the understanding and conservation of the Refuges' resources, activities, and management by 2023.

Rationale: The Refuge System recognizes that strong citizen support benefits the System. These benefits include the involvement and insight of citizen groups in Refuge resource and management issues and decisions, a process that helps managers gain an understanding of public concerns. Partners support Refuge activities and programs, raise funds for projects, are advocates on behalf of wildlife and the Refuge System, and provide support on important wildlife and natural resource issues. In "Fulfilling the Promise", the Service (USFWS 1999) identified the need to forge new and non-traditional alliances and strengthen existing partnerships with States, Tribes, non-profit organizations and academia to broaden citizen and community understanding and support for the National Wildlife Refuge System.

A variety of people including, but not limited to, scientists, farmers, birders, hunters, photographers, and students have a great deal of interest in Sacramento Refuge Complex's management, fish and wildlife species, and habitats. As opportunities, funding, and staff are available, new partnerships will be formed.

Partnership Strategies:
1. Maintain good relations and open communication with partners.

2. Actively look for partnering opportunities with local and regional conservation groups, academic institutions, organizations, and other local, State and Federal agencies.

3. Pursue opportunities to cost-share mutually beneficial projects with other organizations.

4. Expand opportunities with local Chambers of Commerce to participate in local events and improve dissemination of public recreation literature about the Refuges.
5. Stay actively involved in Federal, State, and local planning processes to protect Refuge resources and foster cooperative management of those resources.
6. Work closely with Bureau of Reclamation and local irrigation district personnel on water delivery issues.
7. Continue to participate in the Sacramento Valley Water Quality Coalition.
8. Continue partnership with Altacal Audubon Society to operate the bookstore at Sacramento Refuge.
9. Maintain active participation with the Central Valley Joint Venture.
10. Maintain cooperative agreement with US Geological Survey to conduct management-oriented research and monitoring efforts.
11. Continue partnerships with California Waterfowl Association, Ducks Unlimited, and other conservation non-governmental organizations.

Current Program

The Refuge is part of a mosaic of public and private land in the Sacramento Valley. The private lands include both farms and natural riparian habitat in the vicinity of the Complex. To maximize our conservation efforts the Complex encourages and supports the cooperative management approach by working with Federal, State, and county agencies, private landowners, neighbors, and citizens.

Partnerships in habitat restoration and management, migratory bird studies, and visitor services program include but are not limited to the California Department of Fish and Game, Ducks Unlimited, Inc., California Waterfowl Association, Altacal Audubon Society, Girl Scouts and Boy Scouts of America, and local Chambers of Commerce.

Proposed Change

Maintain and enhance at least 25 partnerships among Federal, State, local agencies, organizations, schools, corporations, and private landowners to promote the understanding and conservation of the Refuges' resources, activities, and management.

Other Applicable Visitor Services Programs:

Youth Conservation Corps

The Youth Conservation Corps (YCC) is a well-balanced work-learn-earn program that develops an understanding and appreciation in participating youth of the Nation's environment and heritage. The YCC program will be administered in accordance with Public Law 93-408 and an interagency Letter of Cooperation. It is administered by the Forest Service, the Service, and National Park Service. YCC offers gainful summer employment to youth 15-19 years of age, for approximately eight weeks. The organization and management of individual YCC projects will be governed by program objectives, budget limitations, and guidelines established by the Service in Fish and Wildlife Service Manual Part 141. Within these objectives, limitations and guidelines, individual program operations, public information and community relations concerning YCC will be the responsibility of the Host Site Supervisor.

YCC Objectives

The stated purpose of the YCC is to further the development and maintenance of the natural resources of the United States by America's youth and, in so doing, to prepare them for the ultimate responsibility of maintaining and managing these resources for the American people.

There are three equally important objectives as reflected in the law:

1. Accomplish needed conservation work on public lands.
2. Provide gainful employment for young males and females from all social, economic, ethnic, and racial classifications.
3. Develop an understanding and appreciation in the participating youth of the Nation's natural environment and heritage.

The objectives are accomplished in a manner that provides the youth with an opportunity to acquire increased self-discipline. They learn work ethics, how to relate to peers and supervisors, and how to build lasting cultural bridges with youth from other backgrounds.

Current Program

A Youth Conservation Corps program, the first in over two decades, was implemented during the summer of 2005. It consisted of one crew leader and four crewmembers. In 2006, YCC consisted of one crew leader, one youth leader, and four crewmembers. During the eight-week program, enrollees complete maintenance, fence construction and painting projects. YCC contributes over 1,000 work project hours annually. For every 8 hours of work, one hour of environmental education is provided as field trips, presentations, or discussions.

Proposed Change

None.

Refuge Law Enforcement

Visitor safety is a key issue in providing quality compatible wildlife-dependent recreation programs. Visitor safety at refuges is a high priority when developing compatible wildlife-dependent recreation programs. Refuge managers provide adequate law enforcement and supply visitors with information about specific hazards, including animal behavior; geographical, topographical, tidal, or flood hazards; inclement weather patterns; road and trail hazards; and other safety concerns. We also use environmental education and interpretive programs to alert visitors to safety issues.

Refuge law enforcement ensures legal use of fish and wildlife resources on the Refuges, as prescribed by law. We use refuge law enforcement to obtain compliance with laws and regulations necessary for proper administration, management, and protection of facilities of the Refuge System. Refuge policy (605 FW 1-7) Guidelines for Wildlife-Dependent Recreation states that refuge law enforcement effort should be sufficient to protect human safety and wildlife populations, ensure compliance with regulations, and based on past experiences and current circumstances.

Law Enforcement Objective

Provide a safe environment for visitors, protect Refuges' resources, and ensure compliance with regulations through effective law enforcement on each Refuge by 2008.

Rationale: An increasing number of Refuge facilities and visitors necessitate an adequate level of safety and security through an enhanced law enforcement presence. Illegal activities, such as drug cultivation, poaching, vandalism, and vehicle stripping, are present on Refuge lands where there are public activities. Strict law enforcement and the support of partners are necessary to provide a safe environment for visitors and staff. In addition, a common belief among neighboring landowners is that public ownership, easements, or access could result in increased vandalism and theft of agricultural equipment, poaching, and disregard of private property rights. A well-planned and coordinated program will be necessary to successfully address these concerns.

Law Enforcement Strategies:

1. Develop Memorandum of Understandings with various law enforcement agencies to improve coordination, improve safety and coordinate efforts in areas of special concern.

2. Provide public education and signage as part of law enforcement programs and provide a sufficient level of law enforcement from various agencies to address these issues.

3. Employ three full-time park rangers (refuge law enforcement officers), one full-time supervisory law enforcement officer, and supplement their duty schedule with dual-function officers.

4. Maintain a daily law enforcement presence to ensure that violations are deterred or successfully detected, investigated, and the violators are apprehended, charged, and prosecuted.

5. Have refuge officers work closely with CDFG game wardens and deputy sheriffs from Glenn, Colusa, and Sutter counties.

6. Develop a Law Enforcement Plan for the Complex.

7. Annually maintain boundary, closed area, and other public use signs.

Current Program

The Sacramento Refuge Complex has a law enforcement staff that consists of three full-time refuge officers and one dual-function officer. These officers are responsible for all law enforcement issues on Sacramento River, Sacramento, Delevan, Colusa, and Sutter Refuges, and on Butte Sink Wildlife Management Area. The dual-function officers conduct law enforcement as a "collateral duty" in addition to their primary responsibility, such as an assistant refuge manager. The refuge officers are responsible for coordinating their activities and cooperating with other local, State, and Federal law enforcement officials.

Proposed Change

Hire an additional full-time refuge law enforcement officer and supervisory law enforcement supervisor for the Complex.

Fee Programs

The Service is one of four Federal land management agencies (Fish and Wildlife Service, Bureau of Land Management, National Park Service, and Forest Service) directed by Congress in 1996, to implement or expand fee collection sites as part of a program to explore the feasibility to better offset costs to administer recreation on public lands.

The fee demonstration program was a four-year effort to create innovative approaches and methods to charge and collect fees for recreation services provided on Service lands. An entrance fee program was implemented at Sacramento Refuge during the spring of 1998. This involved constructing a parking area, sidewalk, kiosk with interpretive panels, and automated fee machine.

A survey was completed in 1998 to determine compliance and the number of people per vehicle. The survey revealed that there was a 90 percent compliance of visitors that paid before entering the Refuge.

In 2004, Congress passed the Federal Lands Recreation Enhancement Act that allows the government to charge a fee for recreation use of public lands managed by the Service, Bureau of Reclamation, National Park Service, Bureau of Land Management, and Forest Service.

Currently, there is an entrance fee program for Sacramento Refuge. A fee for vehicles is collected to pay for visitor facilities and wildlife habitat improvements. A $3 day pass, $12 Refuge Annual Pass or $20 commercial pass can be purchased on-site. Holders of a Federal Duck Stamp or Golden Eagle, Age, Access Passport, or America the Beautiful Pass enter free.

The entrance fee is waived for educational groups studying nature as part of a course of curriculum. Visitors pay a fee at an automated machine at the entrance to the Refuge. The machine is housed within an interpretive kiosk that depicts what to see and do, and brochures are available to assist the tourist in deciding if, when, and where they may visit.

The entrance fee generates approximately $13,000 annually, which is used to hire two visitor services assistants for October-March. The assistants help with many daily tasks, staff the visitor center on weekends, facilitate school groups, update the website, provide hunt data, and answer the phone.

Additionally, there are two photography blinds on Sacramento Refuge and one on Colusa Refuge. The blinds may be reserved one day each week only on Wednesdays through Sundays for $10 per use. They are available October through March depending on habitat conditions.

Cooperating Association/Friends Groups

A bookstore in the Sacramento Refuge Visitor Center (Headquarters Office) was created in 1990 via cooperative agreement with the San Francisco Bay Wildlife Society. Additional shelving was added in 1996 increasing the sales to a consistent $14,000 annually. The cooperative agreement was terminated with San Francisco Wildlife Society in 2001 and a new cooperative agreement was signed with Altacal Audubon Society of Chico, CA in 2002.

Other

In "Fulfilling the Promise", the Service (USFWS 1999) identified the need to forge new and non-traditional alliances and strengthen existing partnerships with States, Tribes, non-profit organizations and academia to broaden citizen and community understanding of and support for the National Wildlife Refuge System. The Service recognizes that strong citizen support benefits the Refuge System. Involving citizen groups in Refuge resource and management issues and decisions helps managers gain an understanding of public concerns. Partners yield support for Refuge activities and programs, raise funds for projects, are activists on behalf of wildlife and the Refuge System, and provide support on important wildlife and natural resource issues.

A variety of people including, but not limited to, scientists, birders, hunters, farmers, outdoor enthusiasts and students are keenly interested in the management of Sacramento Refuge Complex, its fish and wildlife species, and its plants and habitats. This is illustrated by the number of visitors the Refuge receives and the partnerships that have already developed. We will continue to form new partnerships with interested organizations, local civic groups, community schools, Federal, State, and County governments, and other civic organizations.

Implementing the Plan

Essential Staffing Needs

See Chapter 5 of the CCP.

Table of Projects, Costs
See Chapter 5 of the CCP.

Partnership Funding and Resources
See Chapter 5 of the CCP.

Compatibility Determinations
See Appendix B of CCP.

NEPA Document/Decision Document
See Appendix A of CCP.

ESA Section 7 Consultations
See Appendix L of CCP.

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Appendix E. Habitat Management Plan

Sacramento, Delevan, Colusa, and Sutter Refuges' management is determined, guided, and tracked by an annual habitat management planning process. The annual Habitat Management Plans identify individual management units within each Refuge. These units consist of tracts of land, which have common management constraints, conditions, and public use activities. The habitat management plan identifies physical attributes of the unit, habitat objectives, specifies management activities to make any necessary repairs or improvements; emphasizes positive results from previous years; and notes special management considerations (i.e. presence of special status species or other significant wildlife use). It also prioritizes management activities and projects based on the overall condition and functionality of the unit, water management regimes (i.e. flood-up and drawdown schedules), and available resources (i.e. manpower and funding). Examples of management activities include facilities maintenance (i.e. levees, water control structures, roads, fire breaks, fences, gates, boundary signs, etc.), vegetation management (i.e. herbicide application, prescribed fire, grazing, mowing and disking, irrigation, etc.), biological surveys, habitat restoration, research, public use monitoring and facilities maintenance, and law enforcement issues.

Copies of the habitat management plans for 2006 are available for review at the Sacramento National Wildlife Refuge Complex, 752 County Road 99W, Willows, California 95988. (530) 934-2801.

Copies are also available via the internet at the following address
http://sacramentovalleyrefuges.fws.gov

Appendix F. Integrated Pest Management Plan

Table of Contents

Figures

Tables

INTRODUCTION

This Integrated Pest Management (IPM) Plan for controlling mosquito and invasive plants on the Sacramento National Wildlife Refuge Complex (Complex) is divided into two chapters: Chapter 1 Mosquito Control, and Chapter 2 Invasive Species Control.

This Plan is developed under the authority of:

- Federal Noxious Weed Act of 1974, Public Law 93-629, as amended (7 U.S.C. 2801 et seq.)
- Plant Protection Act (7 U.S.C. 7701 *et seq.*)
- Federal Land Policy and Management Act of 1976 as amended, Public Law 94-579 (43 U.S.C. 1701 et seq.)
- Public Rangelands Improvement Act of 1978, Public Law 95-514 (43 U.S.C. 1901 *et seq.*)
- Endangered Species Act, Public Law 93-205, as amended by Public Law 100-478 (16 U.S.C. 1531 *et seq.*)
- National Wildlife Refuge System Administration Act (16 U.S.C. 668dd)
- National Wildlife Refuge System Improvement Act of 1997, Public Law 105-57
- Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 U.S.C. 4701 *et seq.*)
- Executive Order 11514-Protection and Enhancement of Environmental Quality, as amended by Executive Orders 11541 and 11991
- Executive Order 11987-Exotic Organisms
- Executive Order 13112-Invasive Species
- Department of the Interior (DOI) Manual 609 DM 1, Weed Control Program
- Noxious Weed Regulations, 7 CFR Part 360
- Pesticide Programs, 40 CFR Subchapter E
- DOI Manual, Pesticide Use Policy, 517 DM 1
- Administrative Manual, Pest Management Policy and Responsibilities, 30 AM 12

This Plan also follows the requirements of the Refuge Manual, Pest Control Policy (7 RM 14), which states that it is the policy of the Service to engage in the control of wildlife and plants within the National Wildlife Refuge System to assure balanced wildlife and fish populations consistent with the optimum management of refuge habitat.

The Service pest management policy goal (30 AM 12.1) is to eliminate the unnecessary use of pesticides through the use of IPM. IPM uses a combination of biological, physical, cultural, and chemical control methods (30 AM 12.5). This approach notes environmental hazards, efficacy, costs, and vulnerability of the pest.

When plants or animals are considered a pest, they are subject to control on national wildlife refuges if: 1) the pest organism represents a threat to human health, well-being, or private property, the acceptable level of damage by the pest has been exceeded, or State or local governments have designated the pest as noxious; 2) the pest organism is detrimental to the primary refuge objectives; and 3) the planned control program will not conflict with the attainment of Refuge objectives or the purposes for which the Refuge is managed (7 RM 14.2).

A pest is defined as any terrestrial or aquatic plant or animal which interferes, or threatens to interfere, at an unacceptable level, with the attainment of refuge objectives or which poses a threat to human health (7 RM 14.4). Pest management is defined as any practice or combination of practices designed to manipulate pest or potential pest populations and to diminish pest injury or render them harmless. The objectives of pest management activities in the Refuge System (7 RM 14.3) are:

- To protect human health and well-being.
- To prevent substantial damage to significant resources.
- To protect newly introduced or re-established species.
- To control exotic species and to allow normal populations of native species to exist.
- To prevent damage to private property.
- To provide individuals with quality wildlife-oriented recreational experiences.

REFUGE DESCRIPTION

HISTORICAL

The Complex is composed of five National Wildlife Refuges (Refuges) and three Wildlife Management Areas (WMAs) in the northern Sacramento Valley (Figure 1). Historically, vast acreages of natural wetlands were created when the Sacramento River and its tributaries flooded during winter storms. This annual cycle provided habitat for millions of waterfowl and other wetland dependant wildlife. In the early and mid-1900s, the construction of levees along the rivers and agricultural development of the valley floor reduced wetland habitats by approximately 95 percent in the Central Valley (Gilmer et al. 1982, Central Valley Joint Venture [CVJV] 2006). Due to the loss of wetlands, crop depredation by waterfowl became a problem in the Sacramento Valley. Depredation issues and considerations for migratory bird conservation led to the establishment of a number of wildlife refuges, beginning with the Sacramento Refuge in 1937. Since then, Colusa (1945), Sutter (1945), and Delevan (1962) Refuges, Butte Sink WMA (1980), Willow Creek-Lurline WMA (1985), Sacramento River Refuge (1989) and North Central Valley WMA (1992) have also been established. Collectively, they comprise the Complex.

For a detailed description of the Refuges, please refer to the Sacramento, Delevan, Colusa, and Sutter Refuges Draft Comprehensive Conservation Plan (CCP) (USFWS 2008) and the Sacramento River Refuge Final CCP (USFWS 2005a).

PHYSICAL

The Refuges range in size from 2,591 acres to over 11,000 acres. Habitats consist mostly of managed wetlands, with the exception of the Sacramento River Refuge, which consists primarily of riparian habitat (Table 1).

Soils on Sacramento, Delevan, and Colusa Refuges are characterized by poorly drained, slightly to strongly alkaline clays. Sutter Refuge and Butte Sink WMA have poorly drained less alkaline clay soils. Soils on the Llano Seco Unit of the North Central Valley WMA are primarily loamy floodplain soils. Slope on all the Refuges ranges from 0-3 percent; elevation is 40-100 feet mean sea level; and average annual rainfall is 17-20 inches. Maximum daily temperatures can exceed 90 degrees Fahrenheit (°F) from May into October, and minimums can be in the 20s °F during winter months.

Figure 1. Sacramento Refuge Complex map.

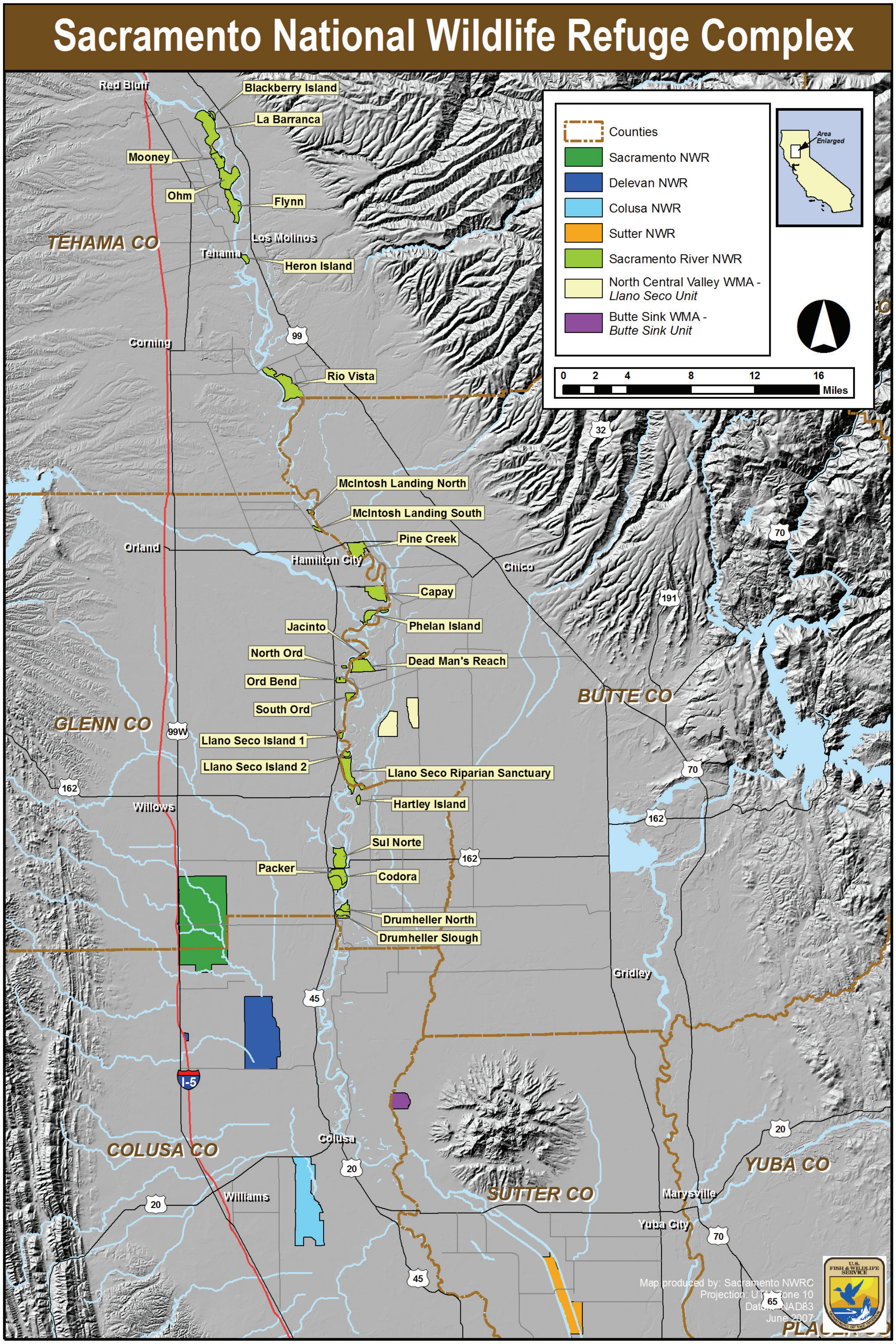

Table 1. Acreages and habitat types of Refuges within the Sacramento National Wildlife Refuge Complex.

Refuge	Total[1]	Managed Wetlands[2] Seasonally Flooded Wetlands[3]	Managed Wetlands[2] Summer Wetlands[4]	Unmanaged Wetlands[2]	Vernal Pool/Alkali Meadow[2]	Irrigated Pasture	Grassland[2,5]	Riparian Forest[2,6]	Other[2,7]
Sacramento	10,819	6,305	781	163	2,941	0	139	117	373
Delevan	5,877	3,939	661	13	461	0	464	46	293
Colusa	4,686[8]	2,957	390	119	619	0	438	15	148
Sutter	2,591[9]	1,708	173	45	0	0	226	403	36
Butte Sink	733	610	35	1	0	0	29	15	43
Llano Seco Unit	1,732	667	93	2	6	184	611	116	53
Sacramento River	10,059	0	0	88	0	0	119	7,373	2,479
TOTAL	**36,497**	**16,186**	**2,133**	**431**	**4,027**	**184**	**2,026**	**8,085**	**3,425**

[1] Official Refuge acres.
[2] Acres calculated with GIS from 2006-07 annual habitat management plans.
[3] Includes irrigated and non-irrigated seasonally-flooded wetlands.
[4] Includes semi-permanent and permanent wetlands.
[5] Includes annual and perennial grasslands.
[6] Includes mixed riparian forest, cottonwood willow, willow scrub, and valley oak riparian forest.
[7] Includes roads, facilities, and other miscellaneous areas.
[8] Includes the 80-acre Rennick property.
[9] Includes 646 acres acquired under North Central Valley Wildlife Management Area.

REFUGE PURPOSES AND GOALS

The Service acquires Refuge System lands under a variety of legislative acts and administrative orders. The official purpose or purposes for a refuge are specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit. The Service defines the purpose of a refuge when it is established or when new land is added to an existing refuge. These purposes, along with the Refuge System mission, are the driving forces in developing refuge vision statements, goals, objectives and strategies in the CCP. The purposes also form the standard for determining if proposed refuge uses are compatible.

The Refuges purposes and goals are described in the Sacramento, Delevan, Colusa, and Sutter Refuges Draft CCP (USFWS 2008) and the Sacramento River Refuge Final CCP (USFWS 2005a).

HABITAT MANAGEMENT PRACTICES

Currently, habitat management objectives at the Complex focus on maximizing benefits for wildlife, emphasizing feeding and resting areas for wintering waterfowl and other migratory birds. Proper water and vegetation management is considered essential to maintaining high quality wetlands to meet the goals of the Complex. Most wetlands are "artificially" created and maintained using delivered water on leveed impoundments. They are flooded and drained with near complete control through inlet and outlet structures. The number of wetland units ranges from 40 to over 150 per Refuge. Flooding regimes are designed to approximate historical percentages of different wetland types as closely as possible, given water availability constraints. Furthermore, the timing of drawdowns, irrigations, and flood-ups largely dictates plant species composition (i.e. germination and growth of desirable food and cover plants). It also governs habitat availability (i.e. how much wetland is flooded at certain times of year for certain wildlife species).

It is necessary to control certain plant and animal species that have undesirable effects on Refuge animals, plants, and habitats. The primary effect is competition with native plants for space, sunlight, nutrients, and water. The distribution and abundance of native plants that are important to wildlife as food, shelter, and nesting areas declines and wildlife habitat suffers.

For a detailed description of habitat types and management practices, please refer to the Sacramento, Delevan, Colusa, and Sutter Refuges Draft CCP (USFWS 2008) and the Sacramento River Refuge Final CCP (USFWS 2005a).

LISTED SPECIES

A significant number of federal and/or state listed species occur on the Complex. In many cases, invasive species management is undertaken to maintain the populations and health of listed species (especially plants) in a variety of habitat types. Table 9 contains a list of federally threatened and endangered species on the Complex. For a description of listed species, please refer to the Sacramento, Delevan, Colusa, and Sutter Refuges Draft CCP (USFWS 2008) and the Sacramento River Refuge Final CCP (USFWS 2005a).

Section 7 consultations with USFWS (2004) and NOAA-Fisheries (2004) concluded that the activities outlined in the Sacramento River Refuge Final CCP (USFWS 2005a) and in the accompanying hunting, fishing, fire management and integrated pest management plans will lead to long-term benefits to federally-listed species. Furthermore, they concluded the activities proposed in the CCP are consistent with the Intra-agency Formal Section 7 consultation (USFWS 1999) regarding the operations and maintenance of the Complex.

The Refuge has also requested Section 7 consultation with the USFWS and NOAA- Fisheries on the Sacramento, Delevan, Colusa, and Sutter Refuges Draft CCP (USFWS 2008).

CHAPTER 1. MOSQUITO CONTROL

INTRODUCTION

The Complex provides critically important habitats for a great diversity of wildlife, particularly migratory birds of the Pacific Flyway. Since the 1800s, over 95 percent of the historic wetlands in the Central Valley have been destroyed or modified (CVJV 2006). Despite these significant changes, approximately 60 percent of the total Pacific Flyway waterfowl population winters in the Central Valley and uses these Refuges (Gilmer et al. 1982). Today, wetlands are valued for their fish and wildlife habitat, recreational opportunities, and the benefits they provide in terms of flood control, water filtration, and ground water recharge.

These wetland-dominated habitats can also produce or harbor significant quantities of mosquitoes during certain times of year. Some Refuges have been of particular concern to local Mosquito and Vector Control Districts (MVCDs or District) (Table 2) as areas that periodically require mosquito control to reduce human health risk from mosquito-transmitted diseases and significant public nuisance. Although the Service fully supports mosquito control under public health disease situations, control of mosquito populations outside of recent arbovirus detection has been allowed more reluctantly. The Service is obligated to both fulfilling its primary mission and refuge goals, while incorporating measures to ensure public safety. During the last 50 years, nationwide use of certain pesticides has resulted in negative effects to humans and natural resources. Consequently, regulations such as the Endangered Species Act, the 1988 revision of the Federal Insecticide, Fungicide, and Rodenticide Act, and increasingly restrictive pesticide use policies have been enacted in the long-term best interests of the public and the nation's resources.

Table 2. Local Mosquito and Vector Control Districts

Refuge	Mosquito Control District
Sacramento Refuge	Glenn County MVCD
Delevan Refuge	Colusa MAD
Colusa Refuge including Butte Sink fee title acres	Colusa MAD
Sutter Refuge	Sutter-Yuba MVCD
Sacramento River Refuge	Butte County MVCD, Colusa MAD, Tehama MVCD
MVCD=Mosquito and Vector Control Districts, MAD=Mosquito Abatement District	

MVCDs and wetland managers have a somewhat controversial history going back over 30 years in the Central Valley (Lusk 1979). MVCDs were perceived as relying solely on the use of chemical pesticides for control activities, while wetland managers were concerned about the potential effects of such control on wildlife and food chain resources such as invertebrates. However, MVCD use of IPM has helped to address this concern by employing a variety of control methods that include habitat management, biological control, and the use of more target-specific pesticide products. The increasing costs of pesticides and concerns over pesticide resistance have also spurred a more holistic approach to mosquito management.

The Service is required to use an IPM approach for pest management activities on refuge lands (U. S. Department of Interior 2007). IPM employs a variety of mosquito control methods that include habitat management, biological control agents, and pesticide application. Wetland best management practices (BMPs) for mosquito control have been recently developed for the Central

Valley (Kwasny et al. 2004) and are a significant component of this plan. They can be used to lower the production of mosquitoes and reduce the need for chemical treatment, without significantly disrupting the ecological character, habitat function, or wildlife use of managed wetlands.

The purposes of this IPM plan are to: 1) describe Refuge habitats and their role in the production or harborage of mosquitoes; 2) describe the use of approved mosquito control methods and materials in an IPM program that is consistent with the goals of the Complex, DOI and Service policy, and minimizes public health risk from Refuge-produced or harbored mosquitoes; and 3) provide long-term planning to meet the Service's goal of using IPM to minimize effects of mosquito control on trust resources to the greatest extent possible.

MOSQUITO CONTROL ACTIVITIES

The Complex coordinates annually with local MVCDs to allow the monitoring and, if necessary, control of mosquitoes to minimize public health risks from mosquito vectored diseases and significant nuisance. Wetland management BMPs for proactive mosquito control are regularly used by the Refuges, and are incorporated into annual habitat management plans. These include, but are not limited to, water management techniques, maintenance and improvement of water control structures, and strategic vegetation control. Refuge staff coordinates closely with the MVCDs on timing of irrigations, flood-up schedules, and communication of any problems with unplanned flooding.

In addition, Pesticide Use Proposals (PUP) developed cooperatively with the MVCDs, are reviewed by Service IPM specialists, and if approved, are issued along with a Special Use Permit (SUP) that identifies conditions under which specific mosquito control activities can be conducted. Conditions specified in these documents include: products approved for use; application methods, rates, and timing; maximum number of applications allowed per season; measures to be taken to avoid sensitive areas; and annual reporting requirements for MVCDs. Currently, PUPs and SUPs are generated annually. Upon Service approval of this plan, approved PUPs can be valid for up to five years.

During the last fifteen years at the Complex, most active mosquito control activities by MVCDs have been conducted during the summer irrigation and fall flood-up seasons. Mosquito control has most commonly been in response to production of floodwater mosquitoes after application of water onto wetland habitats that have been dry for some period of time; and secondarily, for standing water mosquitoes produced as a result of water maintained for periods of greater than two weeks. At times, Refuges also can harbor adult mosquitoes produced in nearby rice fields. Control efforts have focused primarily on Colusa and Sutter Refuges, and Butte Sink WMA, with some active control annually; and to a lesser degree on Sacramento and Delevan Refuges, and the Llano Seco Unit, with active control occurring only in some years. These differences in mosquito control efforts have been related to each Refuge’s proximity to an urban area, the level of arbovirus activity (i.e. West Nile Virus), whether or not the Refuge is within district boundaries, timing of wetland flooding/mosquito production, and differences in Districts’ control programs.

Typically, control strategies at Colusa and Sutter Refuges, and Butte Sink WMA have focused on adulticides, using Ultra Low Volume (ULV) fogging. Larvicides have been used much less frequently, with MVCDs citing excessive cost, application problems, and reduced efficacy associated with their use on large expanses of seasonal wetlands. Despite these issues, there have been some recent changes in budgets for some MVCDs that have resulted in renewed interest to use larvicides, particularly methoprene. Application methods for the various products include ground or aerial depending on the product, virus activity, and environmental conditions. Differences in control strategies among MVCDs (i.e. larviciding vs. adulticiding) have also been attributed to district size, budget, primary equipment on hand (aerial vs. ground), product efficacy, and restrictions of different control materials/methods.

In the last ten years, products used by MVCDs for adult mosquito control have evolved from more toxic or persistent (including malathion and permethrin) to less toxic products that tend to break down in the environment more rapidly (i.e. pyrethrin). The Service has worked with local MVCDs to develop a "tool box" of mosquito control methods and materials available for use under appropriate conditions. These, along with wetland management BMPs implemented by the Refuge, are used as a combination of preventative and active mosquito control when treatment thresholds are met. There are continuing efforts to work with the MVCDs to minimize the amount and toxicity of mosquito control products used on the refuges.

DISEASE HISTORY

Western Equine Encephalitis (WEE), St. Louis Encephalitis (SLE), California Encephalitis (CE), West Nile Virus (WNV), and malaria can all be vectored to humans by mosquitoes. Currently, they are the main diseases that drive mosquito abatement programs based on human health risk in northern California.

ENCEPHALITIS

Encephalitis in humans resulting from exposure to WEE, SLE, or CE can result in mental or physical impairment or death. *Culex tarsalis* is the primary carrier or vector of encephalitis in northern California. Disease studies have also isolated WEE, SLE, and CE viruses from *Aedes melanimon*. *A. melanimon* has been shown to assist in the summer maintenance of WEE in the Sacramento Valley by means of a transmission cycle involving black-tailed jackrabbits (Hardy and Bruen 1974).

WEST NILE VIRUS

WNV was first reported in the United States in 1999. Since that time, cases of WNV have been reported in most states, with California first detecting the virus in 2003. In 2003, three locally acquired human WNV cases were detected in residents of Los Angeles, Imperial, and Riverside counties, and WNV activity was detected in dead birds, mosquitoes, sentinel chickens, and a horse in six southern California counties. As of fall 2007, WNV activity has been detected in most California counties, including all counties within the Complex. Laboratory testing has indicated that *Culex tarsalis* mosquitoes are likely to play a primary role in enzootic maintenance and transmission of WNV in California (Goddard et al. 2002). *Ochlerotatus* sp. and *Aedes* sp. mosquitoes were shown to be only moderately efficient vectors of WNV, and with a preference for mammalian hosts, they have little potential to act as secondary or bridge vectors from birds to mammals (Goddard et al. 2002).

MALARIA

Malaria was a major public health problem in California through the early 1900s (Gray and Fontaine 1957). A combination of case detection and mosquito control reduced transmission to very low levels by the 1920s. Three major outbreaks in the last 40 years have served as reminders that the introduction of the malaria parasites (*Plasmodium falciparum* and *P. vivax*), combined with presence of the *Anopheles* mosquito vectors, can result in transmission.

MOSQUITO BIOLOGY

Mosquitoes are dipteran insects with aquatic immature stages and an aerial adult stage. They have four aquatic larval stages (instars) plus an aquatic pupal stage. The adult emerges from the pupal stage onto the surface of the water, expands its wings, hardens its exoskeleton, and flies off. Depending on seasonal and environmental conditions and the particular mosquito species involved, it generally takes from three to 12 days for a mosquito to complete its life from developed egg to early adult stage. In general, as ambient temperature increases, the number of days required from hatching to emergence as an adult decreases. Although some species of mosquitoes (e.g., *Culex tarsalis*), are capable of long flights from the aquatic habitat, the mosquito problem created by a wetland will generally be proportional to it's distance from concentrations of human and domestic animal populations.

There are three primary species of mosquitoes (*Aedes melanimon, Culex tarsalis,* and *Anopheles freeborni*) that can be produced in managed wetlands and surrounding agricultural lands that have been the subjects of control efforts by MVCDs in the Central Valley. At times, Refuge habitats, such as riparian forest, may harbor mosquitoes produced on surrounding lands. These species can be categorized by life history traits into two distinct groups (floodwater mosquitoes and standing water mosquitoes).

FLOODWATER MOSQUITOES

AEDES MELANIMON

The life cycle of the floodwater mosquito begins with flooding of ground that has undergone a dry period. The summer dry cycle in seasonal or semi-permanent wetlands fits the criteria for this species' habitat needs. Once flooded, eggs that were laid during the previous dry cycle hatch, pupate, and emerge as adults. Research conducted in Merced County found that *A. melanimon* developed from first instar larvae to adult stage in eight to nine days in seasonal wetlands during the last half of September (Mortenson 1963). Gravid females then return to lay their eggs singly on drying soil, in leaf litter, in cracks in the soil, or at the bases of grasses and other plants in areas that have been flooded previously. Each female lays approximately 150 eggs per ovarian cycle. These eggs are very drought resistant, allowing them to survive during the summer.

Floodwater mosquitoes are often the most abundant mosquito produced by managed seasonal wetlands, especially during summer irrigations and/or fall flooding. Relative to other species, adult females are aggressive and feed primarily on mammals. During the day, females will bite if disturbed or if a host presents itself, but generally biting and swarming activities peak at dawn or dusk. Other species of floodwater mosquitoes, including *A. vexans* and *A. nigromaculus*, may also occur in managed wetlands, but are much less common. Floodwater mosquitoes have been identified as a primary nuisance species and as playing secondary roles in transmission of CE and WEE. Floodwater species including *A. melanimon* and *A. vexans* have been shown to have only "moderate transmission rates," for WNV, and with their preference for mammalian hosts, these species have little potential to act as secondary or bridge vectors for WNV from birds to mammals (Goddard et al. 2002).

STANDING WATER MOSQUITOES

CULEX TARSALIS

Peak numbers of *C. tarsalis* occur in the Central Valley during the summer. Females lay their eggs on the water surface in bunches called rafts. Each raft contains around 100 to 150 eggs, hatching about 24 hours after being laid. The immature stages can be found in almost any source of water except tree holes. During the summer, development from egg to adult takes about seven to nine days. Peak populations occur in late June or early July, but can continue into late summer. Adults can emerge continuously throughout the summer and fall in areas that have been flooded for an extended period of time, usually for more than 2 to 3 weeks (i.e. rice fields, poorly drained pastures, semi-permanent/permanent wetlands, seasonal wetlands flooded in August, sewer treatment plants, and dairy farms).

Biting and swarming activities are typically at dawn or dusk. Adults spend daylight hours resting in secluded places such as animal burrows. *C. tarsalis* primarily bite birds, but will bite humans, livestock, and other mammals if the opportunity presents itself. In California, this species commonly feeds on songbirds in spring and early summer, and switches to mammalian feeding in late summer and fall. This change in feeding habits from birds to mammals, combined with large populations and the ability to travel long distances, makes *C. tarsalis* a potent vector of some of California's arboviruses. *C. tarsalis* is considered the primary vector for WEE virus to humans and equines, and SLE virus to humans. *C. tarsalis* has been identified as a primary vector of WNV in the western United States (Goddard et al. 2002).

ANOPHELES FREEBORNI

A. freeborni also occurs in the Central Valley and is numerous during the summer, peaking in late July or August. Rice fields and semi-permanent and permanent wetlands are the primary production areas for this species, although the immature stages are also found in ditches, seepages, and sloughs. Females lay their eggs singly on the surface of the water where they hatch approximately 24 hours later. On the average, it takes about 9 to 12 days for *A. freeborni* to develop from egg to adult. Like *C. tarsalis*, this species can produce a continuous supply of newly emerged adults under the right habitat conditions. Adults rest during the day, and bite and swarm at dusk. In autumn, females enter a physiological state called diapause, during which reproduction is suspended and activity is diminished. They over-winter until January to March, when they come out of diapause and seek blood meals on warm days. After obtaining a blood meal, many females resume their over-wintering state until April or May when they begin laying eggs once more. The females will readily bite humans and livestock. This species can be a vector of malaria in the western United States.

MOSQUITO ABUNDANCE IN REFUGE HABITATS

Mosquito abundance reaches its peak on the Complex during flood-up of seasonally flooded wetlands (SFW) during late summer and early fall. Because hundreds of acres are flooded per week, there can be a constant influx of new mosquito cohorts, resulting in a sustained population of mosquitoes over the fall flood-up period. As each wetland floods, *A. melanimon* can be produced initially (on average within seven to ten days), potentially followed by *C. tarsalis* after approximately two weeks of inundation. There is a second smaller and much shorter-lived peak that is often observed during the spring/summer seasonal wetland irrigation season (Figure 2.).

This involves much less acreage and is not sustained since the irrigations are usually completed in seven to ten days. The irrigated wetlands then revert to a dry period until flooded in the fall.

Semi-permanent and permanent wetlands can produce *A. freeborni* and *C. tarsalis*, but because of their limited acreage, stable water levels, and abundance of mosquito predators (fish, dragonflies, and other predatory invertebrates) they are typically not considered "problem" production areas that require additional control measures. However, they can still be managed to minimize mosquito populations by properly managing water and vegetation (Kwasny et al. 2004). If water levels are allowed to fluctuate, these wetlands can also produce floodwater mosquitoes that may become a concern.

Refuge habitats can also function as staging or resting areas for adult mosquitoes produced both on and off Refuge lands. Sub-adult life stages of *A. freeborni* are typically not abundant; however, adults are found quite commonly during July and early August. This is when *A. freeborni* production in rice fields is at its peak. Riparian forests, or other heavily vegetated habitats, are attractive to adult mosquitoes because they provide moderate temperatures and available blood meals from birds and mammals. About 98 percent of the original riparian habitat has been destroyed in the Central Valley. As a result, riparian areas on Refuges can attract and concentrate adult mosquitoes produced from thousands of acres of surrounding rice fields and pastures.

MONITORING DISEASE ACTIVITY

Viral activity is monitored by local MVCDs by testing adult female mosquitoes or blood samples from live birds for presence of encephalitis virus. Center for Disease Control (CDC) light traps or artificial rest sites are used to collect live mosquitoes for virus testing (Table 3). CDC traps do not require electricity, which allows them to be used in remote areas to assess disease presence or relative abundance in a local area. Pools of 50 adult female mosquitoes of the desired species are collected and sent on dry ice to the Viral and Rickettsial Disease Laboratory (VRDL) for viral analysis. The VRDL tests the mosquitoes for the presence of arboviruses.

To monitor the avian segment of the transmission cycle, sentinel chicken flocks are placed in areas throughout California and exposed to mosquitoes by MVCDs. Flocks exist at various locations around the Refuges. Once every two weeks, generally from May through October, blood samples are drawn from each chicken and centrifuged to collect the sera. The sera is then frozen and sent on dry ice to the VRDL where it is tested. If mosquitoes are actively passing encephalitis among birds, specific viral antibodies would theoretically show up in sera collected from sentinel chickens. Wild birds could also be sampled if they were available, but are otherwise considered too labor-intensive for regular monitoring.

Dead birds and some mammals (squirrels) are also monitored for WNV by local MVCD. Bird carcasses found by the public, Refuge, or District staff may be tested for WNV by local MVCDs, State laboratories, or the U. S. Geological Survey - National Wildlife Health Center. WNV cases in humans and horses are also monitored. Current data from all of these sources are available at the California West Nile Surveillance website (www.westnile.ca.gov).

For malaria, MVCDs do not monitor the *A. freeborni* mosquito population for the presence of malaria parasites, but rely on information concerning human cases provided by local health departments.

Figure 2. Seasonal wetland flooding and potential time periods for significant mosquito production.

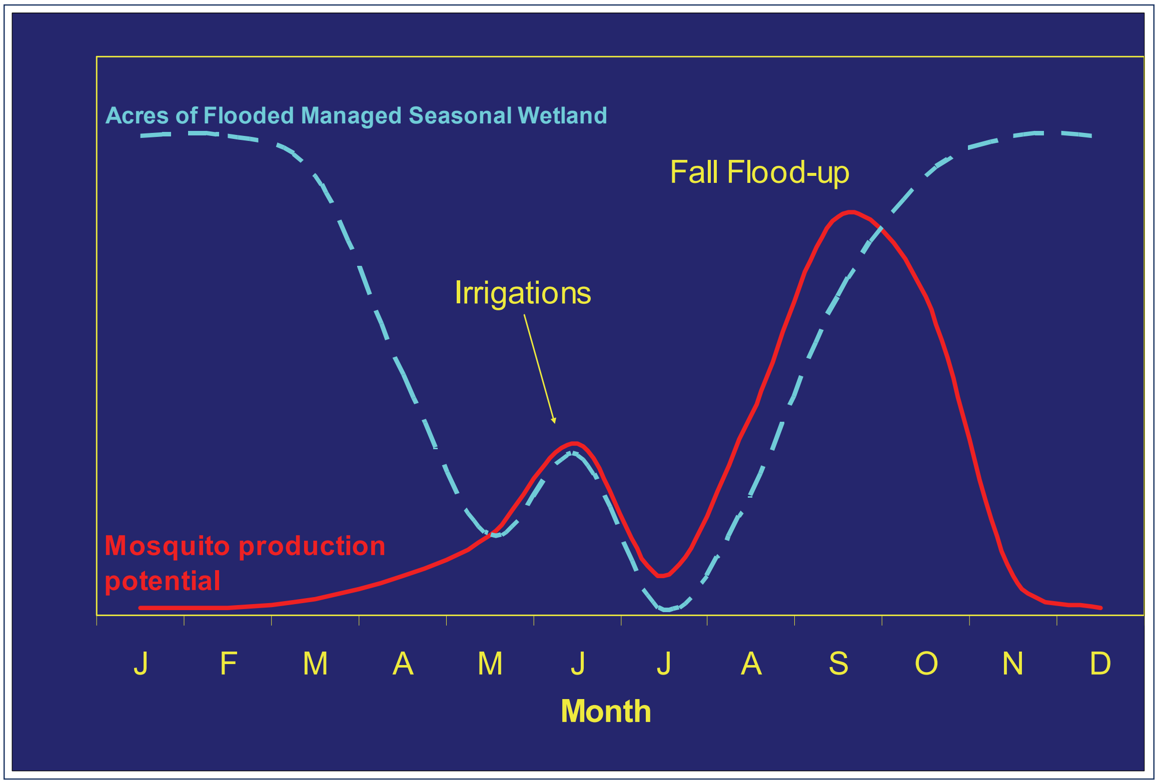

Table 3. Current disease surveillance methods that are employed on or in the vicinity of the Refuges at the Sacramento National Wildlife Refuge Complex.

		Adult Mosquito Pools[1]		
Refuge or WMA	**Sentinel Chicken Flock**	**CDC Traps[2,3]**	**Artificial Rest Sites[2]**	**Dead Birds[4]**
Sacramento	X	X		X
Delevan				X
Colusa	X	X		X
Sutter	X	X	X	X
Butte Sink	X			X
Llano Seco Unit	X	X		X

[1] Composite sample of adult mosquitoes (usually 50).
[2] Often used to follow up specific disease source areas after a local chicken flock conversion.
[3] Carbon dioxide-baited traps to collect adult mosquitoes.
[4] Primarily for surveillance of West Nile Virus.

MONITORING MOSQUITO POPULATIONS

Monitoring mosquitoes on the Complex is facilitated through a Special Use Permit (mosquito control is conducted under the same permit), allowing District personnel to sample wetlands and other areas on a weekly basis throughout the mosquito production season. Refuge maps and water management schedules made available to the MVCDs are used to help mosquito control technicians monitor current and potential mosquito habitat. Direct communication between Refuge staff and District personnel is used to identify changes in water management schedules. MVCDs are required to submit monitoring and treatment data annually.

IMMATURE STAGES

Larvae and/or pupae are typically sampled using a “dipper”, which is a 14-ounce white cup attached to a long wooden or metal handle. The dipper is used to determine the relative density of larvae by taking standard samples of water from a potential mosquito source. The contents are examined, recording mosquito numbers and species, resulting in a “number per dip” index. Sampling immature life stages of mosquitoes serves to identify significant production sites and can help determine the potential need for treatment. This is done based on the quantity and species of larvae found per dip, identification of the larval instar stage, number of days required for the larvae to pupate and emerge, and proximity to urban areas. Monitoring larval mosquito production throughout a wetland can help identify problem areas where certain BMPs can be employed to reduce future production. Larvicide and pupacide treatment thresholds are based on information using this monitoring technique.

ADULT STAGE

The relative abundance of adult mosquitoes is estimated using light traps, carbon dioxide-baited traps, or landing counts, depending on the individual MVCD’s protocol. Traps are hung from trees, buildings, or special stands, and usually remain in the same place throughout the season and from year to year. Light trap contents are collected weekly during the mosquito season. The total number of adult females, by species, is divided by the number of nights the trap was activated, and the index value is reported as adult females per trap night. New Jersey Light Traps (NJLT) are located on-site at Colusa and Sutter Refuges and northeast of Llano Seco Unit (between Llano Seco and the nearest town-Dayton). NJLTs are located in other areas near the Refuges, but are less effective in associating abundance to Refuge lands.

Landing counts are used to sample adult mosquitoes in specific areas. With this method, an observer stands within the sample site, faces away from the wind and counts the number of mosquitoes that land on his/her pant legs over a period of one minute. The count is divided by two for a “leg count” index. This procedure is usually done early in the morning or at dusk, when temperatures are cool and mosquitoes are most active, and is repeated three or four times per site. Adulticide treatment thresholds are based on information using one or both of these monitoring techniques.

POTENTIAL CONTROL METHODS AND MATERIALS

WETLAND MANAGEMENT BMPS (FROM KWASNY ET AL. 2004)

The BMPs in this document are habitat-based strategies that can be implemented when needed for mosquito control in managed wetlands. These strategies represent a range of practices that wetland managers can incorporate into existing habitat management plans, or in the design of new wetland restoration or enhancement projects. Ideally, BMPs can be used to decrease the production of mosquitoes and reduce the need for chemical treatment without significantly disrupting the ecological character, habitat function, or wildlife use of managed wetlands. They can be used to exploit mosquito biology to minimize the production of larvae and ultimate emergence of the adult stage. More specifically, they are designed to take advantage of opportunities to discourage, minimize, delay, or compress mosquito production, and enhance natural mosquito predator populations. It should be recognized that BMPs function as a proactive first line of defense in deterring mosquito production and can be used in combination with other IPM tools such as, biological controls, larvicides, and adulticides when necessary.

In many cases, BMPs overlap with commonly used habitat management practices to conserve water and manage wetland vegetation for wildlife (Batzer and Resh 1992a, Batzer and Resh 1992b, Resh and Schlossberg 1996). Not all BMPs will be appropriate for a given wetland location, or set of circumstances. Therefore, the Refuge staff works closely with local MVCDs to implement BMPs based on their potential effectiveness for regional or site specific conditions (such as wetlands that have a documented history of heavy mosquito production), and habitat management strategies. The implementation of BMPs is limited by cost and personnel constraints, potential impacts on wetland habitat, and wildlife response to these measures.

BMPs have been divided into six categories. These categories are not listed in order of importance and may be used in combination.

- Water Management Practices
- Vegetation Management Practices
- Wetland Infrastructure Maintenance
- Wetland Restoration and Enhancement Features
- Biological Controls
- Coordination with MVCDs

Following this BMP section is a series of tables (4-9) summarizing the BMPs in each category and outlining strategies, mosquito control objectives, advantages, and disadvantages.

WATER MANAGEMENT

Water management is one of the wetland manager's best tools for reducing mosquito populations. Water management BMPs include timing and duration of flooding, the speed at which individual units are flooded or irrigated, and the stability of water levels (Table 4). Starting with the most persistently wet habitats, summer wetlands (permanent and semi-permanent) produce the least amount of mosquitoes, thus receive the least amount of concern from MVCDs. Stable water management is used regularly as a planned effort to discourage rank emergent plant cover from "taking over" wetlands designed for a combination of vegetative cover and open water. It also minimizes floodwater mosquito production. Abundant mosquito predators (fish, dragonflies, etc.) during mosquito production periods are the main attributes of these habitats that naturally discourage large-scale adult emergence.

Historically, irrigations of seasonal wetlands at Colusa and Sutter Refuges, or Butte Sink WMA have periodically triggered mosquito control efforts, often adulticides to control newly emerged *A. melanimon* and in some cases *Culex tarsalis*. Several BMPs may be employed to modify irrigations and minimize mosquito production, while accomplishing habitat objectives for Refuge resources. They include decisions on whether the irrigation is required, how soon after the initial drawdown it can be made, how rapidly the water can be applied, and how rapidly and completely the water can be drained. Following irrigations, a similar set of decisions can be made related to fall flood-up, including modifying flooding schedules, rapid flooding, or using water from summer wetlands that contain an inoculum of natural mosquito predators.

Use of many of these BMPs requires water to be readily available, of sufficient quantity and quality, and that the conveyance infrastructure is adequate to permit rapid flooding or drainage. For some wetlands, circumstances outside the control of wetland managers (e.g. when agriculture drain water is used for flood-up, and must be taken at certain times) may limit their ability to implement water management BMPs. Sutter Refuge, Butte Sink WMA, and the northern portion of Colusa Refuge fall into this category. In managed wetlands where these limitations are not an issue, the following water management practices are considered.

Timing of Flooding

The timing of wetland flooding can greatly influence mosquito production (Fanara and Mulla 1974, Batzer and Resh 1992a). Delayed flooding may reduce mosquito production by shifting flooding schedules later in the year, when temperatures are cooler and mosquito production is less of a problem. Delayed flooding should be considered for wetlands with historic mosquito problems, as well as those in close proximity to urban areas. However, delayed flooding means that less wetland habitat is available for wildlife during times, such as August and September, when wetlands are particularly limited. Delayed flooding cannot be used exclusively on the Complex because Refuges have an obligation to provide habitat for early migrant waterfowl, sandhill cranes, and other waterbirds, and to reduce the potential for crop depredation by waterfowl.

Given the limited feasibility of delayed flooding, phased or staggered flooding of wetlands is useful to provide a level of early-flooded habitat on some wetlands, while delaying flooding on others. Phased flooding involves flooding habitat throughout the fall and winter in proportion to wildlife need, and takes into consideration other wetland habitat that may be available in surrounding areas.

For wetlands that are flooded early (August to early September) or in close proximity to urban areas, the use of vegetation and water management BMPs should be a high priority (Tables 4-9).

BMPs: Delayed or phased fall flooding, Early fall flood-up planning (see Table 4 for additional explanation)

Speed of Wetland Flooding

As a general rule, the faster water can be applied during fall flooding and spring/summer irrigation, the fewer generations of mosquitoes will be hatched. Slow feather-edge flooding, although beneficial to foraging waterbirds, can produce multiple, staggered hatches of floodwater mosquitoes and, if treatment is necessary, often requires MVCDs to visit wetlands over a number of days for control activities (Garcia and Des Rochers 1983). Such an intensive treatment effort is expensive, and can result in more pesticide applications and additional disturbance to wildlife.

BMPs: Rapid fall flooding, Rapid irrigation (see Table 4 for additional explanation)

Water Control

Once wetlands have been flooded, it is important for managers to ensure that pond elevations do not fluctuate, except during planned drawdown or periods of low mosquito production (i.e. winter months). Fluctuating water levels tend to expose wetland edges to drying and provide suitable habitat for floodwater mosquitoes to lay eggs (Garcia and Des Rochers 1983). When water levels are subsequently raised, a new cohort of mosquitoes may be hatched. Water levels should be maintained through frequent monitoring, and adding water to offset any losses. A constant maintenance flow of water will also help maintain steady water levels, improve water quality, and reduce stagnation.

If possible, wetlands can be flooded to deeper water depths during the fall and allowed to recede during the cooler winter months to provide shallow water depths for foraging waterbirds. Deeper water depths (24 inches) at initial flooding have been shown to significantly reduce mosquito densities at Grizzly Island Wildlife Area (Batzer and Resh 1992a,b).

When flooding wetlands, water sources containing mosquito predators should be used to help colonize wetlands with predacious insects or mosquitofish that are passively transported by water from upstream locations (Collins and Resh 1989). Predator populations can be maintained in permanent waterways used to flood seasonal wetlands. In the Suisun Marsh, where water is readily available for flooding, seasonal wetlands are often initially flooded, and if mosquitoes become abundant, water levels are drawn down to concentrate mosquito larvae in ditches for biological control, larvicide treatment, or to drown larvae through turbulent water movement. Following this action, wetlands are immediately re-flooded.

BMPs: Maintain stable water levels, Circulate water, Use deep initial flooding, Subsurface irrigate, Utilize water sources with mosquito predators for flooding, Flood and drain wetland (see Table 4 for additional explanation)

Frequency and Duration of Irrigation

Spring and summer irrigations are a common wetland management practices used to increase seed production and biomass of moist-soil plants (Naylor 2002), and reduce competition from undesirable plants in seasonal wetlands. The need to irrigate should be assessed closely by wetland managers. During years with above average spring precipitation, irrigations may not be necessary to maximize moist-soil plant production. When possible, managers should shorten the duration of irrigation to 4 to 10 days to reduce the likelihood of hatching floodwater mosquitoes and eliminate the possibility of creating habitat for standing water mosquitoes. However, shorter irrigations may not always be feasible, especially when growing more water intensive plants such as watergrass and smartweed, or when conducting flooding to control undesirable plant species. In the case of weed control, plants should be monitored and water held only long enough to eliminate weeds. The necessary timing can be determined when weeds have turned black or have disintegrated. Finally, following wetland irrigations, water should be drawn down into waterways containing mosquito predators that can consume any mosquito larvae, which may have hatched.

BMPs: Reduce number of irrigations, Use rapid irrigation, Drawdown and irrigate in early spring, Irrigate prior to field completely drying, Drain irrigation water into ditches or other water sources with mosquito predators, Use subsurface irrigation (see Table 4 for additional explanation)

VEGETATION MANAGEMENT PRACTICES

Wetland managers commonly use vegetation control to alter plant species composition and abundance to influence wildlife use (Smith et al. 1995). As the vegetative community in a wetland changes through time, undesirable species inevitably encroach. Some species may be relatively benign, while others may be problematic, reducing habitat diversity or crowding out plants important as wildlife forage or cover. Vegetation is also an important habitat requirement for mosquitoes, and can improve mosquito survivorship by providing refuge from predators (Walton and Mulla 1989) and abundant food resources for larvae. Vegetation can also increase mosquito developmental rates by raising water temperatures (Collins and Resh 1989). To manage the vegetative community to benefit wildlife, a number of techniques are used, including mowing, burning, disking, spraying, and grazing. These habitat management practices can be used alone or in combination and can also be used to reduce mosquito production (Table 5).

Any management action that alters the composition of wetland vegetation may create either benefits or detriments to wildlife. The decision to conduct such operations should be determined by the management objectives of an individual Refuge (e.g. in annual habitat management plans). Site-specific characteristics, habitat management objectives, cost, and recreational use (e.g., hunter access) all have to be carefully considered in vegetation management plans. Typically, any vegetation control measure will result in the short-term loss of cover for wildlife. Such compromises have to be weighed in terms of the long-term benefits they provide for wildlife resources versus the ancillary benefits they provide for mosquito control.

Mowing

Mowing is commonly used to create open water habitat for shorebirds and waterfowl. Mowing provides opportunities for the biological control of mosquitoes, and enhances the effectiveness of pesticides by allowing greater saturation of mosquito habitats. Experimental mowing of approximately 50 percent of a wetland has been shown to reduce the density of mosquitoes and concentrate their distribution, while increasing densities of invertebrates that are consumed by waterfowl (Batzer and Resh 1992a). Similarly, Garcia and Des Rochers (1984) found that seasonal wetlands mowed with a 50 percent plant-cover ratio enhanced wind action that moved mosquito larvae to wetland edges where treatment efforts could then be concentrated. The benefits of mowing, unlike burning or disking, tend to be short term and require that the practice be implemented on an annual basis. Mowing may also leave residual matter that, when flooded, provides habitat for mosquitoes (Kwasny et al. 2004).

Burning

Controlled burning, where and when feasible, can effectively control vegetation. Burning, especially when immediately followed with disking, can offer multiple year control of mosquitoes, reduces vegetation used by mosquitoes for breeding activities, and also directly results in the kill of mosquito eggs due to high temperatures associated with fire (Resh and Schlossberg 1996, Whittle et al. 1993). Burning releases nutrients stored in plant materials and makes them available to benefit plant and invertebrate production during the following flooding cycle. However, due to difficulty with obtaining local burn permits on a consistent basis, the amount of acres that can be burned annually is limited.

Disking

Disking is commonly used to reduce dense stands of emergent or undesirable vegetation, and provide favorable conditions for the establishment of moist-soil plants consumed by waterfowl. Disking, unlike mowing, tends to change the vegetation composition of a wetland and provides a more permanent means of control. Disking has also been shown to significantly reduce densities of mosquitoes over multiple years, increase the densities of macroinvertebrates important in the diets of waterfowl, and encourage the replacement of less desirable vegetation by moist-soil plants (Resh and Schlossberg 1996). Lawler et al. (2007) found that the use of herbicide and disking for jointgrass control also resulted in fewer mosquito larvae and pupae. Untreated plots had seven times more larvae and 20 times more pupae than did vegetation-removal plots. The benefit of disking can often be enhanced by first mowing or burning vegetation targeted for control.

Haying and Grazing

Agricultural practices such as haying and grazing may also be useful to control wetland vegetation. However, little information is available on their effectiveness as mosquito control measures. Haying, while functionally similar to mowing, may provide the same mosquito control benefits. Haying has a potential added benefit of removing cut plant material that may decay and negatively affect water quality, thereby increasing mosquito production (Kwasny et al. 2004). However, haying removes valuable seed resources consumed by wildlife and interrupts the cycle of nutrient release back into wetland environments. In addition, haying has limited applicability in most wetland environments because of the relative remoteness of wetlands from agricultural operations, difficulty of running haying equipment in unleveled wetland terrain, and low palatability of wetland vegetation as livestock forage.

Grazing is frequently used to reduce plant biomass in wetlands, and provide short grass and open water habitats for shorebirds and waterfowl. However, grazing animals require sources of drinking water and often irrigated grasslands for forage. Water used to meet these needs may provide additional habitats for mosquitoes. Furthermore, grazing animals can create wallows or depressions in moist wetland terrain, which trap water and create additional microhabitats for mosquitoes (Kwasny et al. 2004). Additional research needs to be conducted to determine the usefulness of grazing as a mosquito reduction tool.

WETLAND INFRASTRUCTURE MAINTENANCE

Wetland infrastructure is the foundation for habitat management. A properly functioning water delivery and drainage system, well maintained levees, correctly operating water control structures, and efficient pumps are key to avoiding the unnecessary production of mosquitoes through simple neglect (Table 6). Time and money invested in these proactive maintenance activities will reduce mosquito production and help landowners improve wetland management efficiency, while avoiding the additional costs of controlling mosquitoes and unwanted vegetation.

Levee and Water Control Structure Inspection and Repair

Levees and water control structures should be inspected on an annual basis to identify problem areas including weak spots or rodent damage that may leak water and produce mosquitoes. Water control structures should be watertight and properly sealed to prevent seepage.

Ditch and Swale Cleaning

Vegetation in water delivery ditches and swales can create habitat for mosquitoes or impede the flow of water that facilitates rapid flooding or drainage. Typical maintenance activities of water delivery/drainage ditches include the use of herbicides or periodic dredging to remove problem vegetation that inhibits water flow. Ditches and swales should be cut to grade to prevent the unintentional trapping of water. Likewise, silt that accumulates in front of inlet or outlet structures should be removed so it does not impede flow or trap water in swales.

Pump Tests and Repair

Pumps used for flooding should be periodically tested to make sure they are operating at optimum efficiency. This will ensure that pumps are providing maximum output, which will facilitate rapid flooding.

WETLAND RESTORATION AND ENHANCEMENT FEATURES

All well planned wetland restoration and enhancement projects begin with an initial survey and design phase. During this phase, landowners and restoration biologists have the opportunity to discuss design features with MVCDs and incorporate BMPs to reduce mosquito production (Table 7). Time spent at the design stage can save thousands of dollars in annual operation and maintenance costs and prevents problems resulting from poor water management and unintended mosquito production. Wetland design typically focuses on aspects of water control that promote vegetation beneficial to wildlife, conserve water, and allow for periodic vegetation control.

Wetland design features to reduce mosquito production

Wetland design features that reduce mosquito production include independent flooding and drainage capabilities, size considerations to facilitate rapid flooding, and the incorporation of features that promote habitats for mosquito predators and allow those predators access to mosquitoes. Water delivery ditches, water control structures and levees should be designed and built to specifications that prevent wind and water erosion, provide equipment access for maintenance activities, and reduce damage caused by burrowing animals. These design features will facilitate other mosquito BMPs such as water and vegetation management practices, infrastructure maintenance, and natural mosquito predation.

BMPs: Independent water management, Adequately sized water control structures, Swale construction, Wetland size consideration, Ditch design, Levee design & compaction, Deep channels or basins constructed in seasonal wetlands, Permanent water reservoir that floods into seasonal wetlands (for additional explanation see Table 7)

BIOLOGICAL CONTROLS

Naturally occurring predators, such as fish, dragonflies, aquatic macroinvertebrates, and certain birds and bats, can contribute to the reduction of mosquitoes (Table 8). However, it often takes time before predator populations become established and have an effect on mosquito numbers. Natural predator populations can be supplemented, for example, through the stocking of mosquitofish (*Gambusia affinis*), but in most instances a habitat manager's best strategy is to maintain natural predator populations on-site. Primary stockings of fish are usually conducted at a minimal initial rate of 0.1 lb per acre. Stockings are augmented up to 1.0 lb per acre, based on larval dipping data. Past tests conducted by the Sutter-Yuba Mosquito Abatement District at the Gray Lodge Wildlife Area have demonstrated that 1 to 4 pounds of fish per acre were necessary for the successful control of *Aedes* sp. larvae, presumably on SFW (Lusk 1979, Hanna 1980). Follow-up test results also showed that sufficient numbers of fish must be stocked when the water is initially turned into each field. Some preparatory vegetation clearing and creation of open channels to facilitate fish movement and water flow were also helpful. For biological controls to be effective, wetland managers need to create an environment that is both conducive to maintaining predator populations and providing predators with access to mosquito prey.

Encourage on-site predator populations

Management practices have been developed that incorporate permanent water within seasonal wetlands to "inoculate" newly flooded habitats with an on-site predator source. This can be accomplished by maintaining permanent water in swales and deep borrow ditches, or by flooding wetlands with water from nearby permanent wetlands. Permanent water sources will need to be maintained when seasonal wetlands are dry, if wild populations of mosquitofish are to be sustained on-site. Such "dry season" predator reservoirs should be 18 inches or greater in depth to reduce predation of mosquitofish by herons and egrets (Collins and Resh 1989). Dry season reservoirs should be interconnected to seasonal wetlands through swales or ditches to allow mosquitofish to seek more permanent habitat as seasonal wetlands are drawn down and, conversely, to allow mosquitofish to disperse into seasonal wetlands as they are re-flooded in the fall.

It is critical to the success of biological control to limit the use, when possible, of broad-spectrum insecticides that not only kill mosquitoes, but also eliminate their natural predators. Control programs that combine biological controls with chemical insecticides often result in suboptimal results because the predators take longer to recover from insecticide induced mortality than mosquito populations (Walton et al. 1990).

Provide predator access to mosquitoes

The extent of wetland vegetation may limit predator access to mosquitoes (Walton and Mulla 1989, Collins and Resh 1989). Wetlands with significantly dense vegetation provide an abundance of hiding places for mosquitoes and can limit aquatic predator dispersion. Vegetation management BMPs can be used to reduce dense stands of cattails, tules, or other emergent vegetation and provide predator access to mosquito prey. Isolated basins that do not interconnect to the main water body of a wetland will also limit an aquatic predator's access to mosquito prey. To encourage mosquito predation, wetland swales can be constructed to connect isolated basins with deep-water areas containing aquatic mosquito predators.

COORDINATION WITH MOSQUITO AND VECTOR CONTROL DISTRICTS

The responsibilities of MVCDs and wetland managers have some inherent conflicts. MVCDs have a responsibility to reduce vectors that may transmit disease to humans or cause a significant nuisance. Wetland managers have a responsibility to maintain and enhance wetlands: a public trust resource that provides habitat for migratory birds, threatened and endangered species, and helps to reduce depredation from waterfowl on agricultural lands. Public resource agencies are increasingly being asked to provide wetland habitat to meet the recreational demands of hunters, anglers, bird watchers, photographers, and hikers. Wetland managers recognize that mosquito production may be a by-product of wetland management and in some cases may contribute to problems requiring mosquito control. However, in order for both MVCDs and wetland habitat managers to accomplish their objectives, cooperation and coordination is essential (Table 9).

Coordinate habitat management and flooding schedules

By providing advanced information regarding habitat and water management schedules, wetland managers enable MVCDs to make suggestions regarding BMPs, schedule monitoring efforts, and, if necessary, control mosquitoes as efficiently as possible. In return, MVCDs can provide the Refuge with useful input and feedback on how to reduce mosquito production and potentially reduce abatement costs.

Identify problem areas for mosquito production and target implementation of BMPs: Coordination is also required on the part of MVCDs and Refuges to identify the highest priority wetlands for the implementation of BMPs. For example, Garcia and Des Rochers (1983) found that *A. melanimon* larvae were largely restricted to specific areas in a few fields on Gray Lodge Wildlife Area. As a result, limited resources could be focused on these problem areas.

Coordinate wetland habitat restoration and enhancement project design

Prior to enhancement or restoration projects, MVCDs should be consulted to determine if design features to reduce mosquitoes can be incorporated. By involving MVCDs early in the process, problems associated with design features or poor engineering that may encourage mosquito production can be avoided.

Table 4. Water Management Practices to reduce mosquito production in managed wetlands.

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
Delayed or phased fall flooding	Delay flooding of some wetland units until later in the fall. Delay flooding units with greatest historical mosquito production and/or those closest to urban areas.	To delay initiation of floodwater mosquito production in seasonal wetlands by reducing the amount of mosquito habitat available during optimal breeding conditions (warm summer/early fall weather). Reduce the time available for standing water mosquito production in seasonal wetlands.	Depending on flood date, can reduce the need or amount of additional treatment. Delayed flooding can provide "new" food resources for wildlife later in the season when wetlands are finally flooded.	Reduces the amount of habitat for early fall migrants and other wetland-dependent species, and may increase potential for waterfowl depredation on agricultural crops (especially rice). Flooding is often dictated by water availability or contractual dates for delivery. Delayed flooding may still produce mosquitoes in warm years. Private hunting clubs can't lease blinds that aren't flooded.
Early fall flood-up planning	Apply BMPs to wetlands identified for early flooding. To the extent possible, areas targeted for early fall flooding should not be near urban centers and should not have a history of heavy mosquito production.	To reduce the early season production of mosquitoes or to reduce their encroachment on urban areas.	Allows for the provision of early flooded habitat while minimizing mosquito production and conflicts with urban areas.	Some additional effort required to monitor and identify suitable areas. Requires the extensive use of BMPs to ensure mosquitoes are not produced.
Rapid fall flooding	Flood wetland unit as fast as possible. Coordinate flooding with neighbors or water district to maximize flood-up rate.	To minimize number of mosquito cohorts hatching on a given area.	Reduces the need for multiple treatments needed by synchronizing larval development and adult emergence. In turn, reduces wildlife disturbance by MVCDs.	Requires coordination & ability to flood quickly. Reduces slow, feather-edge flooding that is heavily utilized by waterbirds.
Rapid irrigation	4-10 day irrigation (from time water enters the pond to complete drawdown).	Shorten irrigation period to reduce time available for mosquitoes (especially *Culex tarsalis* and *Anopheles freeborni*) to complete lifecycle.	Provides some level of wetland irrigation while reducing the time available for mosquitoes to complete lifecycle.	Requires ability to rapidly flood & drain wetland. If flooding is used for weed control, rapid irrigation may not be feasible.

Table 4 (cont.). Water Management Practices to reduce mosquito production in managed wetlands.

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
Maintain stable water level (summer and early fall flooding)	Ensure constant flow of water into pond to reduce water fluctuation due to evaporation, transpiration, outflow, and seepage.	To reduce conditions for additional floodwater mosquito production in summer and fall.	Provides a stable wetland environment for breeding wildlife during spring and summer. Discourages undesired excessive vegetative growth which could also become additional mosquito breeding substrate.	Requires regular monitoring and adjustment to water control structures. May be difficult if water availability is intermittent or unreliable. Reduces mudflat habitat that is attractive to shorebirds and waterfowl.
Water circulation	Provide a constant flow of water equal to discharge at drain structure.	To keep water fresh and moving to deter stagnant conditions for mosquito production; reduces water level fluctuation and potential production of floodwater mosquitoes.	Discourages warm water conditions associated with avian botulism outbreaks.	Requires landowner to purchase additional "maintenance" water. May be difficult if water availability is intermittent or unreliable.
Deep initial flooding (18-24")	Flood wetland as deep as possible at initial flood-up.	To reduce shallow water habitat for mosquito breeding. May provide more open water by over-topping vegetation, thereby facilitating mosquito predation or wind action that drowns larvae.	Potentially slows mosquito development by eliminating warm, shallow water habitat.	Requires additional water and infrastructure adequate to flood deeply. Reduces shallow water foraging habitat for shorebirds and waterfowl.
Utilize water sources with mosquito predators for flooding wetlands	Flood wetlands with water sources containing mosquito fish or invertebrate predators. Water from permanent ponds can be used to passively introduce mosquito predators.	To inoculate newly flooded wetlands with mosquito predators.	May establish mosquito predators faster than natural colonization.	Requires source of water with already established mosquito predators. Not applicable to wetlands flooded with well water.
Drain irrigation water into ditches or other water bodies with abundant mosquito predators	Drain irrigation water into locations with mosquito predators as opposed to adjacent seasonal wetland or dry fields.	To reduce the amount of larvae through natural predation and minimize the number of adults that emerge.	Already a common wetland management practice.	Must have ditch or water body with established predator population available to accept drain water.

Table 4 (cont.). Water Management Practices to reduce mosquito production in managed wetlands.

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
Flood & drain wetland	Flood wetland and hatch larvae in pond. Drain wetland to borrow or other ditch where larvae can be easily treated, drowned in moving water, or consumed by predators. Immediately reflood wetland.	Hatches mosquito larvae and moves them to a smaller area for treatment before they can emerge as adults.	Can eliminate or reduce the need for additional mosquito control efforts.	Additional cost to purchase water to re-flood wetland. Timing is critical. Requires monitoring and is labor intensive.
Reduce number of irrigations	Evaluate necessity of irrigation, especially multiple irrigations, based on spring habitat conditions and plant growth. Eliminate irrigations when feasible.	To eliminate unneeded additional irrigations which could provide potential habitat for mosquitoes.	Reduces potential need for additional mosquito control. Saves water and manpower costs. Discourages excessive growth of undesirable vegetation (i.e. joint and Bermuda grass)	May reduce seed production or plant biomass with less irrigation.
Early spring drawdown and irrigation	Drawdown wetland in late March or early April. Irrigate in late April or early May when weather is cooler and mosquitoes are less of a problem.	To reduce need for irrigation in June, July, and August, when potential for mosquito production would be higher.	Wetland irrigation can be accomplished without creating potential mosquito problems. May allow moist-soil plants to take advantage of natural rainfall during the spring.	Reduces shallow wetland habitat for migratory shorebirds and waterfowl in April and May, during a major migration period. Newly germinated wetland plants may be impacted by cold weather conditions. May stimulate germination and growth of undesirable wetland plants.
Don't let field completely dry and crack between spring drawdown and irrigation	Irrigate wetland before soil completely dries.	To eliminate necessary drying period for floodwater mosquito to lay eggs.	May reduce mosquitoes produced from irrigation	Requires close monitoring of soil moisture to correctly time irrigation.

Table 4 (cont.). Water Management Practices to reduce mosquito production in managed wetlands.

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
Subsurface irrigation	Maintain high ground water levels by keeping channels or deep swales permanently flooded.	To reduce amount of irrigation water during mosquito breeding season.	Reduce need for surface irrigation while maintaining soil moisture to promote moist-soil plant production.	Requires deep swales or boat channels to be effective. Requires additional pipes in channels for equipment access. May not produce intended irrigation result if water table is naturally low. Requires that water be maintained longer than normal in swales. May promote unwanted vegetation growth in swales or promote irrigation of non-target plants in wetland.

Table 5. Vegetation management practices to reduce mosquito production in managed wetlands.

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
Mowing	Mow undesirable or overgrown vegetation that serves as mosquito breeding substrate prior to flooding.	To reduce standing vegetation that mosquitoes can use for egg laying and larval development. To create open water habitat that allows mosquito predators (fish, invertebrates, birds) better access to larvae and potentially more wave action to drown mosquito larvae.	Improves wildlife habitat by providing open-water.	Effects are largely temporary, so must be conducted annually. Overuse could be detrimental to some species of wildlife and non-target invertebrates. Mowed vegetation may float providing mosquito habitat and decomposition may affect water quality.
Burning	Controlled burn of undesirable or overgrown vegetation that may provide mosquito breeding substrate.	See mowing. Can also kill mosquito eggs.	See mowing.	Requires burn permit. Liability concerns. Most landowners are not adequately prepared to conduct a controlled burn. Special consideration should be taken around plastic pipes or water control structures. Overuse could be detrimental to some species of wildlife and non-target invertebrates.
Disking	Disk undesirable or overgrown vegetation that may provide mosquito breeding substrate.	See mowing.	See mowing. Can provide longer-term control of undesirable vegetation by itself or in conjunction with other management practices.	Creates walking problems for hunters. Overuse could be detrimental to some species of wildlife and non-target invertebrates.
Haying/grazing	Mow and bale undesirable or overgrown vegetation that may provide mosquito breeding substrate. Spring, summer, or fall grazing.	See mowing. Also removes vegetation after cutting.	Dual benefits of improving habitat and reducing mosquito breeding substrate. Removal of mowed vegetation further decreases mosquito breeding substrate and may improve water quality. Grazing is relatively inexpensive and can also be used to meet wildlife habitat objectives.	Overuse could be detrimental to some species of wildlife and non-target invertebrates. Removes seed that wintering waterfowl forage on. Expensive. Often difficult to find someone to bale and haul plant material. Irrigation for livestock watering may exacerbate mosquito production. Livestock can also forage on desirable plants.

Table 6.Wetland infrastructure maintenance activities used to reduce mosquito production in managed wetlands.

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
Levee Inspection & Repair	Walk or drive levees, flag problem spots, repair as needed. Consider design elements to improve integrity of levee	To reduce mosquito habitat/production caused by seepage into adjacent fields or dry ponds.	Allows for early identification of problem spots. Helps conserve water and reduces growth of unwanted vegetation.	Requires annual monitoring and funding for repairs.
Water Control Structure Inspection, Repair, & Cleaning	Inspect structures and repair or replace as needed. Remove silt and vegetation build-up in front of structures. Adequately close, board or mud-up controls.	To reduce mosquito habitat/production caused by seepage into adjacent ponds or drainage ditches. Remove silt blockages that may trap water and impede drainage.	Enhances water management capabilities and limits unwanted vegetation or standing water.	Requires annual monitoring and funding for cleaning or repair.
Ditch Cleaning	Periodically remove silt or vegetation from ditches to maintain efficient water delivery and drainage.	To allow for rapid flooding/drainage & reduce vegetation substrate for breeding mosquitoes.	Enhances water management capabilities and limits unwanted vegetation or standing water.	Requires funding for ditch cleaning. Excessive vegetation removal on ditch banks can result in negative impacts to nesting birds and other wildlife.
Pump Tests & Repair	Test pump efficiency and make any necessary repairs to maximize output.	Could identify output problems and if corrected, allow managers to flood more rapidly.	May promote faster irrigation and flood-up if output can be improved.	Requires pump test. May be costly to repair or replace pump/well.

Table 7. Wetland restoration and enhancement features to reduce mosquito production in managed wetlands.

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
Independent water management	To the extent possible, design wetland projects to include independent inlets and outlets for each wetland unit.	To reduce the need to move water through multiple wetland units when flooding or irrigating target areas. This can reduce the number of mosquitoes produced per flood event.	Creates wetland units that are hydrologically distinct from one another allowing for diverse wetland management.	May require additional water control structures and ditches to be constructed and maintained. Increases restoration costs and complexity of management.
Adequately sized water control structures	Increase size and number of water control structures. When installing, set to proper grade to allow for complete drawdown.	To improve ability to implement rapid flooding/irrigation BMPs.	See rapid flooding/irrigation BMPs.	Increased size and number of water control structures will increase restoration costs and management complexity.
Swale construction (sloped from intake to drain)	Construct or enhance swales so they are sloped from inlet to outlet and allow the majority of the wetland to be drained.	To improve ability to implement rapid flooding/irrigation BMPs. Creates a means to move water through wetlands without flooding entire wetland basin. Reduces mosquito habitat by allowing isolated sections of habitat to drain. Provides mosquito predators with access to all portions of wetland.	See rapid flooding and irrigation BMPs. Provides habitat diversity and enhances capabilities to implement moist-soil management. Provides a more cost effective and wildlife friendly alternative to laser leveling to create drainage.	See rapid flooding and irrigation BMPs. Reduces standing water in spring that is often used by foraging waterbirds. May result in additional expense to create swales. Shallow swales must be periodically re-cut if silt deposition or dense emergent vegetation is a problem. Could be a deep water hazard in hunting areas.
Wetland size considerations	Install cross-levees to facilitate more rapid irrigation and flood-up. Build "underwater" levees that isolate irrigation water during the spring, but can be overtopped during fall and winter flooding.	To improve ability to implement rapid flooding/irrigation BMPs.	Assists with faster flooding and drainage. Cross levees (checks) can provide loafing habitat for waterfowl and shorebirds.	Additional levees may result in decreased wildlife use and diversity. Expensive. Requires additional levee maintenance and water control structures.

Table 7 (cont.). Wetland restoration and enhancement features to reduce mosquito production in managed wetlands.

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
*Ditch design (2:1 slopes & minimum 4 foot bottom)** **consider 3:1 slope or greater to discourage burrowing animal damage and potential seepage problems*	Construct or improve ditches to quality standard that prevents unwanted vegetation growth or unnecessary seepage.	Reduces likelihood of vegetation growing along ditch banks. Excessive vegetation slows water flow, traps silt, and can be used as substrate for mosquito eggs.	Improves water flow and decreases maintenance of vegetation that grows along canal banks.	May require re-designing some delivery ditches to meet specific design criteria. Could affect habitat for wildlife species such as giant garter snakes. Steeper slopes may erode more quickly and created a hazard for hunters.
*Levee design & compaction ($\geq$3:1 slopes & >80% compaction)** **consider5:1 slope or greater in areas prone to over-land flooding and levee erosion.*	Construct or improve levees to quality standard that ensures stability and prevents unwanted seepage.	To reduce mosquito habitat caused by seepage into adjacent fields or dry ponds.	Properly constructed levees prevent seepage from erosion or rodent damage, and reduce need for annual maintenance.	Additional expense to repair or build levees on existing properties.
Deep channels or basins constructed in seasonal wetlands	Excavate deep channels or basins to maintain permanent water areas (> 2.5 feet deep) within a portion of seasonal wetlands. Provides year-round habitat for mosquito predators which can inoculate seasonal wetlands when they are irrigated or flooded.	To reduce mosquito larvae through predation.	Provides on-site source of mosquitofish and other mosquito predators to seasonal wetlands. Increases overall habitat diversity.	Expensive to excavate and maintain permanent water. Potential problems with emergent vegetation. May be a deep water hazard in hunting areas.
Permanent water reservoir that floods into seasonal wetlands	Maintain separate permanent water reservoir that conveys water to seasonal wetlands. Provides year-round habitat for mosquito predators which can inoculate seasonal wetlands when they are	To reduce mosquito larvae through predation.	Provides on-site source of mosquitofish and other mosquito predators to seasonal wetlands. Increases overall habitat diversity.	Additional expense to construct reservoir that feeds water to seasonal wetlands and expensive to maintain permanent water.

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
	irrigated or flooded.			

Table 8. Biological Controls to reduce mosquito production in managed wetlands.

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
Encourage or stock Mosquitofish (<u>Gambusia</u> <u>affinis</u>)	Stock managed wetlands with mosquitofish or encourage habitats for naturalized populations. Utilize water sources with mosquitofish to passively transport predators to newly flooded habitats.	To supplement mosquito predator population.	Provides a non-chemical control of mosquito larvae. Mosquito fish are often available free of charge to landowners from their local MVCD.	May reduce non-target populations of invertebrates or other mosquito predators. Not appropriate for vernal pool habitats. May negatively impact sensitive species.
Encourage invertebrate predators	Maintain permanent or semi-permanent water where mosquito predators can develop and be maintained. Discourage use of broad spectrum pesticides.	To reduce mosquito populations through predation.	Provides biological control of mosquito larvae and adults.	None.
Encourage swallow colonies and other insectivorous birds	Do not discourage nesting swallows.	To reduce mosquito populations through predation.	Provides biological control of adult mosquitoes.	Guano. The value of insectivorous birds has not been adequately quantified.
Encourage Bats	Encourage bat colonies (e.g. build bat boxes)	To reduce mosquito populations through predation.	Provides biological control of adult mosquitoes.	Potential (or perceived potential) for transmission of rabies. The value of insectivorous bats has not been adequately quantified.

Table 9.Suggested coordination activities between wetland managers and Mosquito and Vector Control Districts (MVCD).

Best Management Practice	Strategies	Mosquito Control Objective	Advantages	Disadvantages
Habitat management and flooding schedule coordination	Consult with MVCDs on agency-sponsored habitat management plans on private lands (i.e. Presley Program). Consult with MVCDs on the timing of wetland flooding on public lands – urge private landowners to do the same.	Allows MVCDs the opportunity to provide input on habitat management and recommend BMPs to reduce mosquitoes.	Reduces potential conflicts between MVCDs, landowners, and agencies/NGOs when managing or flooding wetlands. Provides information exchange.	Requires a commitment of time from MVCDs, landowners, and agencies/NGOs to meet and coordinate activities.
Identify problem areas for mosquito production and target for implementation of BMPs	Identify problem locations for mosquito production with local MVCDs and work to implement mosquito BMPs. Identify potential cost-share opportunities to implement BMPs.	Work to reduce mosquito production through BMPs on properties that are most problematic.	Allows limited resources from MVCDs and agencies/NGOs to be targeted towards problem areas. Provides opportunities for monitoring the effectiveness of BMPs.	None
Wetland Habitat Restoration and enhancement project design & coordination	Consult with local MVCDs on the design of restoration and enhancement projects.	To determine where features to discourage mosquito production can be incorporated into wetland habitat restoration and enhancement projects where feasible.	Reduces potential conflicts between MVCDs, landowners, and agencies/NGOs when restoring or enhancing wetlands. Provides a priori consultation for MVCDs on wetland projects.	Requires some flexibility from MVCDs, landowners, and agencies/NGOs when designing projects. BMPs will likely increase the project cost.
Coordinate Pest Control Activities	Work with local MVCDs to understand pesticides used for mosquito treatment, and their costs and environmental impacts.	To assure the use of mosquito control agents with the greatest efficacy and environmental safety.	Reduces potential conflicts between MVCDs, landowners, and agencies/NGOs regarding pesticides used for mosquito treatment.	May require additional coordination effort from MVCDs, landowners, and agencies/NGOs.
Coordinate Monitoring Activities	Facilitate monitoring mosquito populations of larval and adult stages before and after implementation of BMPs.	Determine the effectiveness of BMPs to refine and prioritize their future use.	Provides a means to evaluate and document effectiveness of BMPs.	Requires time and resources to accomplish.

OTHER ACTIVE MOSQUITO CONTROL PRODUCTS

BTI (BACILLUS THURINGIENSIS VAR. ISRAELENSIS)

BTI is a bacterium (often considered a biological control) that has demonstrated selective larvicidal activity against mosquitoes, black flies, and some chironomid midges (Ali 1981). A protoxin is active upon being ingested. It must be applied during early stages of mosquito larval development (first instar to early fourth instar). BTI is *not* effective against mosquito pupae or late fourth instar larvae. BTI is not persistent, usually breaking down within 1 to 2 days (Mulla et al. 1982). Under the right environmental and larval density conditions, BTI has proven to be effective against *Aedes* and *Culex* larvae. Its efficacy is limited in anopheline larvae, probably due to the combined effects of their surface feeding behavior and the rapid settling of BTI crystals in the water column when applied (Standaert 1981). BTI's effects can also be limited on *Aedes* in high densities. When larval density is high, there may not be enough toxins available for each larva (Becker et al. 1992). This can often be the case for *Aedes* mosquitoes found within the Sacramento Valley, due to their high densities in ephemeral habitats (i.e. SFW). Water quality can also have an impact on mortality. Water that is enriched with organic material significantly diminishes the effectiveness of BTI, probably due to the availability of other foods, and the binding of the BTI crystals to particulates (Ignoffo et al. 1981). *B. sphaericus* is another bacterium that has been used similar to BTI, but has better efficacy in wetlands with high organic content.

METHOPRENE

Methoprene is a man-made chemical that interferes with normal insect growth during critical developmental periods by mimicking the biological activity of insect juvenile hormones. The result is that larvae do not develop into pupae, and thus do not emerge as adults. It is applied as a liquid, granule, or pellet (depending on desired persistence) to sources, targeting larvae in the late instar stages, generally between late third and fourth stages. Methoprene is not effective against larvae that have already pupated. Methoprene has been found to be very effective against mosquito larvae, although effectiveness is generally better against later instar larvae than early instars (Schaefer and Wilder 1972). At doses required for mosquito control, most non-target organisms are not affected, but several aquatic dipterans showed some sensitivity (Miura and Takahashi 1973). Persistence of liquid methoprene usually does not last longer than 48 hours in the aquatic environment (Schaefer and Dupras 1973). Granular formulations can be applied 5 to 10 days prior to flooding, which could be a proactive treatment, targeted for units with a history of high mosquito production.

CHEMICAL CONTROLS

GOLDEN BEAR OIL (GB-1111)

GB-1111 will effectively control all immature stages by acting as a suffocant. It is one of the few mosquito control products that will effectively control pupae. At the Complex, it is approved for control of mosquito pupae, if necessary. These situations are rare, with GB-1111 only being used infrequently during the last ten years. It is usually associated with pupal concentrations that were undetected during earlier dipper sampling for larvae. It is not intended for widespread use, but to treat discrete areas that provide narrow target applications such as windrows of pupae. Use in open water areas result in maximum efficacy. Dense vegetation hinders the ability of the oil to disperse across the water, requiring high-end application rates or multiple applications to be effective.

ADULTICIDES

Adulticides are applied as an ultra-fine spray using vehicle-mounted (ground or aerial) ULV cold fogger spray units. ULV application rates are much lower than rates used for larviciding or agricultural purposes. Adulticiding is generally done at dusk when adult mosquito activity is at its highest. Adulticides are "drifted" across target areas, with optimal conditions being a light wind (3 to 5 mph) and with an inversion. Three hundred-foot swath-widths are the standard for calculation of labeled application rates. However, MVCDs report efficacious mosquito control at times up to one-half mile under optimal conditions, and actual application routes/swaths tend to be much greater than 300 feet apart.

INSECTICIDE RESISTANCE

Insecticide resistance must be taken into consideration when planning an IPM mosquito control program. Currently, the mosquito species showing the most resistance to insecticides is *C. tarsalis*. Adult *C. tarsalis* are now highly resistant to malathion in most of California (Case and Kauffman 1984, Thompson 1989). Malathion was last used on the Complex in 2003, and has since been removed from this IPM plan. *C. tarsalis* are very susceptible to Pyrethrin and synthetic pyrethroids, including sumithrin. *Aedes* and *Anopheles* adults occurring in northern California remain susceptible to all of the approved adulticides, but District's advise rotating their use on these species to offset resistance (Mike Kimball, Sutter Yuba MCVD pers. comm.).

MOSQUITO CONTROL TREATMENT EFFECTS

MOSQUITO POPULATION

Wetland management techniques, biological control agents, methoprene, larvicidal oils, and adulticides have all been shown to reduce various life stages of mosquitoes effectively under certain conditions. The nature of the wetland habitats at the Complex plays a significant role in the ability to apply control products efficaciously. The MVCDs identify the quantity of vegetation, water quality, and great concentrations of larvae as the most common constraints on the efficacy of the treatment.

Ideally, control efforts on breeding habitat (e.g. water management, larval treatments) would prevent vector populations from reaching threshold levels that trigger more intensive control efforts (i.e. adulticiding). Mosquitofish appear to be most effective in permanent and semi-permanent wetlands based on larvae dip sampling. However, they are not entirely effective in preventing emergence of adult floodwater mosquitoes in SFW, when larval concentrations are extremely high.

The efficacy of BTI on Refuge wetlands has been a point of some debate. Although Garcia and Des Rochers (1984) found that use of BTI was up to 80 to 95 percent effective in reducing larval populations of *A. melanimon* in seasonal wetlands at nearby Gray Lodge Wildlife Area, only limited success has been achieved with BTI on *A. melanimon* on Colusa and Sutter Refuges. Dilution of active material (even at maximum application rates), and dispersal problems due to heavy emergent vegetation, and high organic content in the water are suspected causes (Mike Kimball, Sutter-Yuba MCVD, personal comm.).

The predominant strategy used by MVCDs when faced with a disease epidemic is to reduce numbers of infected adult female vectors through the application of adulticides (Reeves and Milby 1990). However, during non-epidemic periods when treatment is advised, there are inconsistencies in the literature regarding the effects that abatement treatments have on disease transmission. Reeves and Milby (1990) indicated that these effects are not well documented.

EFFECTS ON NON-TARGET ORGANISMS

Effects on non-target organisms can be loss of biomass, loss of diversity, interference with normal ecological relationships, bioaccumulation, or other unknown effects. Because one of the major objectives of the Complex is to provide high quality feeding areas for migratory birds and other wildlife, there is concern that mosquito control treatments may be interfering with that objective by reducing the existing food base. Another concern is that rare insects or insects that function as important pollinators for rare plants may be impacted by mosquito control treatments. Use of non-native biological controls such as mosquitofish may alter ecological relationships of native species. Significant bioaccumulation has not been associated with any of the approved chemical treatments referred to in this plan. In general, risk quotients (calculated by dividing acute and/or chronic exposure estimates by ecotoxicity values) for birds and mammals indicate negligible risk for application rates used for mosquito control. However, for fish and aquatic invertebrates, risk quotients for some products indicate significant risk (USFWS 2003). Depending on the product, these risks are mitigated by: 1) allowing active mosquito control (i.e. pesticides) only when thresholds are met; 2) using the least toxic methods/products (e.g. BMPs, larvicides) possible before more toxic products (e.g. adulticides) are considered; and 3) implementing measures to avoid sensitive areas/species identified in PUPs/SUPs.

INVERTEBRATES IN AQUATIC ENVIRONMENTS

Invertebrates are an important source of food for many wildlife species, particularly migratory birds. Waterbirds are a major focus of Refuge goals and objectives, and they consume a significant amount of aquatic invertebrates. Midges of the family Chironomidae and others, which are biologically, morphologically, and behaviorally similar to mosquitoes, appear to be susceptible to most mosquito control treatments. Chironomid midge larvae are important dietary components for waterfowl, shorebirds, and other waterbirds (Euliss and Harris 1985, Severson 1987). Midge larvae and/or adults may be subject to population reductions due to habitat modifications, or during mosquito abatement periods.

Water management techniques associated with irrigations likely have little or no effect on aquatic invertebrates. Irrigated SFW habitats support relatively good biomass of chironomid and other invertebrates in the fall and winter (Severson 1987), plus a short-term bloom of invertebrate production during the actual irrigation (Lawler et al. 1997).

Physical wetland management techniques could potentially result in some effects on aquatic invertebrate populations. Reducing rank wetland vegetation to improve moist-soil plant stands and seed biomass balances a temporary loss of vegetative substrate that could support significant invertebrate populations including mosquitoes, chironomids, and many others. This could be especially true in cases where jointgrass or Bermuda grass have been treated. However, one year following treatment, these units often become very productive in terms of desirable vegetation and bird use. Because these techniques are used on a small proportion of the habitat base at any one time, the overall effects are not likely to be significant.

BTI has traditionally been a “preferred” mosquito control material because of its status as a biological control. However, it has been shown to impact some non-target invertebrate species, including chironomid midge larvae (Charbonneau et al. 1994). Effects on chironomid midges were significant under laboratory conditions, but may be mitigated during use in the field because of reduced efficacy (Garcia et al. 1980, Charbonneau et al. 1994). Efficacy problems have been cited by MVCDs as a major reason that widespread BTI use is not cost-effective for mosquito control in many cases at the Complex. Current levels of use are low and overall effects on non-targets are not likely to be significant.

GB-1111 can cause significant mortality in surface-breathing invertebrates that are susceptible to suffocation. Some diving beetle larvae and adults, as well as corixids and notonectids, are markedly affected (Mulla and Darwazeh 1981). Miles et al. (2002) found that both adult and immature corixids declined 73 percent and 78.5 percent, respectively, in treated areas, although populations rebounded within one week of treatment. Corixids are common in Refuge wetlands and are important prey items for waterfowl (Miller 1987) and other wetland birds. Young ducklings may be at risk from GB-1111 applications due to the oil matting feathers and potentially impeding their ability to thermoregulate, especially during cooler temperatures (Miles et al. 2002). GB-1111 applications would be avoided in areas with significant numbers of young duck broods when nighttime temperatures are below about 15º C (~59º F) (Miles et al. 2002). The use of GB-1111 may also damage vegetation or produce an unsightly appearance. Typical use of GB-1111 has been infrequent (0-2 applications/year) and localized (specific edges of certain wetlands) for control of mosquito pupae. No increases in frequency of use are planned or expected, so overall effects on non-targets are not likely to be significant.

Risk quotients for all of the adulticides (using rates for mosquito control) in this plan indicate significant risk to aquatic invertebrates. The risk quotients for both pyrethrin and sumithrin also indicate significant risk for fish. Surprisingly, in a study conducted at Sutter and Colusa Refuges, the use of pyrethrin, malathion, or permethrin as adulticides (applied with ULV ground fogger) did not result in reductions in abundance or biomass in a wide variety of taxonomic groups of aquatic invertebrates (Lawler et al. 1997). Aerial life stages of chironomids were affected however (see next section). Surface water samples taken immediately after applications directly adjacent to the application route represented the highest probability for detection and the highest concentrations. Water samples did not contain detectable amounts of pyrethrin or permethrin, but malathion was present at six parts per billion (ppb). In a similar more recent study at Colusa Refuge, pyrethrin and piperonyl butoxide deposition in wetlands following adulticide applications were as high as 34.5 and 14.9 ppb, respectively (Lawler et al. 2008, in press). These malathion and pyrethrin concentrations are within acute toxicity levels for some invertebrate species.

Because there is a negative relationship between the amount deposited in water and the distance from application, there is more concern for non-target aquatic mortality in areas closest to the application routes. Based on pesticide deposition testing from ground ULV adulticide applications at Colusa Refuge, the amount of malathion deposited into adjacent wetlands was estimated to be approximately eight percent of what was applied over open water areas within a 300-foot swath (Steinke 1995, unpubl. data). The total amount expected to be deposited in the water over a 1037-meter distance was 32 percent. Predicted malathion concentrations in the water immediately after treatment were 0.8 ppb in open water areas and 0.3 ppb in areas of emergent vegetation, an order of magnitude less than detected directly next to the treatment routes in the previous study (Lawler et al. 1997).

INVERTEBRATES OUTSIDE AQUATIC ENVIRONMENTS

Invertebrates outside the aquatic environment include non-aquatic species or life stages of aquatic species that have left aquatic environments. These invertebrates function as food items for migratory birds, but also serve as pollinators for a variety of plant species. There are some that serve other functions in the biological community, including maintenance of predator-prey relationships, scavenging, and contributing to the overall biological diversity.

These species may be susceptible to adulticide applications. In particular, species which are active around dusk or later, concurrent with typical adult mosquito activity, are likely incurring some degree of mortality.

A limited sampling effort for non-target flying insects during adulticide applications at Colusa Refuge indicated some mortality based on a combination of knockdown boxes, significant sentinel mosquito mortality, and light trap data (Lawler et al. 1997). The extent of the mortality could not be determined, but species of chironomids comprised the majority. Light trap data indicated immediate drops in adult chironomids; however, populations rebounded back to pre-adulticide treatment levels within 24 hours.

SENSITIVE SPECIES AND HABITATS

Table 10 lists federal and state listed species and federal species of concern and their habitats that exist at the Complex. The study conducted at Colusa and Sutter Refuges (Lawler et al. 1997) did not detect any significant mortality to aquatic insects. Because toxicity levels for higher species (reptiles, birds, and mammals) are at least a magnitude greater than for aquatic insects, it is likely that the risk of toxicity impacts to higher aquatic organisms (i.e. those listed in Table 10 in wetland or riverine habitats) are not as great. Timing of use by other species, relative to applications of mosquito control products, is also a factor in determining risk.

Species that feed primarily on aerial insects or rely on them for pollination probably have the greatest probability of being impacted by the effects of adulticide treatments. Although bats are not listed in Table 10, they would be a good example of a species group that could potentially be impacted significantly from adulticide treatments. Sacramento Valley bat species are mostly insectivorous and likely to be feeding around the same time treatments are being made. Insects

Table 10.Federally listed and candidate species that can be found or suitable habitat occurs for at the Sacramento National Wildlife Refuge Complex.

Species	Scientific Name	Habitat	Status[1]	Refuge Occurrence[2]
Giant Garter Snake	*Thamnophis gigas*	W, U	FT, ST	All
Western Yellow-billed Cuckoo	*Coccyzus americana occidentalis*	R	CS	SR, NC, SU, BS
Winter-run Chinook Salmon	*Oncorhynchus tshawytscha*	RV	FE, SE	SR, NC, SU,BS
Chinook Salmon-Fall and Late Fall Run	*Oncorhynchus tshawytscha*	RV	CS	SR, NC, SU,BS
Steelhead, Central Valley ESU	*Oncorhynchus mykiss*	RV	FT	SR, NC,SU,BS
Conservancy Fairy Shrimp	*Branchinecta conservatio*	VP	FE	SA, D, C
Vernal Pool Fairy Shrimp	*Branchinecta lynchi*	VP	FT	SA, D, C, NC
Vernal Pool Tadpole Shrimp	*Lepidurus packardi*	VP	FE	SA, D, C, NC
Valley Elderberry Longhorn Beetle	*Desmocerus californicus diamorhpus*	R	FT	SR, NC
Palmate-bracted Bird's Beak	*Cordylanthus palmatus*	AM	FE	SA, D, C
Hairy Orcutt Grass	*Orcuttia pilosa*	VP,AM	FE	SA, D, C
Green's Tuctoria	*Tuctoria greenei*	VP,AM	FE	SA, D, C
Hoover's Spurge	*Chamaesyce hooveri*	VP,AM	FT	SA, D, C

[1] FT-federal threatened, FE-federal endangered, CS-Federal Candidate Species

[2] SA-Sacramento NWR, D-Delevan NWR, C-Colusa NWR, SU-Sutter NWR, BS-Butte Sink WMA, SR-Sacramento River NWR, NC-North Central Valley WMA-Llano Seco Unit; has been observed at Refuge or suitable habitat is present.

active during dusk or later (i.e. adulticide application periods) are likely to be affected to some degree, depending on species and habitat. Although aerial insect populations rebounded within 24 hours of applications during the Colusa/Sutter Refuge study (Lawler et al. 1997), effects on insectivorous species (e.g. songbirds) were not studied. Of the insectivorous birds listed in Table 10, western yellow-billed cuckoo (YBC) may be most impacted by adulticide treatments by reducing the aerial invertebrate food base. Applications made during the irrigation period (June-July) would coincide with the nesting season of YBC, possibly impacting food resources available to feed nestlings. Recent surveys have indicated YBC breed at Sutter and Sacramento River Refuges (Halterman et al. 2001). Sutter and Sacramento River Refuges represent areas where riparian areas are treated with adulticide and not treated, respectively. Direct comparisons of bird densities between the two areas are not available. YBC are present during fall migration and could be impacted by reduced food resources during fall adulticiding. Rapid rebounding of aerial insect abundance following adulticide applications reported by Lawler et al. (1997) may indicate that the short-term reduction in insects would not affect YBC or other insectivorous animals.

Other insectivorous birds, including burrowing owl and Swainson's hawk, are likely unaffected by mosquito control treatments. Chemical treatments do not focus on the upland habitats where these species and other raptors tend to feed. Some wetland BMPs that remove vegetation in wetlands during their dry phase provide short-term benefits by attracting Swainson's hawks and other raptors in great numbers to feed on rodents and large invertebrates (e.g. grasshoppers during and after a burn).

Giant garter snakes (GGS), federal and state-listed as threatened, historically ranged from the Sacramento/San Joaquin Delta to the south end of the Tulare Lake Basin. The present distribution is from Chico to central Fresno County. Based on recent research and monitoring efforts, Colusa Refuge has a large and healthy population of GGS, relative to many other areas in the Central Valley (Wylie et al. 2006). The GGS requires freshwater wetlands, such as marshes and low gradient streams. Permanent wetlands are of particular importance, as they provide habitat over the summer and early fall when seasonal wetlands are dry. Giant garter snakes have adapted to drainage and irrigation systems, especially those associated with rice cultivation. Direct applications of mosquito pesticides are restricted and do not occur in the flooded ditches or permanent wetlands that GGS prefer. The effects of adulticides on GGS are unknown. Conditions in SUPs identify permanent wetlands as sensitive and are to be avoided with adulticide treatments.

Valley Elderberry Longhorn Beetles (VELB) may be present at the Sacramento River Refuge on any areas containing elderberry plants (*Sambucus* sp.). Conditions in SUPs identify these habitats as sensitive and are to be avoided with adulticide treatments.

Animal species occupying vernal pools in their aquatic phase (i.e. fairy and tadpole shrimp) are likely unaffected by mosquito control treatments, due mostly to timing of their annual cycle. Vernal pools receive no larvicide treatments (including mosquitofish) and adulticide applications are conducted after they have gone into their dry cycle. Conditions in SUPs identify these habitats as sensitive and are to be avoided with adulticide treatments based on the 300-foot application swath and/or prevailing wind conditions.

Plant species growing in dry vernal pools or alkali meadow habitats during the mosquito season may be affected if insects that serve as pollinators are reduced by adulticide treatments. Because these habitats are very rare on the valley floor, they may also contain other rare invertebrates that have yet to be identified and may be at risk. Conditions in SUPs identify these habitats as sensitive and are to be avoided with adulticide treatments based on the 300-foot application swath and/or prevailing wind conditions.

The anadromous fish (i.e. salmon and steelhead) listed in Table 10 potentially could occur in the Butte Creek system, including the east and west Sutter Bypass canals, or the Sacramento River. Adult fall-run Chinook salmon are present in the lower Butte Creek system during fall mosquito control activities. The other species/runs do not coincide as significantly, and in some cases (i.e. winter-run Chinook), most fish would be absent during mosquito control periods. Avoidance measures include no direct applications made to riverine environments, and adulticide applications not made within 100 feet of wetlands, lakes, or streams containing listed fish species (this would include Butte Creek, the east and west Sutter Bypass canals, and the Sacramento River), unless winds or inversions favor pesticide drift away from the water. Currently, mosquito control is not an issue on units directly adjacent to the Sacramento River.

Because mosquitofish are a non-native species, there is some concern that their presence has changed the biological community and may have some detrimental consequences to native species. In the Central Valley, including the Complex, mosquitofish exist as a naturalized species, along with many other non-native fish species. They undoubtedly have contributed to changes in the biological community, but the extent or significance of such changes is unknown. They do serve as prey for other fish, reptiles (including giant garter snakes), and fish-eating birds. There are numerous other non-native fish species that exist throughout the Valley. In fact, the majority of fisheries resources on the Complex are non-native.

CONSIDERATION OF OTHER EFFECTS

Although local studies of the effects of adulticides at the Complex documented little or no effect on aquatic invertebrate populations, deposition of those pesticides in wetlands were measured to be at levels shown to be harmful to similar invertebrates in laboratory studies. While actual field application conditions appear to have moderated these effects (at least in these studies), there are still concerns about sub-lethal effects to invertebrates and other animals that would not have been detected. These effects are inherently difficult to document and study, but should not be dismissed. Continuing to work to reduce the amount and toxicity of pesticides will, by default, minimize the risk of these effects.

RESPONSE THRESHOLDS

Thresholds for mosquito control are based on a combination of mosquito-borne public health risk levels and the presence of mosquito populations on Refuge lands. Table 11 outlines threat categories and corresponding mosquito monitoring or control responses allowed on Refuges. Table 12 defines the specific action thresholds (identified in Table 11) by Refuge for using adulticides, larvicides, and pupacide based on Refuge-specific populations of adult, larval, and pupal mosquito populations as determined by standard monitoring by the Districts. These thresholds were developed in consultation with the Districts based on relating mosquito population indices and distance to urban areas (i.e. nearest town) with perceived outbreak risk or nuisance complaints by local residents. Generally, the closer a refuge is to an urban area, the lower the treatment threshold. Based on historical treatment patterns and risk of level of human health threat, certain Refuges would not be treated unless mosquito-borne virus is detected in the local area. The terms public "health threat" and "health emergency" used in the tables are as follows:

Mosquito-associated health threat - an adverse impact to the health of human populations from mosquitoes. A health threat determination will be made by the appropriate Federal, State, or local public health authority that has the expertise and the official capacity to identify human health threats. Documentation of a specific health threat from refuge-based mosquitoes by a Federal, State, or local public health agency must be based on local and current mosquito population and/or mosquito-borne disease monitoring data.

Health emergency - indicates an imminent risk of serious human disease or death. A health emergency represents the highest level of mosquito-associated health threats. Health emergencies will be determined by Federal, State, or local public health authorities and documented with local and current mosquito population and disease monitoring data.

For the purposes of this plan, the Refuge will consider the local county Public Health Officers the appropriate authority to make these declarations.

Table 11. Mosquito-Borne Disease Health Threat and Response Matrix (adapted from USFWS 2005b).

Current Conditions			
Health Threat Category[1]	**Refuge Mosquito Populations[2]**	**Threat Level**	**Refuge Response**
No documented existing or historical health threat/ emergency	No action threshold	**1**	Remove/manage artificial mosquito breeding sites such as tires, tanks, or similar debris/containers. Allow compatible monitoring by MVCDs.
Documented historical health threat/ emergency	Below action threshold	**2**	Response as in threat level 1, plus: allow compatible non-pesticide management options (BMPs) by MVCDs to reduce mosquito production.
	Above action threshold	**3**	Response as in threat level 2, plus: allow compatible site-specific larviciding of infested areas by MVCDs as determined by monitoring.
Documented existing health threat	Below action threshold	**4**	Response as in threat level 2, plus: allow increased monitoring and disease surveillance by MVCDs.
	Above action threshold	**5**	Response as in threat levels 3 and 4, plus: allow compatible site-specific larviciding, pupaciding, or adulticiding of infested areas by MVCDs as determined by monitoring data.
Officially determined existing health emergency	Below action threshold	**6**	Maximize monitoring and disease surveillance by MVCDs.
	Above action threshold	**7**	Response as in threat level 6, plus: allow site-specific larviciding, pupaciding, and adulticiding of infested areas by MVCDs as determined by monitoring.

[1] **Mosquito-associated health threat** - an adverse impact to the health of human populations from mosquitoes. A health threat determination will be made by the appropriate Federal, State, or local public health authority that has the expertise and the official capacity to identify human health threats. Documentation of a specific health threat from refuge-based mosquitoes by a Federal, State, or local public health agency must be based on local and current mosquito population and/or mosquito-borne disease monitoring data.

Health emergency - indicates an imminent risk of serious human disease or death. A health emergency represents the highest level of mosquito-associated health threats. Health emergencies will be determined by Federal, State, or local public health authorities and documented with local and current mosquito population and disease monitoring data.

For the purposes of this plan, the Refuge will consider the local county Public Health Officers the appropriate authority to make these declarations.

[2] Action (treatment) thresholds represent mosquito population levels that may require intervention measures and are identified in Table 12.

Table 12. Treatment thresholds for larvicide, pupacide and adulticide applications on Refuges within the Complex.

		Treatment Thresholds			
		Larvicide	Pupacide[1]	Adulticide	
Refuge	Distance From Nearest Urban Area	Dipper[2]	Dipper	*Aedes* sp. Landing Count[3]	NJLT Index for *C. tarsalis*[4]
Sacramento	6 miles south of Willows	Nt[5]	nt	nt	60[6]
Delevan	4 miles east of Maxwell	nt	nt	nt	40[6]
Colusa	1 mile west of Colusa	2	nt	5	20
Sutter	3 miles south of Sutter	2	nt	10	40
Butte Sink	3.5 miles northeast of Colusa	2	nt	10	no trap present
Llano Seco Unit	1.5 miles southwest of Dayton	2	nt	5	20

[1]Refers specifically to GB-111; used under rare circumstances where pupae have accumulated in abundance in discrete areas (i.e. windrows) would be conducted in consultation with Refuge staff to avoid areas with significant numbers of young duck broods (Miles et al. 2002).
[2] Average number per dip.
[3] Average number landing per pant leg per minute.
[4] Per trap night, based on weekly index of adult females.
[5] No threshold established.
[6] Only during an existing human health threat or emergency.

RESEARCH NEEDS

There are still concerns about the applications of adulticides because of their toxicity and potential negative impacts to aquatic species. Because adulticides are not insect-selective (although the application rate may be), reduction of non-target aerial or terrestrial insects, especially those that are rare or serve as pollinators for rare plant species, is still a concern. Inventories of these invertebrate species should be undertaken, and those at risk based on their susceptibility to mosquito control treatments should be identified. The studies at Colusa and Sutter Refuges (Lawler et al. 1997, Lawler et al. 2008) provided data that indicated no major impacts to aquatic macroinvertebrates from the use of three adulticides. Despite those somewhat encouraging results, concentrations of mosquito adulticides documented to be harmful have been measured in wetlands following applications in some cases. This remains a significant concern. Aerial insects are still subject to local reductions whenever adulticides are applied. How these reductions affect the overall ecological functions (predator-prey relationships, etc.) of wetlands and other habitats is still largely unknown. Sub-lethal effects of adulticides on invertebrates and other animals have not been well-studied, and represent an unknown level of impact. As new methods or products become available to control mosquitoes, those that can provide adequate control with less toxicity and negative impacts than the existing methods should be evaluated for use on the Complex.

CHAPTER 2. INVASIVE SPECIES CONTROL AND OTHER VEGETATION MANAGEMENT

INTRODUCTION

The Complex contains critically important habitats and core use areas for a great diversity of wildlife, particularly migratory birds of the Pacific Flyway and a number of indigenous, rare, and endangered plants and animals. Over 95 percent of the historic wetlands, riparian forests, and grasslands in the Central Valley have been destroyed or modified since the 1800s (Gilmer et al. 1982, CVJV 2006). Despite these significant changes, approximately 60 percent of the total Pacific Flyway waterfowl population winters here. Millions of waterfowl and other migratory birds use the Complex annually (USFWS 1989-2007). It serves as a significant breeding, migration, and wintering area for Neotropical migrants (Small et al. 2000). The Refuges support some of the last remaining habitats for a number of rare plants and invertebrate species (Center for Conservation Biology 1994, Silveira 2000, USFWS 1993-2007).

Invasive species are a significant threat to native fauna and flora on refuges and other resource areas throughout the country (USFWS 2002). Unfortunately, exotic and invasive plant species are very common throughout the Central Valley, and recently published floras have indicated that 23-41 percent of plant species are non-native, depending on the county or basin (Oswald and Ahart 1994, Oswald and Silveira 1995). They occur throughout the Complex's habitat types and infrastructure (i.e. canals, levees, roads, etc.). The area's mild climate creates a year-round growing season that results in the germination and expansion of a variety of undesirable species throughout the year. Controlling or eliminating non-native species are objectives found in many local and regional habitat management plans, endangered species recovery plans, and various weed management areas. Some native plant species can also become problematic, or even invasive due to local conditions or successional changes. In such cases, they may also be controlled, if necessary, to maintain desirable abundances and distributions to meet wildlife and habitat objectives of the Complex. As a result, vegetation management is relatively common on the Refuges, and is a primary component of the Refuges' annual habitat management plans, where control and enhancement objectives are identified and treatments are prescribed to achieve them (USFWS 1988-2007).

Specific reasons for vegetation management include maintaining biodiversity, maintaining desirable proportions of emergent vegetation in wetlands, enhancing desirable species, preparing for habitat restoration projects, reducing mosquito breeding habitat, and providing maintenance and safety around facilities including protecting communities and assets at risk to wildfire. Non-native and invasive species are often a significant impediment to habitat restoration and maintenance, and without their control, many native species cannot be re-established. A variety of vegetation management techniques (e.g. mow, disk, burn, graze, spray, etc.) are used, depending on the habitat type, plant species, and resource objectives. Some are used alone, while others may be used in combination with one or more other techniques. In general, mechanical methods are preferred over herbicides, but in some cases, the opposite is true (i.e. to avoid ground disturbance an herbicide may be the most effective method). The need to use any of these techniques annually depends on species present, condition of the habitat, effects of climate on plant growth, available funding and resources, and in some cases, the extent that legal mandates allow (e.g. burning restrictions due to local air quality legislation).

The Service is required to use an integrated pest management approach for pest management activities on refuge lands (U. S. Department of Interior 2007). IPM employs a variety of control methods to control invasive species and other weeds that include various forms of physical habitat management, biological control agents, and herbicide application. The purposes of this IPM plan are to: 1) describe refuge habitats and their role in the conservation of trust animal and plant species; and 2) describe the use of vegetation control methods and materials in an IPM program that is consistent with the purposes and goals of the Complex, and DOI and Service policy.

SPECIES TO BE CONTROLLED

Table 13 summarizes the invasive, exotic, and other undesirable plant species that are of primary concern to control or eliminate at the Complex. The plant species targeted for treatment were chosen due to their actual or potential threat to ecosystem processes, federally listed species and/or their status as noxious weeds in the State of California. The full extent (current distribution and abundance) of these species are unknown, but in some cases has been estimated and mapped. The size of an infestation, its pervasiveness, and management difficulty will determine whether the goal is eradication or containment. For instance, relatively small, separated populations of perennial pepperweed will be targeted for eradication. The current goal for the extensive pepperweed infestations is containment, with a long-term goal of reduction.

Species that are not on the target species list (see Table 13) will still be considered for treatment if they are found to be threatening rare and/or desirable species, or are newly established on the Refuge. The list will be reviewed and updated periodically as more information is gained.

The following profiles of targeted species include a discussion of possible treatment methods and priority sites for treatment. Most of these profiles were taken directly, or slightly adapted for this document from the UC IPM Online Statewide Integrated Pest Management Program (University of California 2007), the Cal-IPC online version of Invasive Plants of California's Wildlands (Bossard et al. 2000), or The Nature Conservancy (TNC) Element Stewardship Abstracts from the TNC Global Invasive Species Team website (TNC 2007). For additional information on the descriptions, phenology, and other ecological characteristics of these species and other weeds, see DiTomaso and Healy (2003, 2007). Relevant information and observations from the Complex were also included.

Table 13. Selected invasive, non-native, or undesirable plant species of concern at Sacramento Refuge Complex[1].

Species [1]	Common Name	Habitat
ASTERACEAE [Compositae]	**SUNFLOWER FAMILY**	
Centaurea solstitialis	YELLOW STAR-THISTLE	grassland, fields, levees, roadsides, ditch banks
Xanthium strumarium	ROUGH COCKLEBUR	wetlands, riparian habitats, vernal pools
BRASSICACEAE [Cruciferae]	**MUSTARD FAMILY**	
Lepidium latifolium	BROAD-LEAVED (PERENNIAL) PEPPERWEED	wetland edges, riparian habitats, fields, levees, ditch banks
CHENOPODIACEAE	**GOOSEFOOT FAMILY**	
Salsola soda	FLESHY-LEAVED RUSSIAN-THISTLE	alkali meadows, non-native alkali grassland
CONVOLVULACEAE	**MORNING-GLORY FAMILY**	
Convolvulus arvensis	BINDWEED	vernal pools
HALORAGACEAE	**WATER-MILFOIL FAMILY**	
Myriophyllum aquaticum	PARROT'S-FEATHER	wetlands, ditches
JUGLANDACEAE	**WALNUT FAMILY**	
Juglans californica var. *hindsii* [2]	NORTHERN CALIFORNIA BLACK WALNUT	riparian forest
MORACEAE	**MULBERRY FAMILY**	
Ficus carica	FIG	riparian forest
MYRTACEAE	**MYRTLE FAMILY**	
Eucalyptus camaldulensis	RIVER RED GUM	uplands, wetland edges
ONAGRACEAE	**EVENING-PRIMROSE FAMILY**	
Ludwigia peploides ssp. Peploides	YELLOW WATERWEED	wetlands, waterways
Ludwigia peploides ssp. *montevidensis*	MONTEVIDEO WATERWEED	wetlands, waterways

Table 13. (cont.). Selected invasive, non-native, or undesirable plant species of concern at Sacramento Refuge Complex[1].

Species [1]	Common Name	Habitat [2]
POACEAE [*Gramineae*]	**GRASS FAMILY**	
Arundo donax	GIANT REED	riparian habitats, ditch banks
Crypsis schoenoides	SWAMP-TIMOTHY	vernal pools
Crypsis vaginiflora	AFRICAN PRICKLEGRASS	vernal pools
<u>*Cynodon dactyton*</u>	BERMUDA-GRASS	wetlands
Elytrigia pontica ssp. *pontica*	TALL WHEATGRASS	alkali meadows
Phalaris aquatica	HARDING-GRASS, PERLA-GRASS	alkali meadows
<u>*Lolium multiflorum*</u>	ANNUAL RYEGRASS	various habitats
Sorghum halepense	JOHNSONGRASS	wetland edges, fields, ditches, roadsides
<u>*Taeniatherum caput-medusae*</u>	MEDUSA-HEAD	uplands
<u>Paspalum distichum</u>	JOINTGRASS/KNOTGRASS	managed wetlands
PONTEDERIACEAE	**PICKERELWEED FAMILY**	
Eichhornia crassipes	WATER HYACINTH	wetlands, waterways
SCROPHULARIACEAE	**FIGWORT FAMILY**	
<u>*Kickxia elatine*</u>	SHARP-LEAVED FLUELLIN	various disturbed areas
SIMAROUBACEAE	**QUASSIA FAMILY**	
<u>*Ailanthus altissima*</u>	TREE-OF-HEAVEN	riparian forest
TAMARICACEAE	**TAMARISK FAMILY**	
Tamarix parviflora	SMALL-FLOWERED TAMARISK	riparian habitats
Tamarix ramosissima	SALT-CEDAR	riparian habitats
ROSACEAE	**ROSE FAMILY**	
<u>*Rubus discolor*</u>	HIMALAYAN BLACKBERRY	riparian habitats

[1] This table contains the species with the highest priority of concern to control or eradicate; other species are also controlled as deemed necessary to meet wildlife and habitat objectives.
[2] Non-native plants are indicated by an italic typeface. Severe problem plants indicated by <u>underline</u>.
[3] Feral hybrid with commercial English walnut (*J. regia*).

YELLOW STARTHISTLE (FROM BOSSARD ET AL. 2000)

In California, yellow starthistle (*Centaurea solstitialis*) grows as a deep taprooted winter annual, or rarely as a short-lived perennial. It produces one to many solitary, spiny, yellow flower-heads during late spring, summer, and fall. Seeds begin to germinate soon after fall rains, and young plants grow as prostrate to ascending taprooted rosettes until bolting occurs in late spring or early summer. Yellow starthistle is most widely distributed in the Sacramento and northern San Joaquin valleys, Inner North Coast Ranges, northern Sierra Nevada foothills, Cascade and Klamath ranges, and the central-western regions of the state (Hickman 1993). There are many small to large relict populations in the southwestern region of California. It is currently spreading in mountain regions of the state below 7,500 feet (2,250 m) and in the central-western region. It is uncommon in deserts and at moist coastal sites. It is primarily a problem in moderately warm, exposed areas on fertile, drier soils, including disturbed sites, grasslands, rangeland, hay fields, pastures, roadsides, and recreational areas (DiTomaso et al. 1999a).

Yellow starthistle is native to southern Europe and western Eurasia and was first collected in Oakland, California, in 1869. It was most likely introduced after 1848 as a contaminant of alfalfa seed. By 1917, it had become a serious weed in the Sacramento Valley and was spreading rapidly along roads, trails, streams, ditches, overflow lands, and railroad rights-of-way (Newman 1917).

Human activities are the primary mechanisms for the long-distance movement of yellow starthistle seed. Seed is transported in large amounts by road maintenance equipment, as well as on the undercarriage of vehicles. The movement of contaminated hay and uncertified seed is also an important long-distance transportation mechanism. Once established, seed is transported in lesser amounts and over short to medium distances by animals and humans. The short, stiff, pappus bristles are covered with microscopic, stiff, appressed, hair-like barbs that readily adhere to clothing and to hair and fur (Gerlach unpubl. data). The pappus is not an effective long-distance wind-dispersal mechanism, as wind moves seeds only short distances, with maximum wind dispersal being sixteen feet (<5 m) over bare ground with wind gusts of twenty-five miles per hour (40 km/hr) (Roché 1992).

Dense infestations of yellow starthistle displace native plants and animals, threatening natural ecosystems and nature reserves. Yellow starthistle also significantly depletes soil moisture reserves in annual grasslands in California (Gerlach unpubl. data) and in perennial grasslands in Oregon (Borman et al. 1992). Long-term ingestion by horses causes a neurological disorder known as chewing disease, a lethal lesion of the nigropallidal region of the brain. This disease is expressed as a twitching of the lips, tongue flicking, and involuntary chewing. Permanent brain damage is possible, and affected horses may starve to death (Kingsbury 1964). Yellow starthistle interferes with grazing and lowers yield and forage quality of rangelands, thus increasing the cost of managing livestock (Roché and Roché 1988). It can also reduce land value and limit access to recreational areas.

Plants reproduce only by seed and generally flower from May to September. When adequate moisture is available, yellow starthistle can survive as a short-lived perennial and flower throughout fall, winter, and spring. However, the flowers produced during winter are often killed by frost (Gerlach unpubl. data). Almost all plants are self-incompatible and require pollen from a genetically compatible plant to produce seed (Maddox et al. 1996).

European honeybees are an important pollinator, and in some populations are responsible for 57 percent of seed set (Barthell unpubl. data). Seeds produced per head (30-80) and flowerhead production per plant (1-1,000) is variable, depending on soil moisture levels and intensity of competition (DiTomaso, unpubl. data). Large plants can produce nearly 75,000 seeds. Seed production in heavily infested areas varies between fifty to 200 million seeds per acre. Studies of seed survival in soil have found significant survival to ten years (Callihan et al. 1993). Seeds typically germinate in late fall or early winter, when soil moisture is present (Maddox 1981) and overwinter as basal rosettes.

Germination responses in yellow starthistle are greatly reduced in dark environments and by exposure to light enriched in the far-red portion of the spectrum (Joley 1995). The two types of achenes also differ in response to light (Joley 1995). During early seedling establishment, root growth is vigorous and can extend deeper than one meter (3.3 ft) (Roché et al. 1994, DiTomaso unpubl. data), providing plants with access to deep soil moisture reserves during dry summer months. Reduced light levels cause the rosettes to produce fewer but larger leaves and to assume a more upright growth form (Roché et al. 1994). Reduced light levels also significantly reduce root growth and flower production (Roché et al. 1994). Consequently, survival and reproduction are significantly reduced in shaded areas, and the plant is probably less competitive in dense stands of established perennials. Bolting occurs from late spring to early summer, and spiny flowerheads generally are produced from early summer to late summer or fall. The spines on the flowerheads may protect them from herbivory by large animals, but they do not prevent significant herbivory by grasshoppers or seed predation by birds (Gerlach unpubl. data).

It is important to prevent large-scale infestations by controlling new invasions. Spot eradication is the least expensive and most effective method of preventing establishment of yellow starthistle. In established stands, any successful control strategy will require dramatic reduction or, preferably, elimination of new seed production, multiple years of management, and follow-up treatment or restoration to prevent rapid reestablishment.

Effective control using any of the available techniques depends on proper timing. Combinations of techniques may prove more effective than any single technique. For example, prescribed burning followed by spot application of post-emergence herbicides to surviving plants can prevent the rapid reinfestation of the treated area. Similarly, combining mowing and grazing, revegetation and mowing (Thomsen et al. 1996a, 1996b), or herbicides and biological control may provide better control than any of these strategies used alone. Effective combinations may depend on location or on the objectives and restrictions imposed on land managers.

MECHANICAL METHODS

Tillage can control this thistle; however, this will expose the soil for rapid reinfestation if subsequent rainfall occurs. Under these conditions, repeated cultivation is necessary (DiTomaso et al. 1998). During dry summer months, tillage practices designed to detach roots from shoots prior to seed production are effective. For this reason, the weed is rarely a problem in agricultural crops. Weedeaters or mowing can also be used effectively. However, mowing too early, during the bolting or spiny stage, will allow increased light penetration and more vigorous plant growth and high seed production. Mowing is best when conducted at a stage where 2 to 5 percent of the seed heads are flowering (Benefield et al. 1999). Mowing after this period will not prevent seed production, as many flowerheads will already have produced viable seed. In addition, mowing is successful only when the lowest branches of plants are above the height of the mower blades. Under this condition, recovery is minimized. Results should be repeatedly monitored, as a second or perhaps a third mowing may be necessary to ensure reduced recovery and seed production (Thomsen et al. 1996a, 1996b).

PRESCRIBED BURNING

Under certain conditions, burning can provide effective control and enhance the survival of native forbs and perennial grasses (Robards, unpubl. data, DiTomaso et al. 1999b). This can be achieved most effectively by burning after native species have dispersed their seeds but before yellow starthistle produces viable seed (June-July). Dried vegetation of senesced plants will serve as fuel for the burn. At Sugarloaf Ridge State Park in Sonoma County, three consecutive burns reduced the seedbank by 99.5 percent and provided 98 percent control of this weed, while increasing native plant diversity and perennial grasses (DiTomaso et al. 1999b). No additional control method was used in the fourth year. In that year, unfortunately, the seedbank of yellow starthistle increased by thirty-fold compared to the previous year (DiTomaso unpubl. data).

BIOLOGICAL CONTROL

Six U.S. Department of Agriculture (USDA) approved insect species that feed on yellow starthistle have become established in California (Pitcairn 1997a, 1997b). These include three weevils, *Bangasternus orientalis*, *Eustenopus villosus*, and *Larinus curtus*, and three flies, *Urophora sirunaseva*, *Chaetorellia australis*, and *C. succinea* (Woods et al. 1995). All of these insects attack yellow starthistle flowerheads, and the larvae utilize the developing seeds as a food source. The most effective of these species are *E. villosus* and *C. succinea* (Balciunas and Villegas 1999). With the possible exception of a few sites, the insects do not appear to be significantly reducing starthistle populations, but success may require considerably more time for insect numbers to increase to sufficient levels.

Current evidence indicated a 50 to 75 percent reduction in seed production in areas with significant bioagent populations (Pitcairn and DiTomaso unpubl. data). A root-attacking flea beetle (*Ceratapion brasicorne*) is also being studied (Pitcairn, pers. comm.). Researchers are seeking other starthistle-specific foliar- and stem-feeding insects in Asia Minor. Research is also currently being conducted on three native or naturalized fungal pathogens, *Ascochyta* sp., *Colletotrichum* sp., and *Sclerotinia sclerotiorum* for the control of yellow starthistle seedlings (Woods and Popescu 1997).

GRAZING

Intensive grazing by sheep, goats, or cattle before the spiny stage but after bolting can reduce biomass and seed production in yellow starthistle (Thomsen et al. 1996a, 1996b). To be effective, large numbers of animals must be used for short durations. Grazing is best between May and June, but depends on location. This can be a good forage species.

PLANT COMPETITION

Revegetation with annual legumes capable of producing viable seed provides some level of control in pastures (Thomsen et al. 1996a, 1996b). In some areas, subterranean clover (*Trifolium subterraneum*) proved to be the best of sixty-six legumes tested. In other sites, rose clover (*T. hirtum*) and/or perennial grasses may be the preferred species. Control was enhanced when revegetation was combined with repeated mowing (Whitson et al. 1987). At the Complex, a number of areas infested with yellow starthistle have been successfully replaced with native perennial grasses, including purple needlegrass, blue wildrye, and meadow barley (M. Wolder, pers. comm.). Regular maintenance control on these areas includes sheep grazing, mowing, or spot herbicide treatments.

CHEMICAL CONTROL

Although several non-selective pre-emergence herbicides will control yellow starthistle, few of these can be used in rangeland or natural ecosystems. The exception is chlorsulfuron, which provides good control in winter when combined with a broadleaf selective post-emergence compound. However, chlorsulfuron is not registered for use in rangelands or pastures.

The primary options for control in non-crop areas are post-emergence herbicides: 2,4-D, triclopyr, dicamba, clopyralid, and glyphosate (DiTomaso et al. 1998). All but glyphosate are selective and preferably applied in late winter or early spring to control seedlings without harming grasses. Once plants have reached the bolting stage, the most effective control can be achieved with glyphosate (1 percent solution). The best time to treat with glyphosate is after annual grasses or forbs have senesced, but prior to yellow starthistle seed production (May-June). The most effective compound for yellow starthistle control is clopyralid (as Transline), a broadleaf selective herbicide (DiTomaso et al. 1998). Clopyralid provides excellent control, both pre-emergence and post-emergence, at rates between 1.5-4 acid equivalent or 4-10 oz formulated product per acre. Although excellent control was achieved with applications from December through April, earlier applications led to significant increases in quantity of other forage species, particularly grasses.

<u>ROUGH COCKLEBUR</u> – Adapted from the TNC Element Stewardship Abstract for *Xanthium strumarium*

Cocklebur (*Xanthium strumarium*) is considered one of the world's worst weeds (Holm et al. 1977). Cocklebur is often associated with open, disturbed areas, particularly flood-prone areas with good soil moisture (Martin and Carnahan 1982), but it is found in a wide variety of habitats. Cockleburs are broadleaf annuals that grow in seasonal wetlands and floodplains in many areas of California, and are common in the Central Valley (Wolder, pers. comm.). Cocklebur seeds are easily spread, due to their ability to float or 'hitchhike' on humans and animals. The plants can quickly become dominant in an area because of their prolific seed production and high germination and survival rates. It reproduces from seeds that are viable for several years. Cocklebur grows on a wide range of soils (sands to heavy clays) and available moisture. On rich soils with abundant moisture and little competition from other plants, it grows tall and luxuriant, forming pure stands. In dry, poor soils, plants may grow to only a few centimeters high, persist through drought, and set seed. The ability to grow under a variety of conditions results in a continuous seed supply if plants are not controlled (Holm et al. 1977). Open grown plants produce 500 to 5,400 burs per plant. The number of fruits produced is dependent upon the amount of vegetative growth at the time of floral initiation. On crowded plants, production is reduced to 71 to 586 burs per plant (Weaver and Lechowicz 1983). Burs are buoyant and will float for up to 30 days (Kaul 1961), thus being easily dispersed to shorelines, downstream areas, and areas subject to flooding. The burs also become entangled in animal hair or human clothing. The burs are a serious problem in sheep production areas where they become entangled in the wool, reducing its value (Wapshere 1974). *X. strumarium* burs contain a highly toxic substance, carboxyatractyloside, capable of killing hogs, cattle, goats, horses, sheep, and poultry.

Germination of cocklebur seeds has been extensively researched (Crocker 1906, Davis 1930, Katoh and Esashi 1975, Zimmerman and Weis 1983). More than 80% of cocklebur seeds are viable in most populations (Weaver and Lechowicz 1983). Plants produce seeds of two types (termed somatic polymorphism). Each bur contains two seeds, with the smaller one often pushed upwards toward the beaked end of the fruit. The lower seed has a shorter dormant period and germinates first. Dormancy in *Xanthium* involves the presence of a different water-soluble germination inhibitor in each seed type, to which the testa are impermeable. The presence of oxygen causes degradation of these two inhibitors and subsequent rupture of the seed coat, but apparently at very different rates in the two types. Thus, at least two batches of seeds are present in each generation to assure germination in the event the immediate environment happens to be unsuitable (Redosevich and Holt 1984).

For the purposes of this IPM Plan, cocklebur is considered invasive in managed wetlands, as it has little value for forage or cover and tends to out compete vegetation that is more desirable for waterfowl and other waterbirds.

PHYSICAL CONTROL

Cocklebur control requires that treatments be made prior to seed being set on actively growing plants. Young plants can be controlled effectively by short-term flooding, often referred to as "scalding." Water should be turned in at a point when plants can be completely covered for a period of 7-14 days. The actual length of time it takes to kill the plants can vary based on air/water temperature, the size of the plants, and how deeply they are flooded. The warmer the temperature, the smaller the plants, and the deeper they are flooded, the quicker they will succumb. Cocklebur plants should be monitored during the scalding process, and when they turn completely black and slimy they are dead and water can be removed. This treatment will often result in the added benefit of irrigating a number of desirable aquatic species such as watergrass, sprangletop and smartweeds. However, if plants are not fully inundated, killing them will require prolonged flooding. Often, this can mean enhancement of other undesirable species, such as Bermuda grass and jointgrass, and potentially cause significant production of mosquitoes (which may initiate mosquito control in some areas).

The other method of controlling cocklebur is mowing plants prior to their formation of burs. Plants should be allowed to put maximum energy into vertical growth and flowers, then mowed as close to the ground as possible. In cases where significant soil moisture is still present, plants may regrow and require an additional mowing to kill them. A third option, especially with larger plants is to mow, then follow with a short inundation. Mowed plants are particularly susceptible to scalding. Refer to Mensik and Reid (1995) for additional information.

PERENNIAL PEPPERWEED (FROM BOSSARD ET AL. 2000)

Perennial pepperweed (*Lepidium latifolium*) is a multi-stemmed herb that grows three to eight feet tall with a heavy, sometimes woody, crown and a spreading underground root system. Pepperweed invades brackish to saline or alkaline wetlands throughout California, from the coast to the interior, and north and eastward into the Great Basin and Columbia Basin. According to observations by wildlife area managers and others, within the last fifteen years pepperweed populations in California have expanded, and the plant has significantly increased its overall range. Pepperweed can be distributed by seeds, or by pieces of the underground stems. The small seeds have no special adaptations for long-distance dispersal. They are capable of being transported by wind, water, and possibly waterfowl. Pepperweed is an aggressive invader of coastal and interior wetlands and adjacent uplands throughout California. It forms dense monospecific stands that exclude other plants, including natives (Corliss 1993, Trumbo 1994). Pepperweed reproduces from seed, as well as vegetatively from intact root systems or from pieces of rootstock. Flowering time varies from May to July in different parts of California. Peak bloom lasts for several weeks. Seeds mature by June or July. Each mature plant has the capacity to produce thousands of seeds each year.

PHYSICAL CONTROL

Manual/mechanical methods: Mechanical methods are unlikely to control pepperweed because new plants quickly regenerate from pieces of rootstock left in the soil (Young et al. 1995). Segments much shorter than one inch (2.5 cm) are capable of resprouting. Disking of pepperweed at Grizzly Island Wildlife Area resulted in a significant increase in distribution (Feliz, pers. comm.). Young et al. (in press) attempted to control pepperweed in native hay meadows near Honey Lake, Lassen County, in tillage experiments conducted from 1991 to 1992, using monthly disking throughout the growing season. They concluded that this treatment resulted in no permanent reduction in pepperweed cover. This conclusion was based on the finding that the year following disking, pepperweed reestablished approximately 100 percent cover.

PRESCRIBED BURNING

Experiments at Malheur National Wildlife Refuge in southern Oregon indicate that fire alone is unlikely to be effective in controlling pepperweed, in part because typical fuel loads in infestations of this plant are inadequate to sustain burns.

INUNDATION

Pepperweed may be intolerant of prolonged inundation. At West Navy Marsh in Contra Costa County, pepperweed distribution and abundance were significantly reduced after a diked marsh was returned to tidal action, increasing inundation time (May 1995). Young et al (1995) report that pepperweed does not appear to survive lengthy periods of flooding during the growing season.

BIOLOGICAL CONTROL

Insects and fungi: Development of a biological control program seems unlikely because of risks to many important crop plants that are members of the mustard family (Brassicaceae) (Young et al. 1995, Birdsall et al. 1997). Additionally, several native *Lepidium* species from the western United States either are listed as endangered or are being considered for listing (Young et al. 1995). Fifteen species of *Lepidium* are native to California, including four that are considered rare and endangered by the California Native Plant Society (Skinner and Pavlik 1994). Acknowledging these difficulties, Birdsall et al. (1997) pointed out the limitations of herbicidal control and suggested that *L. latifolium*-specific biocontrol agents, either insects or fungi, be sought in the many European countries with other native *Lepidium* species.

CHEMICAL CONTROL

Attempts have been made to control pepperweed with chemical herbicides in California, Oregon, Wyoming, Idaho, Nevada, and Utah. The most effective herbicides appear to be chlorsulfuron (as

Telar), metsulfuron methyl (as Escort), and imazapyr (as Arsenal) based on field trials of one to four years (Cox 1997). Neither Escort nor Arsenal is registered for use in California at this time.

Trumbo (1994) reports that tests of chlorsulfuron, triclopyr, and glyphosate at Grizzly Island Wildlife Area in Suisun Marsh, California, showed that each of these compounds can provide significant control of pepperweed. Chlorsulfuron (as Telar) was most effective, with one application resulting in a reduction in cover of more than 95 percent after two years. Telar was applied at the recommended rate of 0.75-1 oz/acre, mixed in 30 gallons water with 0.5 percent non-ionic surfactant. It is selective against broadleaved plants. This was advantageous at Grizzly Island Wildlife Area because desirable grasses were not affected. After the initial test, large-scale use of Telar at Grizzly Island Wildlife Area has confirmed its effectiveness. However, retreatment may be necessary because of the regenerative ability of pepperweed. Telar exhibits some residual soil activity, and its use is not permitted near water.

Triclopyr as Garlon3A and Garlon4 provided moderate to good control after one year in tests at Grizzly Island Wildlife Area. Garlon3A was applied as a 2 percent solution with 0.5 percent non-ionic surfactant added. Garlon4 was applied as a 1.5 percent solution with 0.5 percent non-ionic surfactant added. Currently, neither formulation of Garlon is registered for use over water in California. Triclopyr is broadleaf-specific, so it generally does not affect grasses. Garlon4 does not show residual soil activity. As with chlorsufuron, retreatment may be needed to maximize control.

Glyphosate as Rodeo and Roundup provided fair to moderate control after one year in tests at Grizzly Island Wildlife Area. Roundup was effective as a 2 percent solution. Rodeo was also used as a 2 percent solution with the addition of 0.5 percent non-ionic surfactant. Rodeo can be used over water, but Roundup cannot. Roundup and Rodeo are broad-spectrum herbicides that control most plants, including grasses. At Grizzly Island Wildlife Area, resprouting of pepperweed the year following treatment indicated that several follow-up treatments likely are needed for full control.

In Lassen County, California, Young et al. (in press) tested the effectiveness of 2,4-D, glyphosate, and chlorsulfuron against pepperweed. They found that, while 2,4-D and glyphosate greatly reduced top growth and eliminated seed production in the year of application; they provided no permanent control, since cover returned to 100 percent by the second year after application of these compounds. One application of chlorsulfuron provided up to three years of nearly complete control of pepperweed.

In Nevada, Young et al. (1997) found that chlorsulfuron is effective in controlling pepperweed. The highest level of control was obtained from applications during the bud stage. However, in the native hay meadows where the studies were conducted, excellent control was possible with early spring or late fall applications.

At Malheur National Wildlife Refuge in Oregon, chlorsulfuron and metsulfuron methyl were tested alone and in combination with either fire or disking. The herbicides were more effective when used alone, with chlorsulfuron reducing pepperweed densities by 100 percent in all three sites tested, and metsulfuron methyl resulting in density reductions of 90 to 100 percent.

In Idaho herbicides used to control pepperweed include metsulfuron methyl, 2,4-D, dicamba (as Vanquish), imazapyr, chlorsurfuron, and picloram (Cox 1997). Metsulfuron methyl is the most commonly used and is described as "quite" effective. Other compounds noted as "successful" in controlling this species include imazapyr and chlorsulfuron (Cox 1997).

In Wyoming, metsulfuron methyl and chlorsulfuron proved most effective in controlling pepperweed. Either compound, used at the recommended rate of 0.75-1.0 oz/acre, resulted in stand reductions of 90 percent or more that persisted for four to five years.

RUSSIAN THISTLE (FROM UNIVERISITY OF CALIFORNIA 2007)

Russian thistle, also known as tumbleweed, is in the goosefoot family (Chenopodiaceae). Its scientific name is *Salsola tragus*, but it also has been known as *S. iberica*, *S. kali*, and *S. australis*. It is a summer annual that is primarily a weed in sites where the soil has been disturbed, such as along highways. At the Complex, fleshy-leaved Russian thistle (*Salsola soda*) is a similar species and also of concern (Silveira, pers. comm.). However, little species-specific information is available at this time, so control efforts will follow this profile in the interim, until more information becomes available.

Russian thistle has numerous slender ascending stems that become quite woody at maturity. Stems vary from eight to 36 inches in length and usually have reddish to purplish stripes. Seedlings have very finely dissected leaves that almost look like pine needles. Leaves of young plants are fleshy, dark green, narrow, and about 1 inch in length. Young plants are suitable for livestock forage and are sometimes grazed.

The Russian thistle seed is a naked, coiled embryo that begins to uncoil when it is exposed to the proper temperature (52° to 90°F) and moisture conditions. As it uncoils, the taproot extends into the soil within about 12 hours, making the germination period quite rapid and giving Russian thistle a decided advantage under limited moisture conditions. A minimum amount of moisture, lasting only a few hours, will allow germination and root growth to deeper, subsurface moisture.

Russian thistle normally will not germinate successfully in firm soil: the soil in the site must be loose. Likely sites for germination include vacant lots, abandoned gardens and agricultural fields, roadsides, fence lines—any open site with loosened soil. Germination normally occurs in late winter or early spring when the seed can take advantage of winter moisture. Seed viability is rapidly lost in soil. Over 90 percent of the seed either germinate or decay in the soil during the first year.

Russian thistle is extremely drought tolerant. The taproot can extend several feet into the soil to reach subsurface moisture. Early leaves are linear and fleshy, much like pine needles, but as the plant matures, later leaves are short, spiny, and much more capable of conserving moisture. Russian thistle normally matures in late summer. An abscission layer forms in the stem near the soil surface that allows the shoot to break off from the taproot in fall and early winter. The seed is spread when mature plants are blown along by the wind. A large Russian thistle plant may produce more than 200,000 seeds. In spring, months after their dissemination, it is possible to trace the paths of tumbleweeds across plowed fields by the green trails of germinating Russian thistle seedlings.

Russian thistle can tolerate alkaline soil conditions. It is very competitive when moisture is a limiting factor to the growth of other vegetation, when soils are disturbed, or when competing vegetation is suppressed by overgrazing or poor crop establishment. If moisture is not limiting, Russian thistle is less competitive with other species. Seedlings of Russian thistle are suppressed when other plants become established first and shade out the sunlight.

Control of Russian thistle is difficult. There have been numerous attempts through the years to import biological control agents, but none has been successful. Normally the best place to look for a biological control agent is the native habitat of the species. Unfortunately, Russian thistle's native habitat is thought to be at the site of major military installations in Russia. Until recently, it was impossible to collect potential biological control organisms in these areas.

Cultural control practices such as mowing or destroying young plants can prevent seed production. Avoid disking or loosening the soil in abandoned areas because loose soil is necessary for Russian thistle germination. Burning is sometimes used to destroy accumulated Russian thistle plants. While this may eliminate the accumulated organic debris and some seed, much of the seed will already have been disseminated. Planting competitive, more desirable species can be an effective method of preventing Russian thistle establishment in most non-crop environments. Russian thistle competes poorly in situations with firm, regularly irrigated soil, and it is rarely a problem in managed gardens, turfgrass, or landscapes.

In addition, there are many herbicides that will control Russian thistle in agricultural crops and non-crop areas. Aim treatments at controlling the immature plants to prevent them from reaching the seed production stage. The selection of an appropriate herbicide depends on the site or the crop.

Pre-emergent herbicides are applied to the soil before the weed seed germinates and are usually incorporated into the soil with irrigation or rainfall. The most effective pre-emergent herbicides are Aatrex (atrazine), Velpar (hexazinone), Devrinol (napropamide), Telar (chlorsulfuron), Oust (sulfometuron), Princep (simazine) and Hyvar (bromacil). Other pre-emergent herbicides that are registered but only moderately effective in controlling Russian thistle are Surflan (oryzalin), Treflan (trifluralin), Prowl (pendimethalin), Endurance (prodiamine), Lasso (alachlor), Predict (norflurazon), and Kerb (pronamide).

Herbicide-resistant biotypes of Russian thistle have evolved in only a couple of years following treatment with Telar (chlorsulfuron) or Oust (sulfometuron). Avoid repeated use of a single herbicide or of herbicides that have the same mode of action to prevent the evolution of herbicide-resistant populations.

Post-emergent herbicides are applied to plants, but timing is critical. For best results, these herbicides must be applied while the weed is in its early growth stages, preferably the early seedling stage, before it becomes hardened and starts producing its spiny branches. Do not use post-emergent herbicides to try to control the mature seed (either on the plant or on the ground) as they are not effective for this purpose. In addition, the later spiny stage of Russian thistle is not readily controlled by any post-emergent herbicide. If rain or irrigation occurs after a post-emergent application, additional seedlings may emerge and require future treatments. Post-emergent herbicides that are effective when properly applied include Banvel or Vanquish (dicamba), Roundup (glyphosate), 2,4-D and Gramoxone (paraquat).

FIELD BINDWEED (FROM UNIVERSITY OF CALIFORNIA 2007)

Field bindweed (*Convolvulus arvensis*) is a hardy perennial found throughout California below 5,000 feet elevation. It spreads from an extensive rootstock as well as from seed. Most parts of the bindweed roots and rhizomes can produce adventitious buds, which can create new roots and shoots. Roots capable of budding are found to depths of 14 feet. This extensive underground network allows for over-wintering without foliage, and it can persist for many years in the soil. Drought tolerance is a characteristic of field bindweed. In California, it seems to prefer heavy clay soils rather than sandy soils. When water is withheld, bindweed competes better than most other plants.

Control of field bindweed is not easy, and it cannot be accomplished with a single treatment or in a single season. It has a vigorous root and rhizome system that makes it almost impossible to control with cultivation. Once established it is almost impossible to control with herbicides.

Effective control requires prevention of seed production, reduction of stored carbohydrates by deep tillage of the root system, competition for light from other plants, and constant vigilance in removing top growth. It is important to control new infestations when they are small, because spot control is least expensive and the most effective. Seedlings of field bindweed are easy to control with cultivation, but only for about 3 to 4 weeks from germination. After that, perennial buds are formed, and control is much more difficult.

Cultivation or hoeing has been partially effective in reducing established stands of field bindweed. Cultivate about every 2 to 3 weeks, as soon as the bindweed reaches 6 inches in length, and repeat whenever necessary. In conjunction with cultivation, withholding water to dry the site may help to reduce the perennial population in a summer season.

Herbicides have been relatively effective for suppression of bindweed, but have not been very effective for eradication. If herbicides are used, supplement them with appropriate preventive and cultural controls.

In areas outside the landscape or orchard, cultivation and herbicide treatment can be used. If herbicides are to be used, treat the bindweed plants before they are drought stressed. Use a translocated herbicide, such as glyphosate or a combination of glyphosate and dicamba in areas where its use is allowed, at the flowering stage of growth. The addition of dicamba gives the treatment some soil residual activity that helps with control of new seedlings. Re-treatments will be necessary to control both established plants and seedlings. If possible, grow a competitive planting of other plants to reduce field bindweed growth.

BLACK LOCUST (FROM BOSSARD ET AL. 2000)

Black locust (*Robinia pseudoacacia*) is widespread, particularly in northern California, below about 6,300 feet (1,910 m) elevation (Hickman 1993). This tree can grow on a wide range of sites, but grows best on rich, moist, limestone-derived soils. It does not do well on heavy or poorly drained soils, although it appears to be tolerant of some flooding (Huston and Smith 1987, Huntley 1990). In the northeast United States, it is found on floodplain sites with a 40 to 100 percent probability of flooding in any given year. Through root sprouts and seedling establishment, black locust creates large stands that displace native vegetation. Its seeds, leaves, and bark are toxic to humans and livestock (Hickman 1993). Black locust reproduces both by seed and by root sprouts. It flowers in May-June. Fruits ripen in fall and open on the tree, dispersing seeds throughout fall and winter (Olson 1974). Seeds remain viable for ten years or more and require scarification for germination (Olson 1974, Strode 1977). Seedlings are intolerant of shade and herbaceous competition, but once established, they are capable of growing over 3.3 feet (1 m) per year on better sites (Huntley 1990). Saplings begin producing seed at about six years. Black locust produces root and stump sprouts. Sprout production is stimulated by top damage. Root suckers usually are more important to reproduction than are seedlings. Root suckers first appear when stems are four to five years old. Sprout production is greatest in full sun (Huntley 1990). Sprouting is an important mechanism for colonizing areas that have herbaceous plant cover but no woody canopy. Grasses form a sod that prevents establishment of black locust seedlings, but root sprouts are able to colonize these areas (Hardt and Forman 1989).

Physical control: Mechanical methods: Cutting or girdling a black locust stem will result in prolific root suckering. Mechanical removal therefore will be ineffective in controlling black locust unless all stems are cut several times per year. Repeated cutting of sprouts can kill the tree. Cutting probably will need to be repeated for several years. Mowing may not be effective in controlling seedlings and sprouts. More effective control can be obtained by immediately brushing the freshly cut surface of the stem with herbicide.

PRESCRIBED BURNING:

Burning has not been effective in controlling black locust. Fire may kill main stems, but this will result in prolific sprouting. Fire also may stimulate seed germination and create favorable conditions for seedling establishment.

BIOLOGICAL CONTROL

Black locust suffers considerable damage from insects, particularly the black locust borer, *Megacylline robinine*. However, no USDA biological control program for black locust has been attempted, and no USDA approved biocontrol agents exist for this species. Black locust suffers some browse herbivory, particularly the young growth of sprouts, which may aid eradication efforts (Huntley 1990, Luken 1992).

CHEMICAL CONTROL

Black locust has been effectively controlled with herbicides (Gouin 1979, Liegel et al. 1984, Scheerer and Jackson 1989). Herbicide applications should be most effective in spring, just after leaves are fully expanded. Smaller sprouts may be controlled by spraying all foliage with 4 percent glyphosate (Chemical & Pharmaceutical Press 1997). Young stems may be killed by generously applying 15-20 percent triclopyr (as GarlonÂ®) to the bark from the stem base to twenty inches above the ground (Gouin 1979, Chemical & Pharmaceutical Press 1997). The thicker bark of larger stems interferes with uptake of herbicide, and therefore, to kill larger plants, the stem needs to be frilled (have an encircling ring of bark removed) and the herbicide applied to the freshly exposed surface.

Applying herbicide to freshly cut stumps is probably the most effective means of controlling black locust. Wiping the stump with 100 percent glyphosate (as Roundup Ultra®) within fifteen minutes of cutting should reduce or even eliminate subsequent root suckering (Chemical & Pharmaceutical Press 1997).

<u>PARROT'S FEATHER (FROM BOSSARD ET AL. 2000)</u>

Parrot's feather (*Myriophyllum aquaticum*) is a stout aquatic perennial that forms dense mats of intertwined brownish stems (rhizomes) in water. These stems grow to six and a half feet in length and resemble bright green bottlebrushes emerging from the water. Both parrot's feather and spike watermilfoil can be found in freshwater lakes, ponds, and canals with slow-moving waters in northern and central California (Anderson 1990). Parrot's feather is capable of sexual reproduction in its native range, but the spread of parrot's feather in the United States results solely from vegetative reproduction. The stems of parrot's feather are brittle and fragment easily. These fragments settle in sediments and produce new plants (Orchard 1981, Kane et al. 1991). Fragments can be spread by boats, trailers, and by dumping aquarium plants in waterways. Parrot's feather may compete with native aquatic plants, eliminating them or reducing their numbers in infested sites. It forms dense mats that can entirely cover the surface of the water in shallow lakes and other waterways. These mats clog waterways, making them unusable for navigation or recreation and causing flooding out of the channel. It can block irrigation pumps and water intakes, and it provides optimal habitat for mosquitoes (Orr and Resh 1989, Systma and Anderson 1989; Parsons 1992). In California, this species is becoming an increasing problem in irrigation and drainage canals. A 1985 survey of irrigation, mosquito abatement, flood control, and reclamation agencies in California indicated that parrot's feather infested nearly 600 miles of waterways and over 500 surface acres (Washington Water Quality Program 1998). Growth is most rapid from March until September. In spring, shoots begin to grow rapidly from over-wintering rhizomes as water temperature increases. Rhizomes function as a support structure for adventitious roots and provide buoyancy for emergent growth in summer.

Parrot's feather is difficult to remove from an aquatic system, so it is best to prevent it from establishing in the first place. The public must be made aware of the problems caused by parrot's feather and how it can be spread by dumping unwanted plants from water gardens or aquaria, or by boats, trailers, and fishing equipment that are not cleaned before being moved to a new waterway. If parrot's feather becomes established, only chemical and mechanical control methods are available.

PHYSICAL CONTROL

Parrot's feather can be removed by mechanical harvesters. In Washington, workers use a dragline to remove parrot's feather plants. A truck-mounted crane with a special attachment plucks weeds out of the ditch. The dragline operation is conducted annually from August to December, with control generally lasting for one growing season (Washington Water Quality Program 1998). Care must be taken to ensure removal of all plant parts during harvest, since even tiny stem or rhizome fragments can root and establish new plants. Because of this, mechanical harvesting often results in the spread of parrot's feather rather than its elimination or suppression.

BIOLOGICAL CONTROL

Parrot's feather has a high tannin content, so most grazers, including grass carp (*Ctenopharyngodon idella*), find it unpalatable. Grass carp also prefer soft plants, such as *Elodea canadensis*, and the tough, woody parrot's feather stems are avoided. USDA approved biological control agents are not currently available. Potential agents do exist, but they have yet to be tested for host specificity. A complex of insects feed on parrot's feather in its native habitat. *Lysathia flavipes*, a flea beetle found on parrot's feather in Argentina, causes moderate damage under field conditions. Also found in Argentina is a weevil, *Listronotus marginicollis*, that apparently feeds only on parrot's feather in its native range. Other insects have been found on parrot's feather in Florida. *Lysathia ludoviciana*, a flea beetle native to the southern United States and the Caribbean, uses parrot's feather as a host plant for larvae under laboratory conditions. However, the flea beetle is not often found on parrot's feather in the field. Two members of the Tortricidae family, *Argyrotaenia ivana* and *Choristoneura parallela*, have also been found on parrot's feather in Florida, but their effect on the plant is unknown. In addition, larvae of the caterpillar *Parapoynx allionealis* mine parrot's feather leaves, but the impact of these larvae is unknown.

Fungal control options exist as well. An isolate of *Pythium carolinianum* collected in California has shown some promise as a potential biocontrol agent. Parrot's feather stems experimentally inoculated with this fungus produced significantly less growth than control plants (Washington Water Quality Program 1998).

CHEMICAL CONTROL

The underwater and above-water foliage of parrot's feather make herbicides difficult to deliver effectively. Emergent stems and leaves have a thick, waxy cuticle that inhibits herbicide uptake, and a wetting agent is required to penetrate it. Often the weight of the spray will cause emergent vegetation to collapse into the water, where the herbicide is washed off before it can be translocated throughout the plant. The most recent version of an herbicide label will give recommended rates and information about whether the compound is registered for use in specific situations. Herbicide use is more highly regulated in aquatic systems than in terrestrial systems.

Westerdahl and Getsinger (1988) report excellent control of parrot's feather with 2,4-D, diquat, diquat and complexed copper, endothall dipotassium salt, fluridone, and endothall and complexed copper. Diquat is used on emergent parrot's feather, as well as in the water to kill rhizomes. Copper complexes are used only on submersed plants. Diquat is not legal for use in aquatic systems in California. Fair control was obtained with acrolein and glyphosate. Acrolein is used only in non-fisheries water, and glyphosate, formulated as Rodeo, is used only on emergent parrot's feather. The Monsanto Company suggested that applying a 1.75 percent solution of Rodeo with surfactant to the plants in summer or fall when water levels are low would give about 95 percent control. Control of parrot's feather may be achieved with low-volatility ester of 2,4-D at 4.4-8.9 kg/ha, sprayed onto emergent foliage. The granular formulation of 2,4-D was needed to control parrot's feather for periods greater than twelve months. It is more effective when applied to young, actively growing plants (Washington Water Quality Program 1998).

In practice, weed control efforts report little success with herbicides to control parrot's feather. Glyphosate causes emergent vegetation to turn black, but within two weeks, the plants have recovered. An experimental fall application of triclopyr also proved ineffective (Washington Water Quality Program 1998).

<u>COMMON FIG (FROM BOSSARD ET AL. 2000)</u>

Mature trees often have multiple trunks and may grow to thirty feet tall. The heavy trunk and branches are covered with a smooth, light gray, flaky bark. The sap is thick, sticky, and slightly milky. The leaves are rough to the touch, bright green, with three to five lobes, the classic fig-leaf shape. Edible figs (*Ficus carica*) invade and dominate riparian forests, streamside habitats, levees, and canal banks in and around California's Central Valley, surrounding foothills, the south coast, and the Channel Islands (Hickman 1993). They are also widely cultivated for fruit and ornament in areas below 2,500 feet (800 m) elevation.

Edible fig is most likely to escape where soils stay moist throughout the summer. It is not clear how edible fig spreads into natural areas. It grows quickly and can spread vegetatively by root sprouts, soon forming dense thickets that exclude most other plants. Limbs that have been cut or broken and fallen to the ground can take root, and it is thought that branches broken off during storms or floods may wash up and root at downstream sites. Many birds eat the fruits and may spread the seeds. Hujik (pers. comm.) reports that deer also feed on the fruits. Seeds germinate only if they are removed from the fleshy synconium during passage through an animal's gut or by mechanical means such as heavy rainfall (Lisci and Pacini 1994).

It has invaded many nature preserves and parks in California. Plants form dense thickets covering roughly twenty-five acres along a seven-mile-long section of Dye Creek at the Dye Creek Preserve northeast of Chico and have begun to invade the riparian forest at Woodson Bridge State Park along the Sacramento River to the west. Several rapidly expanding fig thickets were found in the most pristine valley oak riparian forest on the Cosumnes River Preserve south of Sacramento. These thickets were repeatedly cut and the stumps treated with herbicide, but they were difficult to eliminate.

If not controlled, edible fig trees could crowd out native trees and understory shrubs characteristic of California's riparian forests. Riparian forests are already rare in California, especially in the Central Valley, where over 95 percent have been converted to cropland, pasture, or developed areas in the past 150 years. No published or unpublished reports are available with quantitative information on the impacts of edible figs invading natural vegetation in California or elsewhere.

Edible fig grows quickly in soils with enough moisture and with exposure to high light levels. It is winter-deciduous, and the timing of leaf-out and leaf drop varies with the cultivar and with climatic conditions.

Edible fig reproduces by seed and by vegetative growth. Most of the world's *Ficus* species depend on a species-specific agaonid wasp (family Agaonidae, Hymenoptera) for pollination. *Ficus carica* depends on the wasp *Blastophaga psenes*. The wasps are in turn dependent on *F. carica* because they breed only inside its fruits (Kjellberg et al. 1987).

An efficient control method for edible fig has not yet been developed. The trees resprout vigorously after cutting and are difficult to control without herbicides.

MANUAL/MECHANICAL

Edible figs are shallow-rooted in heavy, wet soils typical of riparian forests and can be pulled up fairly easily when young. They often root-sprout, however, so what looks like one small sapling may be one of many sprouts from a large network of roots. A small or medium-sized weed wrench may help remove some of the mid-sized specimens. Repeated cutting of resprouts may eventually exhaust the root reserves of a tree or small thicket if the interval between cuttings is short enough, but this has not yet been demonstrated.

BIOLOGICAL CONTROL

No biological control species are approved by the USDA for this species. However, figs are subject to damage from nematodes, tree borers, and rust.

CHEMICAL CONTROL

At the Cosumnes River Preserve, all trunks and sucker shoots in a thicket were cut six to eighteen inches above the ground and the cut stumps treated with a 100 percent solution of an amine formulation of triclopyr (sold under the names Garlon3A and Brush-B-Gone). This was successful, although some thickets had to be retreated at least once because there was some resprouting. The retreatments were carried out at yearly intervals, but shorter intervals (two to six months) might have improved their impact by giving the plants less time to replenish root reserves. Managers at the Cosumnes River Preserve recently have been using a hack-and-squirt method, applying 100 percent triclopyr amine formulation to the wounds, but it is too early to tell if this will be as effective as the cut-stump treatments. This method was also tried at the Dye Creek Preserve, but was not effective there.

Herbicide may be applied in an eight- to twelve-inch-wide band around the uncut trunks of trees with trunk diameters up to two or three inches and perhaps greater. This is known as basal bark application, and it has been shown to be highly effective for a variety of trees and shrubs. Other herbicides, including glyphosate (marketed under a variety of names, including Rodeo and Roundup) and imazapyr (as Chopper and Arsenal) may be at least as effective as triclopyr against edible fig, but studies of this have yet to be conducted.

RED RIVER GUM (FROM BOSSARD ET AL.2000)

This profile is specific to blue gum (*Eucalyptus globulus*), which is a close relative, but may, in fact, also refer to Red River gum (*E. camaldulensis*) as well based on description and range given in Bossard et al. (2000). For the purposes of this IPM Plan, the control and management of Red River gum will follow this profile. Red River gum is abundant in local areas throughout the Sacramento Valley, and groves or treelines occur in areas such as roadsides, parking areas, and around buildings in several areas on the Complex. Within gum tree groves, biological diversity is lost due to displacement of native plant communities and corresponding wildlife habitat. Abundance and diversity of understory vegetation is dependent on stand density. Understory establishment is inhibited by the production of allelopathic chemicals and by the physical barrier formed by high volumes of forest debris consisting of bark strips, limbs, and branches. The fuel complex formed by this debris is extremely flammable, and under severe weather conditions could produce drifting burning material with the potential to ignite numerous spot fires. Because stringy bark is carried away while burning, eucalyptus forests are considered the worst in the world for spreading spot fires. The Oakland hills firestorm was both intense and difficult to control because of the many stands of eucalyptus. Individual trees growing near structures or in public use areas are hazardous because of the potential for branch failure. Stature and growth form are distinctive and unlike native tree species, which compromises the visual quality of natural landscapes.

Blue gum reproduces by seed and by resprouting. In California, flowering occurs from November to April. Seeds are small and abundant. Capsules open immediately on ripening, and seed is dispersed by wind within one to two months. Dispersal distance from one 131-foot (40 m) tall tree, with winds of six miles per hour (10 km/h), was sixty-six feet (20 m). Newly released seeds germinate within a few weeks under suitable conditions. Blue gum sprouts readily from the main trunk, from stumps of all sizes and ages, from the lignotuber, and from roots. Large masses of foliage are produced by sprouting stumps after tree felling. Numerous clusters of shoots later thin to one stem per cluster. A number of small-diameter stems can continue to thrive on each stump, resulting in bush-like growth. Production of lignotubers, which may live for many years in soil, may account for sprouting that sometimes occurs away from the main stump of cut trees (Skolmen 1983).

PHYSICAL CONTROL

Manual/mechanical methods: Removing trees is a difficult task and can be expensive if individual trees are felled. It is also unlikely that this cost can be offset because of the low value of the wood as fuel. An effective method to control stump resprouting is absolutely necessary. Stump grinding can eliminate sprouting, as well as remove all evidence of trees. Where there are few stumps and the terrain is gentle, this may be a preferred method. It is expensive to treat many stumps this way, even if a powerful and efficient self-propelled grinder is used. Care must be taken to grind all underground portions of stumps to a depth of approximately two feet. Provision must be made to fill resulting craters with soil.

Manual removal of eucalyptus sprouts from stumps results in eventual control as food resources are exhausted. This method is expensive and impractical if a large number of stumps are to be treated. Manual removal should be limited to situations where close attention can be given to a few stumps.

PRESCRIBED BURNING

This method can reduce fuels in blue gum stands, but the species is fire tolerant. Only seedlings can be killed by fire. Fuel replenishment is rapid.

BIOLOGICAL CONTROL

None known to be effective, although the red gum lerp psyllid has infested at least 27 species of eucalyptus in California, including local Red River gum at the Complex. These infestations have resulted in some defoliation and possibly some weakening of some branches, but no mortality has been documented.

CHEMICAL CONTROL

The most effective control of sprouting is achieved through application of triclopyr or glyphosate directly to the outer portion of the stump's cut surface at the time of tree felling. Triclopyr (as Garlon 4 and Garlon 3A) should be applied at the rate of 80 percent in an oil carrier. Imazapyr (as Arsenal or Stalker) can be used as an alternate to Garlon. Glyphosate (as Roundup or Rodeo) should be applied at 100 percent. Stumps should be cut as low to the ground as practical and brushed clean of sawdust to maximize absorption of the herbicide. For best results, herbicides should be applied to the freshly cut surface as soon after cutting as possible. Maximum success is achieved if cutting occurs in fall (Carrithers, pers. comm.). Complete control of sprouting on every stump will not always be achieved. Any resprouts, when three to five feet tall, should be treated with a foliar application of 2 percent of triclopyr or glyphosate.

Triclopyr (as Garlon 4) offered the best results of the herbicides currently available in California for a 1996 eucalyptus removal project at Angel Island State Park in Marin County. A high concentration was used (80 percent Garlon 4, 20 percent oil carrier; an alternative is 100 percent Garlon 3A). Glyphosate (as Roundup) was used in 1990 on a similar eucalyptus removal project on Angel Island, but with less consistent results. When sprouting occurred following the 1990 eucalyptus removal project on Angel Island, excellent follow-up control was achieved by applying triclopyr as Garlon 4 (80 percent Garlon 4, 20 percent oil carrier) to overlapping frill cuts. These cuts were made on portions of the vertical surfaces of stumps with live cambium.

Application of these herbicides to the foliage or stems of sprouts are less effective. Several years of foliar applications of triclopyr at Annadel State Park, Sonoma County, following a major eucalyptus removal project produced only incremental results. The visual impact of tall, herbicide-killed sprouts must also be considered.

At TNC's Jepson Prairie preserve near Rio Vista, Solano County, over 1,200 eucalyptus stumps were killed by repeated foliar herbicide treatments over one summer period (Serpa, pers. comm.). The stumps were not treated at the time of felling, and sprouts were allowed to grow to a height of about ten feet. The sprouts were then cut and the resulting resprouts were treated with glyphosate as Roundup (5 percent solution). By the third herbicide application, all of the stumps were dead. It is possible that the dry climate of this site contributed to the success of this method.

WATER PRIMROSE (FROM UNPUBLISHED OBSERVATIONS AT THE COMPLEX)

Water primrose (*Ludwigia* sp.) is a floating or emergent perennial that occurs in wetlands, irrigation canals, and drainage ditches. There are at least two subspecies that occur and have expanded in many areas of California. In the last 5 years, there have been significant infestations in parts of the state, including the Central Valley and the Complex. It can form tangled mats of stems that can reduce water flow in irrigation canals and drains, causing water management problems in managed wetlands, replacement of native species, and potential mosquito abatement issues.

Literature regarding control methods is sparse, but experience at the Complex has indicated that combinations of mechanical removal, dewatering, disking, and herbicide applications can control water primrose to some degree. Applications of aquatic-labled glyphosate at 1.5-2% with ~1% Agri-dex adjuvant has resulted in containment in irrigation canals and drainage ditches. In some cases, removing most above-canal bottom stems by raking or excavating and/or dewatering prior to spraying resprouting stems has enhanced control. Although, this provides short-term control, it requires annual retreatment in some areas. More rigorous studies of these treatments are being undertaken starting in 2007 (Grewell pers. comm.). Water primrose has more recently started expanding into managed seasonally flooded wetlands at the Complex. Control has been achieved through disking during the dry phase of the wetlands during the summer. Following disking, the plants, including stems and rhizomes are allowed to desiccate for several weeks to 2 months. Although, this provides short-term control, it requires annual retreatment in some areas.

GIANT REED (FROM BOSSARD ET AL. 2000)

Giant reed (*Arundo donax*) is a robust perennial grass nine to thirty feet tall, growing in many-stemmed, cane-like clumps, spreading from horizontal rootstocks below the soil, and often forming large colonies many meters across. Giant reed occurs in central and southern California and in Baja California, usually below 1,000 feet (350 m) elevation. It has invaded central California river valleys in San Luis Obispo and Monterey counties, the San Francisco Bay Area, and in the Sacramento and San Joaquin River valleys, and is also increasing in the North Coast region (Dudley and Collins 1995). Giant reed displaces native plants and associated wildlife species because of the massive stands it forms (Bell 1994, Gaffney and Cushman 1998). Competition with native species has been shown to result from monopolization of soil moisture and by shading (Dudley unpubl. data). It clearly becomes a dominant component of the flora, and was estimated to comprise 68 percent of the riparian vegetation in the Santa Ana River (Douthit 1994). As giant reed replaces riparian vegetation in semi-arid zones, it reduces habitat and food supply, particularly insect populations, for several special status species such as least Bell's vireo, southwestern willow flycatcher, and yellow-billed cuckoo (Frandsen and Jackson 1994, Dudley and Collins 1995). Giant reed is also suspected of altering hydrological regimes and reducing groundwater availability by transpiring large amounts of water from semi-arid aquifers. It alters channel morphology by retaining sediments and constricting flows, and in some cases may reduce stream navigability (Lake, pers. comm., TNC 1996).

Plants in North America do not appear to produce viable seed, and seedlings are not seen in the field. Population expansion here occurs through vegetative reproduction, either from underground rhizome extension of a colony or from plant fragments carried downstream, primarily during floods, to become rooted and form new clones.

PHYSICAL CONTROL

Manual methods: Minor infestations can be eradicated by manual methods, especially where sensitive native plants and wildlife may be damaged by other methods. Hand pulling is effective with new plants less than six feet (2 m) in height, but care must be taken that all rhizome material is removed. This may be most effective in loose soils and after rains have made the substrate workable. Plants can be dug up using hand tools (pick-ax, mattock, and shovel), especially in combination with cutting of stems near the base with pruning shears, machete, or chainsaw. Stems and roots should be removed or burned on site to avoid re-rooting, or a chipper can be used to reduce material, although clogging by the fibrous material makes chipping difficult (R. Dale, pers. comm.). For larger infestations on accessible terrain, heavier tools (rotary brush-cutter, chainsaw, or tractor-mounted mower) may facilitate biomass reduction, followed by rhizome removal or chemical treatment. Such methods may be of limited use on complex or sensitive terrain or on slopes over 30 percent, and may interfere with reestablishment of native plants and animals.

MECHANICAL METHODS

Mechanical eradication is extremely difficult, even with a backhoe; as rhizomes buried under three to ten feet (1-3 m) of alluvium readily resprout (R. Dale, pers. comm., Else et al. 1996). Removal of all such material is infeasible, especially where extensive soil disturbance would be disruptive.

PRESCRIBED BURNING

In most circumstances burning of live or chemically treated material should not be attempted, as it cannot kill the underground rhizomes and probably favors giant reed regeneration over native riparian species (Gaffney and Cushman 1998). Burning in place is problematic because of the risks of uncontained fire, the possibility of damage to beneficial species, and the difficulties of promoting fire through patchily distributed stands. There may be some cases where burning of attached material can be done, but only if other means of reducing biomass cannot be carried out. Cut material is often burned on site, subject to local fire regulations, because of the difficulty and expense involved in collecting and removing or chipping all material.

BIOLOGICAL CONTROL

No biological control agents against *Arundo donax* have been approved by the USDA, although some invertebrates are known to feed on the grass in Eurasia/Africa (Tracy and DeLoach 1999). The green bug (*Schizaphiz graminum*) has been observed to feed on giant reed in winter (Zuniga et al. 1983). In France, *Phothedes dulcis* caterpillars may feed on it. The insect *Zyginidia guyumi* uses giant reed as an important food source in Pakistan (Ahmed et al. 1977). A moth borer (*Diatraea saccharalis*) has been reported to attack it in Barbados. A USDA evaluation of the potential benefits of biological control against giant reed ranked it as a promising candidate and suggested several insects and pathogens as possible control agents (Tracy and DeLoach 1999).

GRAZING

Vertebrate grazers such as cattle and sheep may be useful in controlling giant reed, and Angora goats have been partially successful in reducing this plant and other brush in southern California (Daar 1983). Grazers are unlikely to reduce population size sufficiently to eliminate the risks posed. Likewise, management of native plants to increase competition with giant reed probably provides insufficient control, and in fact seems to offer little resistance against the invading reeds.

CHEMICAL CONTROL

In many, if not all, situations it may be necessary to use chemical methods to achieve eradication, especially in combination with mechanical removal. The most common herbicidal treatment against giant reed is glyphosate, primarily in the form of Rodeo, which is approved for use in wetlands (Round-Up can be used away from water). Because glyphosate is a broad-spectrum herbicide, care should be taken to avoid application or drift onto desirable vegetation. The standard treatment is a foliar spray application of 1.5 percent by volume glyphosate with a 0.5 percent non-ionic surfactant (Monsanto 1992). Most effective application is post-flowering and pre-dormancy, usually in late August to early November when plants are translocating nutrients into roots and rhizomes (TNC 1996). Foliar uptake and kill may be achieved by spray application during active growth periods, primarily late spring through early fall (Monsanto 1992). Small patches can be treated from the ground using backpack or towed sprayers, and major infestations have been aerially sprayed using helicopters.

Direct treatment to cut culms can reduce herbicide costs and avoid drift onto desirable plants, with fair results year-round and best kill in fall, although it appears to be more successful in shaded sites (Else et al. 1996, Vartanian, pers. comm.). Concentrated glyphosate solution (50 percent to 75 percent Rodeo, or 27 percent to 40 percent glyphosate) is applied to stems, cut within two to four inches (5-10 cm) of the substrate, by painting with a cloth-covered wand or a sponge or spraying with a hand mister. It may be helpful to add a dye or food coloring to the solution to identify treated material. Solution must be applied immediately following cutting because translocation ceases within minutes of cutting: a five-minute maximum interval is suggested (TNC 1996).

New growth is sensitive to herbicides, so a common alternative is to cut or mow a patch and allow regeneration, returning three weeks to three months later when plants are three to six feet (1-2 m) tall to treat new growth by foliar spraying of glyphosate. Promoting regrowth causes nutrients to be drawn from the roots, potentially reducing the movement of glyphosate to the roots (TNC 1996). With all methods, follow-up assessment and treatment should be conducted, and some professional applicators suggest six return spot treatments over six months (Van Diepen, pers. comm.). Other chemical control methods have been tested, including paraquat and triclopyr compounds (Arnold and Warren 1966, Horng and Leu 1979, Franklin 1996), but are not recommended near water.

Imazapyr has also been reported to be effective on giant reed. Habitat herbicide is an aquatic-labeled imazapyr product that can be used near water (M. Wolder, personal comm.)

SWAMP-TIMOTHY AND PRICKLEGRASS (FROM UNPUBLISHED OBSERVATIONS AT THE COMPLEX)

These species are both common non-native annuals in seasonal wetlands. Swamp-timothy (*Crypsis schoenoides*) is a high-quality forage species for waterfowl and considered a desirable species in managed wetlands. However, swamp-timothy and pricklegrass (*Crypsis vaginiflora*) are considered invasive in vernal pools (J. Silveira, pers. comm.). The ability to control them in vernal pools is currently limited because any control measures other than grazing or burning could likely be more detrimental to the pools than the control they would provide. Physical manipulation of the soil, such as disking would greatly alter the hydrology and make the site receptive for potentially worse invasive species. Both species are likely susceptible to chemical control, but the effect of herbicides, such as glyphosate, on the integrity of the pools is unknown, and would need a thorough evaluation before using them given the number of listed and/or rare endemic species that occur there. Maintaining the natural hydrology is a standard strategy for maintaining the native biological communities in vernal pools. Hand-pulling young swamp-timothy and pricklegrass may have some merit, but would be very labor intensive. At this time, there are no plans to specifically control these species at the Complex.

BERMUDA GRASS AND JOINTGRASS (FROM UNPUBLISHED OBSERVATIONS AT THE COMPLEX)

Bermuda grass (*Cynodon dactylon*) and jointgrass (*Paspalum distichum*) are very similar in their growth forms, habitats that they can dominate, and methods used to control them. They also commonly occur together and are controlled similarly. Therefore, they are considered together in this profile.

Bermuda grass and jointgrass are low-growing, wiry perennials that have two types of shoots: those aboveground (stolons) and those belowground (rhizomes). The stolons and rhizomes are capable of rooting in the soil, thus creating new plants as they grow out from the original plant or when they are cut and left on moist soil. In areas where the soil has not been disturbed, rhizomes are shallow (1 to 6 inches). However, where the soil has been spaded or tilled deeper than 6 inches, or in sandy soil, under sidewalks, and against solid structures such as building foundations or walls, the rhizomes may be deeper than 6 inches. Both species commonly occur in managed wetlands, and are more often a problem in those that are irrigated during the summer. They can form dense sod mats that replace desirable moist-soil plant species and can create homogenous stands. When these mats are allowed to persist, they can become so thick and wiry that they are difficult to impossible to control mechanically.

MECHANICAL CONTROL

Neither species are easy to control, but can be managed in seasonal wetlands with a persistent program of mechanical methods and water management. Ideally, they are burned after being allowed to dry in the summer, followed by disking, and then withholding water until later in the fall to desiccate the remaining stolons and rhizomes. In certain areas, it is rare for these species to dry out enough to burn them: these areas typically also have the thickest mats and are the most extreme problem sites. In such cases, spraying first (see chemical control below) to "crisp" above-ground vegetation, will facilitate burning and disking. Disking alone can be effective in many cases, however multiple passes with a heavy stubble disk are often necessary to cut into the sod mats and effectively turn over rhizomes so they can desiccate in the summer heat. Ideally, these rhizomes are left to "bake" in the sun for at least several weeks to achieve best results.

CHEMICAL CONTROL

Bermuda grass and jointgrass can be controlled with post-emergent herbicides applied to actively growing foliage and stems during spring and summer. Glyphosate (Roundup and other brand names) is a nonselective herbicide that kills plants by translocating down into the root system, in addition to killing top-growth. Both species require different application rates for control, with Bermuda grass requiring a greater rate. If the species are mixed together, use the higher (Bermuda grass) rate. For glyphosate to be most effective it must be applied to vigorously growing plants (not drought stressed) that have lots of leaf surface (do not mow the weed for 2 to 3 weeks before treating). At least 7 days after applying glyphosate plants can be disked for additional control. Disking will bring the remainder of any still living underground parts of the plant (stolons and rhizomes) to the surface of the soil so they can dry. Spraying alone can be effective in some areas, but without the follow-up disking, deeper rhizomes and roots may survive the first application and regrow.

ANNUAL (ITALIAN) RYEGRASS

Annual ryegrass (*Lolium multiflorum*) is a common annual grass in roadsides, fields, and pastures. Plants produce abundant seed, which is their only form of reproduction. In non-irrigated situations in California, most seeds germinate in the fall after the first significant rainfall. The seed bank is apparently short-lived, although seed has been reported to survive for many years under certain conditions (DiTomaso and Healy 2007). At the Complex, annual ryegrass is invasive in native grasslands, alkali meadows, and roadsides/levees. It can form dense monocultures that out compete native plant species for sunlight and soil moisture. In many cases, this includes rare, listed, and or endemic species in alkali meadows.

CONTROL METHODS

Annual ryegrass and other non-native Mediterranean annual grasses can be controlled a number of different ways. Prescribed burning can be effective (also see medusahead profile), especially when conducted in a dry fall after seedlings have recently germinated. If this opportunity in timing and conditions can be taken advantage of, burning can eliminate a good portion of seed produced that year plus young seedlings that would mature the following spring/summer. In many cases, there will be an increase in broadleaf forbs the next spring.

Grazing can be an effective tool for maintaining control of annual ryegrass and other palatable non-native annual grasses. These palatable grasses are readily consumed by domestic livestock, and especially selected for by cattle. Recent operational and experimental grazing treatments applied to Refuge grasslands and alkali meadows have shown improvements in native species diversity. Typically, timing of grazing should be in the spring when grass is tall enough to provide reasonable forage for cooperating permittees, and continues into early summer until target stubble height is achieved (typically 1-3”). Refer to grazing management plans in overall Refuge Annual Habitat Management Plans for more specific details.

JOHNSONGRASS (FROM NEWMAN 1990)

Johnsongrass (*Sorghum halepense*) is considered to be one of the ten worst weeds in the world (Holm et al. 1977). Fifty-three countries, ranging in latitude from 55°N to 45°S report Johnsongrass as a major problem; the problem is most serious in the region from the Mediterranean to the Middle East and India, Australia, central South America and the Gulf Coast of the United States (Holm et al. 1977).

Johnsongrass is an invasive and tenacious weed, which thrives in disturbed soils. The prolific seed production, extensive rhizome system, sprouting ability of fragmented rhizomes and ability to grow in a wide range of environments make Johnsongrass difficult to control. The best time to implement control techniques is during the first two weeks of growth when new rhizome development has not yet begun and when the carbohydrate supply is at its lowest concentration. During the fall the rhizome carbohydrate levels are again low, due to the formation of over- wintering rhizomes, making this an appropriate time for herbicide application. A combination of mowing, tilling, and herbicide applications may provide adequate control of Johnsongrass and may produce better effects than just one technique alone. Once successful control has been reached, a rapid re-vegetation project should be implemented for the establishment of native plants. If transplants are to be used, plants should be grown during the eradication period (Newman 1989). Subsequent spot control of remaining Johnsongrass, that avoids jeopardizing the native plants, may be necessary during the subsequent years to fully eradicate this weed.

Several techniques may be helpful in controlling Johnsongrass: torching and burning, mowing and grazing, tilling and plowing, and herbicide applications. These methods primarily focus on starving the plants by reducing growth, thus limiting photosynthesis, which results in a reduction of stored carbohydrates (Oyer et al. 1959, McWhorter 1961a&b, Horowitz 1972b, McWhorter 1974).

A single application of the herbicide glyphosate results in an 85 percent reduction in Johnsongrass (Heathman pers. comm.). The encouraging effects of chemicals on the control of Johnsongrass are addressed below.

MECHANICAL CONTROL

Mowing Johnsongrass for several seasons weakens the plants and reduces rhizome growth (McWhorter 1981, Hamilton B. pers. comm.). Removing aerial grass shoots close to the ground is a technique used to exhaust the stored carbohydrates of perennial weeds (Horowitz 1972a). Horowitz (1972a) reports that clipping three-week-old seedlings will kill them, whereas McWhorter (1961b) claims that seedlings must be clipped within 14 days after emergence for death of the plants to occur. As compared to the single clipping of seedlings, plants arising from rhizomes require two clippings within the first two weeks of growth to insure death of the plant (McWhorter 1961b). Because the lowest rhizome carbohydrate concentration occurs in the spring, during initial above-ground growth, and in the fall, during over-wintering rhizome formation, clipping at this time will have the maximum controlling effect by preventing the formation of photosynthates and thus precluding a stored energy supply (Horowitz 1972b).

Repeated clipping is required to control plants, which emerged more than 20 days prior to the initial treatment. Slight amounts of rhizome growth occur even under continuous clipping (McWhorter 1961b). Bi-weekly clipping of potted plants severely reduces growth during that growing season; however, one quarter of clipped plants display renewed growth the following year (Horowitz 1972a). A single clipping of the aerial growth of plants 28 days after germination or sprouting reduces the amount of total carbohydrates in the rhizomes by 25 percent; however, a rapid replenishment of carbohydrates is seen within 30 days after clipping (McWhorter 1974). McWhorter (1981) reports maximum growth reduction when plants are allowed to reach 12 to 15 inches in height before cutting them at ground level, whereas Lorenzi and Jefferey (1987) feel that eight inches is the maximum size that Johnsongrass should be allowed to reach in order to starve the plants.

Hand hoeing is practical only where the concentration of Johnsongrass is low. Shallow cultivation using sharp hoes, shovels, knives or hand pulling will remove the plants and the rhizomes from the upper portion of the soil without dividing or pulling up deep rhizomes (Heathman et al. 1986, Lorenzi and Jefferey 1987). Hoeing early in the season when plants are under three weeks old will be much more effective than hoeing older plants, which have larger rhizome systems and greater concentrations of stored carbohydrates (McWhorter 1961b). Six to eight fallow plowings throughout the summer is the most effective tilling routine for large-scale problems. Plows break up the rhizomes and bring them to the surface of the soil where they desiccate (McWhorter 1981). A 99 percent reduction in rhizome production resulted from six thorough tillings at two-week intervals (Warwick and Black 1983). However, plowing could spread the rhizomes and increase the problem if contaminated machinery is used in uninfested areas (Cox pers. comm.).

CHEMICAL CONTROL

Extensive literature is available on herbicides available for Johnsongrass control. The use of soil-active herbicides is not recommended due to the residual activity seen eight years after application (Hunter et al 1978). Herbicides alone will not successfully eradicate Johnsongrass (Cox pers. comm.). Yearly applications will be required for an effective control plan.

Many herbicides are recommended for use on Johnsongrass. Only two of them are foliar sprays that are mildly toxic and rapidly decay in the soil: glyphosate (commercial name -- Roundup) and dalapon (commercial name -- Dowpon). Both of these chemicals are translocated to the underground tissue and act on all of the growing sites (Ross 1986).

Glyphosate is recommended for controlling Johnsongrass in natural, non-agricultural sites (Brookbank pers. comm., K. Hamilton pers. comm., Heathman pers. comm., Lorenzi and Jefferey 1987). K. Hamilton (pers. comm.) recommends using spot applications of glyphosate with a knapsack sprayer to control small areas of Johnsongrass. Multiple applications for several years will be required. An 85 percent reduction in Johnsongrass is commonly seen during the first year of application using glyphosate. Seeds and nonactive rhizomes account for the 15 percent regrowth of Johnsongrass during herbicide activity (Heathman pers. comm.).

Best results in controlling Johnsongrass with glyphosate have been seen when the plants are actively growing, greater than 18 inches tall and have reached the bloom-to-head stage of growth (Silberman pers. comm., McWhorter 1981). The inflorescences should be removed to prevent the dispersal of mature seeds. In southern Arizona, maximum control of Johnsongrass occurs with fall applications of glyphosate (Brookbank pers. comm.). The low amount of rhizome carbohydrates in the fall may account for the effectiveness of the herbicide during this season of maximum rhizome growth. The land should not be tilled for at least a week after applying the herbicide in order to insure optimal efficiency from the single application (McWhorter 1981).

Johnsongrass grown under high salt and low water conditions result in reduced plant growth (Sinha et al. 1986). High salt concentrations have little effect on the overall biomass accumulation when water availability is not reduced. There is, however, a decrease in the ratio of growth between shoots and roots with increased salinity (Sinha et al. 1986).

MEDUSAHEAD (FROM BOSSARD ET AL. 2000)

Medusahead (*Taeniatherum caput-medusae*) is a slender annual grass. The one- to three-inch awns are straight and compressed when green, but upon drying, the awns twist and spread erratically in a manner reminiscent of the snake-covered head of the mythic Medusa. It has been reported from almost every county in northern California and in many areas of central California, extending as far south as Riverside County. It also infests rangeland, grassland, and sagebrush communities in Oregon, Washington, Idaho, Nevada, and Utah.

Medusahead invades grasslands, oak savannah, oak woodland, and chaparral communities. It grows in a wide range of climatic conditions. Clay or clay-loam soils with at least ten inches of rainfall annually are most susceptible to invasion (Dahl and Tisdale 1975). However, medusahead has been found on coarse-textured soils as well (Young 1992). The grass reproduces by seed, which is dispersed locally by wind and water. The long-awned seeds cling to the coats of grazing animals, such as sheep or cattle, and in this way are transported to more distant sites. Seeds can also disperse by attaching to machinery, vehicles, and clothing. Medusahead out competes native grasses and forbs, and, once established, can reach densities of 1,000 to 2,000 plants per square meter. After seed set, the silica-rich plants persist as a dense litter layer that prevents germination and survival of native species, ties up nutrients, and contributes to fire danger in summer. Because of its high silica content, medusahead is unpalatable to livestock and native wildlife except early in the growing season.

Medusahead is predominantly self-pollinating and reproduces by seed. In California, medusahead seeds usually germinate in October or November. The shoot system remains small, while the root system develops throughout the cold winter months. Early germination and rapid root growth consumes available water and nutrients, out competing slower-growing native species. Medusahead continues to grow, extract soil moisture, and produce seeds after most other annual grasses have turned brown.

Flowering usually occurs in May. An average of eight to fifteen seeds is produced per spike in late spring or early summer. Seeds usually disperse by mid-summer. Seed dormancy varies from a few weeks to over six months, depending on location. Germination normally occurs with the first rains in fall, and the germination rate is high. The seeds are well adapted to germinating and growing in the dense litter layer. Under these conditions, seeds can germinate even if they are not touching the soil. If they dry out, the primary root dies, but if they are moistened again, a new adventitious root develops (Young et al. 1971).

PHYSICAL CONTROL

Mowing alone, or in combination with grazing, was found to be effective in reducing infestations. Plowing or disking is also effective means for controlling medusahead (Hilken and Miller 1980). Several studies have shown that burning stands of medusahead prior to seed dispersal is an effective control measure (Furbush 1953, Hilken and Miller 1980, McKell et al. 1962, Murphy and Lusk 1961, Pollak and Kan 1996). Burns should be scheduled for late spring, after seed set but before seed heads have shattered (known as the “soft dough” stage of seed development). Seeds still on the plants are destroyed by the burn, while dispersed seeds lying on or buried below the soil surface are protected from the intense heat of the burn. With few seed reserves in the soil, medusahead abundance can be dramatically reduced if the seed input for even one year is eliminated.

This method takes advantage of the fact that medusahead matures later than most of the surrounding vegetation so most other species have already dispersed their seeds and are dry enough to carry a burn. At the Jepson Prairie Preserve in Solano County effective control burns were conducted in late May and early June. Proper timing may vary depending on local conditions and weather. Some studies have found medusahead to increase after burning, but most of these studies conducted burns in August, presumably after seed dispersal.

GRAZING

Heavy grazing by sheep in early spring (when medusahead is still palatable) can assist in controlling medusahead, but animals should be removed before seed heads form to limit seed dispersal. Early spring grazing is especially effective in areas where dried medusahead litter has been previously burned or grazed. Fertilizing with nitrogen improves the palatability of medusahead (Lusk et al. 1961). Properly timed grazing may reduce, but not eliminate, medusahead infestations.

CHEMICAL CONTROL

Small-scale infestations can be controlled by chemical herbicides. Atrazine applied in fall at 2 lbs/acre, was effective in controlling medusahead (Hilken and Miller 1980).

WATER HYACINTH (FROM BOSSARD ET AL. 2000)

Water hyacinth (*Eichhornia crassipes*) is a floating aquatic plant with bright green, waxy leaves and attractive, violet flowers that have yellow stripes on the banner petals. These plants tend to form mats on the water surface. Sometimes water hyacinth can be found growing in muddy soils near the edge of an aquatic system. The leaves are arranged in a rosette. The leaf stem usually is somewhat to completely swollen and filled with spongy tissue and thus acts as a float. In plants anchored in mud, the leaf stem tends not to be swollen. The blade of the leaf is oval to round and usually much smaller than the leaf stem.

Water hyacinth can be found in both natural and man-made freshwater systems (ponds, sloughs, rivers). It will not tolerate brackish or saline water with salinity levels above 1.8 percent

(Penfound and Earle 1948). In California, water hyacinth typically is found below 660 feet (200 m) elevation in the Central Valley, San Francisco Bay Area, and South Coast. The Sacramento-San Joaquin Delta and several of the rivers drained by this delta are heavily infested (Thomas and Anderson 1984).

Native to the Amazon River basin of tropical South America, water hyacinth has now spread to all tropical and subtropical countries and is universally regarded as one of the most serious of the world's weeds (Parsons 1992). It was introduced into the United States in 1884 as an ornamental plant for water gardens. The plant quickly spread throughout the country, becoming a major weed in southern states from Florida to California. By 1897, it had clogged many waterways and was interfering with shipping (Parsons 1992). It was found in California in 1904 (Thomas and Anderson 1984).

Water hyacinth spreads through fragmentation of established plants and may resprout from rhizomes or germinate from seeds (Penfound and Earle 1948). Dispersal also occurs by water-borne seeds and by seeds that stick to the feet of birds. Migratory birds may be important in long-distance dispersal (Parsons 1992). Water hyacinth can quickly dominate a waterway or aquatic system because of rapid leaf production, fragmentation of daughter plants, and copious seed production and germination. It degrades habitat for waterfowl by reducing areas of open water used for resting, and when decomposing it makes water unfit for drinking. It displaces native aquatic plants used for food or shelter by other wildlife species. Water hyacinth causes problems for humans by obstructing navigable waterways, impeding drainage, fouling hydroelectric generators and water pumps, and blocking irrigation channels.

The protected water within mats of water hyacinth makes ideal breeding sites for mosquitoes and other vectors, which, in tropical countries, increases the danger of malaria, schistosomiasis, and other diseases (Parsons 1992). Water hyacinth increases water losses from lakes and rivers because of the plant's high transpiration rate, calculated to be almost eight times the evaporation rate of open water surfaces (Parsons 1992). It changes water quality beneath the mats by lowering pH, dissolved oxygen, and light levels, and increasing carbon dioxide tension and turbidity (Penfound and Earle 1948; Center and Spencer 1981). This affects the health of fish, while decaying plants make water unfit for drinking by humans, livestock, and wildlife.

Water hyacinth can reproduce either sexually or vegetatively. Flowering (i.e., sexual reproduction) occurs in mid-summer and early fall. The flower stalks bend back into the water once they are pollinated (it is thought to be self-pollinated) and release the seeds. Seeds sink to the bottom and can remain viable in sediments for several years. Water hyacinth seeds require warm, shallow water and high light intensity for germination. Vegetative reproduction occurs from late spring through fall. Parts of the stem may break off at the water surface to form independent plants called daughter plants (Penfound and Earle 1948). These daughter plants are capable of producing additional reproductive stem segments within weeks. Water hyacinth grows rapidly. Growth of more than one ton of dry matter per day per hectare is not uncommon. One plant may be able to produce enough growth to cover 600 square meters in one year.

PHYSICAL CONTROL

For small ponds or lakes infested with water hyacinth, harvesting and removal of plant material from the water can be attempted. Care must be taken to remove all plant material, including small fragments. Harvesting and removal of plant material is labor-intensive and expensive. A less expensive method of containing water hyacinth is the use of floating barriers that can contain the weed in a small area. Dredges, which drag plants onto river banks, are effective if the material is allowed to dry and is then burned. These are costly efforts, and they have been replaced in most areas by chemical control (Parsons 1992).

BIOLOGICAL CONTROL

Biological control has been successful in many, but not all, areas. Three insects and a fungus have been extensively studied and subsequently released by the USDA to control water hyacinth. The insects include two weevils, *Neochetina eichhorniae*, and *N. bruchi* (Coleoptera: Curculionidae), and a moth, *Sameodes albiguttalis* (Lepidoptera: Pyralidae). The fungus is *Cercospora rodmanii* (Fungi Imperfecti: Moniliales), which was first found in Florida in 1976 (Conway 1976).

In the southern United States, the weevils have been most effective in reducing water hyacinth populations (Center et al. 1989). In Florida, the weevils combined with the fungus have also produced good results. In California, all three species of insects have been released. However, only *Neochetina eichhorniae* has established, and its impact on density of water hyacinth is slight. The fungus is currently unavailable for use in California.

GRAZING

Most animals, except rabbits, do not readily eat the plant, possibly because its leaves are 95 percent water and have high tannin content.

CHEMICAL CONTROL

Water hyacinth can be controlled using glyphosate as a foliar spray (formulated as Rodeo) and copper complexes used only as a foliar spray. Herbicide use is more highly regulated in aquatic systems than in terrestrial systems. A current label for the herbicide must be obtained to determine suitability for a given system and amount of active ingredient to be applied. Both suitability and the amount of active ingredient may change from one year, habitat type, and/or jurisdiction to another. Consult your county agricultural agent or a certified herbicide applicator.

<u>TREE-OF-HEAVEN (FROM BOSSARD ET AL. 2000)</u>

Ailanthus (*Ailanthus altissima*) is a deciduous tree thirty to sixty-five feet high, with gray bark, and generally with root sprouts. Its branches have a large pith and prominent heart-shaped leaf scars. Ailanthus has large compound leaves with several circular glands on the underside of most leaflets. Ailanthus is widely but discontinuously distributed in California. It is most abundant along the coast and in the Sierra foothills, primarily in wastelands and disturbed, semi-natural habitats. However, it also occurs in riparian areas and other naturally disturbed habitats throughout California's mid-lower elevations, below 6,600 feet (2000 m). A native of eastern China, ailanthus has been introduced throughout the northern hemisphere.

Ailanthus reproduces by seed and vegetatively by root sprouts. By producing abundant root sprouts, ailanthus creates thickets of considerable area, displacing native vegetation (Kowarik 1983, 1995). Although it may suffer from root competition by other trees already established, usually it competes successfully with other plants (Cozzo 1972, Hu 1979). In California, its most significant displacement of native vegetation is in riparian zones. It also produces allelopathic chemicals that may contribute to displacement of native vegetation (Lawrence 1991). A high degree of shade tolerance gives ailanthus a competitive edge over other plant species (Grime 1965). A tree generally become reproductive at ten to twenty years, but younger shoots also may produce fruits. Trees are deciduous, leaving clumps of stark, bare stems over the winter. Most trees produce only male or only female flowers (dioecy). Flowering follows leaf expansion in late spring. Female trees may produce several hundred inflorescences per year, and at maturity an inflorescence contains hundreds of seeds (Hunter 1995). A single tree can produce up to a million seeds per year. Seeds ripen in large, crowded clusters from September to October of the same year and may persist on the tree through the following winter (Little 1974, Hu 1979). Most ailanthus seeds are viable, even those that have over-wintered on the tree (Little 1974, Hunter 1995). Germination ranges from 14 to 75 percent. Because its seeds do not remain dormant for more than a year, ailanthus does not have a persistent soil seed bank. Despite prolific seed production, seedling establishment of ailanthus is infrequent in California. Most new shoots are root sprouts. Root sprouts are produced up to fifty feet (15 m) away from the nearest shoot. Their initial growth is rapid, commonly over a meter per year (Miller 1990, Hunter unpubl. data). In favorable settings, rapid growth continues, but for shaded sprouts growth drops to several centimeters per year (Hunter unpubl. data).

PHYSICAL CONTROL

If mechanical and/or chemical control is attempted, sites should be monitored several times per growing season. All new root sprouts should be removed, and monitoring should be continued for one year after the last sprout is removed.

Hand pulling

Young seedlings are best pulled after a rain when the soil is loose. This allows removal of the root system, which may resprout if left in the ground. After the tap root has developed, root removal is more difficult. Plants should be pulled as soon as they are large enough to grasp but before they produce seeds.

Hand digging

Removal of rootstocks by hand digging is a slow but sure way of destroying weeds that resprout from roots. The work must be thorough to be effective as every piece of root that breaks off and remains in the soil may produce a new plant. This technique is suitable only for small infestations and around trees and shrubs where other methods are not practical.

Cutting

Manually operated tools such as brush cutters, power saws, axes, machetes, loppers, and clippers can be used to cut ailanthus. This is an important step before many other methods are tried, as it removes the above-ground portion of the plant. For thickly growing, multi-stemmed shrubs and trees, access to the base of the plant may be not only difficult but dangerous where footing is uncertain.

Girdling

This involves manually cutting away bark and cambial tissues around the trunks of undesirable trees. A relatively inexpensive method, girdling is done with an ordinary ax in spring when trees are actively growing. Hardwoods are known to resprout below the girdle unless the cut is treated with herbicides. Although it may be undesirable to leave standing dead trees in some areas, this technique has been shown to reduce stump sprouting in live oaks, and may be a useful technique for controlling ailanthus.

Cutting an ailanthus stem induces prolific root suckering and the production of stump sprouts. After a stem is cut, its stump sprouts may grow over ten feet (3 m) per year and its root sprouts three to seven feet (1-2 m) per year (Pannill 1995). As a consequence, mechanical removal will be ineffective unless all stems are cut at least several times per year (Pannill 1995).

PRESCRIBED BURNING

This is probably not an effective technique for controlling ailanthus. Fire may kill main stems, but this will result in prolific sprouting.

BIOLOGICAL CONTROL

Biological control of ailanthus has not been investigated. The species is not significantly affected by insects or disease (Miller 1990). French (1972) reports that the zonate leafspot fungus (*Cristulariella pyramidalis*) causes defoliation of ailanthus in Florida. In India the insect *Atteva fabricella* is considered an ailanthus defoliator (Misra 1978), and seedlings in Italy, weakened by cold, were weakly parasitized by the fungus *Placosphaeria sp.* (Magnani 1975).

GRAZING

Ailanthus may suffer extensive browse herbivory from deer and cattle, particularly the young growth of sprouts, which may aid eradication (Pannill 1995, Hunter 1995).

PLANT COMPETITION

In most cases ailanthus prevents the establishment of other native plants and must be initially removed. Following removal of mature plants, root crowns must be treated to prevent resprouting. Seedlings of native plant species usually cannot establish fast enough to compete with sprout growth from untreated stumps. Ailanthus is shade tolerant, so presumably will sprout under other plants.

CHEMICAL CONTROL

Herbicide applications should be most effective in spring, just after leaves are fully expanded. Smaller sprouts probably can be controlled by spraying foliage with 4 percent glyphosate (as Roundup). Young stems usually can be killed by generously applying 15-20 percent triclopyr (sold as Garlon) to all of the bark from the stem base to twenty inches above the ground. The thicker bark of larger plants interferes with uptake of herbicide, and therefore, to kill larger individuals, the stem needs to be frilled (have an encircling ring of bark removed) before herbicide is applied. In order to damage the root system, concentrated herbicide (such as 15 to 20 percent triclopyr or 15 to 40 percent glyphosate) needs to be applied with brush or wick to the freshly exposed surface immediately after cutting (Pannill 1995). Applying herbicide to freshly cut stumps is probably the most effective technique for controlling ailanthus. Wiping the stump with full strength, 41 percent glyphosate within several minutes of cutting should reduce or even eliminate subsequent root suckering.

TAMARISK/SALTCEDAR (FROM UNIVERSITY OF CALIFORNIA 2007)

Saltcedar (*Tamarix ramosissima*) is a deep-rooted shrub or small tree (5 to 20 feet tall) in the tamarisk family (Tamaricaceae). A single mature saltcedar may produce hundreds of thousands of tiny seeds, which are readily dispersed by wind and water. Seed dispersal may occur throughout the spring and summer months. Seedling growth is very rapid. The species can resprout vigorously from buried, submerged, or damaged stems and mature plants spread vegetatively as well (Sudbrock 1993). Once established, even dramatic changes in soil moisture will not eliminate saltcedar, as long as abundant ground water is available (Brotherson and Field 1987, Frasier and Johnsen 1991).

Aggressive and long-lived, saltcedar has colonized more than one million acres of floodplains, riparian areas, and wetlands throughout the arid west. Saltcedar out competes and crowds out native vegetation and alters patterns of sediment deposition (Carpenter 1999, Sudbrock 1993, Tallent-Halsell and Walker 2002). Saltcedar uses more water than comparable native plant communities use and alters local hydrology by lowering the water table (Hoddenbach 1987 cited in Carpenter 1999). The stems and leaves of mature plants secrete salt, increasing soil salinity and further excluding many native plant species (Sudbrock 1993). Infestations also have detrimental impacts on wildlife. Saltcedar is not favored habitat for most bird species. Saltcedar seeds have almost no protein and are too small to be eaten by most granivores, and the scale-like leaves offer little suitable forage for browsing animals (Anderson et al. 1977). Stands of saltcedar are associated with lower diversity of aquatic invertebrates (Bailey et al. 2001).

The following is from the TNC Element Stewardship Abstract for *Tamarix* species (Carpenter 1999):

Tamarisk can be controlled by five principal methods: 1) applying herbicide to foliage of intact plants; 2) removing above ground stems by burning or mechanical means followed by foliar application of herbicide; 3) cutting stems close to the ground followed by application of herbicide to the cut stems; 4) spraying basal bark with herbicide; and 5) digging or pulling plants. In addition, The USDA has tested and proposed the release of two species of insects for tamarisk bio-control.

Selecting an appropriate control method involves considering the size of the area where tamarisk is to be controlled, restrictions on the use of particular herbicides or herbicides in general, the presence or absence of desirable vegetation where tamarisk is growing, the presence or absence of open water, adjacent land uses that might restrict prescribed burning, and the availability and cost of labor.

For larger areas (> 2 hectares) that are essentially monotypic stands of tamarisk, the best methods would likely be foliar application of imazapyr (Arsenal) [Also now available in an aquatic-approved formulation called Habitat] herbicide to the intact plants or burning or cutting plants followed by foliar application of imazapyr or triclopyr (e.g. Garlon4 or PathfinderII) to the resprouted stems. Foliar application of imazapyr or imazapyr in combination with glyphosate (e.g. Rodeo) can be effective at killing large, established plants. Over 95 percent control has been achieved in field trials during the late summer or early fall. The herbicide can be applied from the ground using hand-held or truck-mounted equipment or from the air using fixed-wing aircraft [or helicopter (B. Lee, pers. comm.)]. Foliar application of herbicide works especially well in monotypic stands of tamarisk, although experienced persons using ground equipment can spray around native trees and shrubs such as cottonwood and willow. As an alternative to herbicides, prescribed fire or a bulldozer can be used to open up large stands of tamarisk. Once opened, the resprouts can be sprayed when they are 1 to 2 m tall using imazapyr, or imazapyr plus glyphosate, or triclopyr.

Tamarisk eradication in areas that contain significant numbers of interspersed, desirable shrubs and trees is problematic. Depending upon site conditions, it may not be possible to rapidly kill tamarisk plants without also killing desirable shrubs and trees. In such situations, it may be necessary to cut and treat tamarisk stumps with herbicide, as outlined in the next paragraph. While this method is relatively slow and labor-intensive, it will spare desirable woody plants. Alternatively, it may be more cost-effective to kill all woody plants at a site and replant desirable species afterward.

For modest-sized areas (< 2 hectares), cutting the stem and applying herbicide (known as the cut-stump method) is most often employed. The cut-stump method is used in stands where woody native plants are present and where their continued existence is desired. Individual tamarisk plants are cut as close to the ground as possible with chainsaws, loppers or axes, and herbicide is applied immediately thereafter to the perimeters of the cut stems. The herbicides triclopyr (e.g. Garlon4 or PathfinderII) and imazapyr (Arsenal) can be very effective when used in this fashion. This treatment appears to be most effective in the fall when plants are translocating materials to their roots. The efficacy of treatments is enhanced by cutting the stems within 5 cm of the soil surface, applying herbicide within one minute of cutting, applying herbicide all around the perimeter of the cut stems, and retreating any resprouts 4 to 12 months following initial treatment.

No matter how effective initial treatment of tamarisk might be, it is important to re-treat tamarisk that is not killed by initial treatment. It is also essential to continue to monitor and control tamarisk indefinitely because tamarisk is likely to re-invade treated areas. However, follow-up control is likely to require much less labor and materials than the initial control efforts.

HIMALAYAN BLACKBERRY (FROM BOSSARD 2000)

Himalayan blackberry (*Rubus discolor*) grows as a dense thicket of long, bending branches (canes), appearing as tall, ten-foot mounds or banks, particularly along watercourses. Canes have hooked prickles. Flowers are white, yielding black berries that usually ripen later than native blackberries.

Himalayan blackberry occurs in California along the coast in the Coast Ranges, Central Valley, and the Sierra Nevada (Dudley and Collins 1995). It forms impenetrable thickets in wastelands, pastures, and forest plantations. It grows along roadsides, creek gullies, river flats, fence lines (Parsons and Amor 1968), and right-of-way corridors. It is common in riparian areas, where it establishes and persists despite periodic inundation by fresh or brackish water. Periodic flooding can produce long-lived early seral communities conducive to the growth and spread of blackberries. Himalayan blackberry is one of few woody plants that pioneer certain intertidal zones of the lower Sacramento River (Katibah et al. 1984).

Blackberries grow well on a variety of barren, infertile soil types (Brinkman 1974). These shrubs tolerate a wide range of soil pH and texture, but do require adequate soil moisture. Himalayan blackberry prefers disturbed and wet sites even in relatively wet climates. It prefers areas with an average annual rainfall greater than 76 cm on both acidic and alkaline soils (Amor 1972). It appears to be tolerant of periodic flooding by brackish or fresh water (Willoughby and Davilla 1984). It grows at elevations of over 6,000 feet in Arizona and to 5,000 feet in Utah (Kearney et al. 1960, Welsh et al. 1987).

Himalayan blackberry is native to western Europe (Hickman 1993). There is no botanical evidence to show that it is native to the Himalayan region. It may have found its way there as a cultivar. Himalayan blackberry probably was introduced to North America in 1885 as a cultivated crop (Bailey 1945). By 1945, it had become naturalized along the West Coast. By this time, it also occurred in nursery and experimental grounds along the East Coast and in Ohio (Bailey 1945). It seeds heavily, and seeds are readily dispersed by mammals and birds. Seeds can be spread considerable distances by streams and rivers (Parsons 1992). It also spreads vegetatively by rooting of cane tips.

Himalayan blackberry colonizes areas initially disturbed and then neglected by humans and can dominate range and pasture lands if not controlled. Himalayan blackberry is a strong competitor, and it rapidly displaces native plant species. Blackberries are highly competitive plants. Thickets produce such a dense canopy that the lack of light severely limits the growth of other plants. Because plants are prickly, livestock, particularly sheep and cattle, avoid grazing near them, effectively decreasing the usable pasture area. Young sheep and goats that get tangled up in the canes have been known to die of thirst and hunger. In wet areas, blackberries may hinder medium-sized to large mammals from gaining access to water. The impenetrable nature of blackberry thickets reduces access for maintenance of fence lines and for forestry practices, as well as recreational pursuits. Dense thickets around farm buildings and fence lines are a considerable fire hazard.

Flowering begins in May and continues through July. Fruit is produced from July to September. Most blackberries produce good seed crops nearly every year. Immature fruit of Himalayan blackberry is red and hard, but at maturity, fruit becomes shiny black, soft, and succulent.

Himalayan blackberry thickets can produce 7,000 to 13,000 seeds per square meter (Amor 1974). When grown in dense shade, however, most species of blackberry do not form seeds (Brinkman 1974). Seeds of blackberries are readily dispersed by gravity and by many species of birds and mammals. The large, succulent fruits are highly favored and, after they mature, rarely remain on the plant for long (Brinkman 1974). A hard seed coat protects the embryo even when seeds are ingested. Passing through animal digestive tracts appears to scarify seeds and may enhance germination. Prompt invasion of cut-over lands by Himalayan blackberry suggests that dispersed seeds can remain viable in the soil for several years (Brinkman 1974). Seeds germinate mainly in spring.

Blackberry seeds have a hard, impermeable coat and a dormant embryo (Brinkman 1974). Consequently, germination is often slow. Most blackberries require, at a minimum, warm stratification at 68 to 86 degrees F (20 to 30 degrees C) for ninety days, followed by cold stratification at 36 to 41 degrees F (2 to 5 degrees C) for an additional ninety days (Brinkman 1974). These conditions are frequently encountered naturally as seeds mature in summer and remain in the soil throughout the cold winter months.

In Australia, Himalayan blackberry seedlings receiving less than 44 percent of full sunlight did not survive (Amor 1974). The slow growth of seedlings and their intolerance of shading suggest that few seedlings would be expected to survive in dense pastures or forest plantations. Blackberry thickets are also poor sites for seedling development. Amor (1972) counted less than 0.4 seedlings per square meter near thickets. Establishment of Himalayan blackberry seedlings depend on the availability of open habitats such as land neglected after cultivation, degraded pastures, and eroded soils along streams (Amor 1974). Although seedlings show the potential for rapid growth under laboratory conditions, they grow much more slowly in the field and are easily surpassed by the more rapid growth of daughter plants.

MECHANICAL METHODS

Mechanical removal may be the most effective way of removing mature plants. Subsequent treatment with herbicides should be conducted.

Most mechanical control techniques, such as cutting or using a weed wrench, are suitable for Himalayan blackberry. Care should be taken to prevent vegetative reproduction from cuttings. Burning slash piles is an effective method of disposal.

An advantage of cane removal over use of foliar herbicides is that cane removal does not stimulate sucker formation on lateral roots. Amor (1974) provides evidence that herbicides such as picloram are not much more effective than cane removal. However, removal of canes alone is insufficient to control Himalayan blackberry, as root crowns will resprout and produce more canes.

MANUAL METHODS

Removing rootstocks by hand digging is a slow but effective way of destroying Himalayan blackberry, which resprouts from roots. The work must be thorough to be effective because every piece of root that breaks off and remains in the soil may produce a new plant. This technique is suitable only for small infestations and around trees and shrubs where other methods are not practical.

Himalayan blackberry plants may be trimmed back by tractor-mounted mowers on even ground or by scythes on rough or stony ground. Perennial weeds such as Himalayan blackberry usually require several cuttings before underground plant parts exhaust their reserve food supply. If only a single cutting can be made, the best time is when plants begin to flower. At this stage, the reserve food supply in the roots has been nearly exhausted, and new seeds have not yet been produced. After cutting or chopping with mechanical equipment, Himalayan blackberry may resprout from root crowns in greater density if not treated with herbicides.

PRESCRIBED BURNING

Burning is also an effective way of removing mature plants. Prescribed burning is suitable for removing large thickets, but requires follow-up to control resprouts.

BIOLOGICAL CONTROL

The USDA will not support introduction of herbivorous insects to control Himalayan blackberry because of the risk posed to commercially important Rubus species.

GRAZING

Sheep, cattle, and horses can be effective in reducing the spread of Himalayan blackberry (Amor 1974). In New Zealand infestations have been controlled by the grazing of large numbers of goats. This method has been effective in preventing canes from covering large areas (Featherstone 1957). Crouchley (1980) mentions that blackberry is readily eaten by goats throughout the year, even when there is an abundant supply of other plants. In many areas of California, the use of angora and Spanish goats is showing promise in controlling Himalayan blackberry (Daar 1983).

CHEMICAL CONTROL

Picloram suppresses cane regrowth of Himalayan blackberry but stimulates the development of adventitious shoots. Picloram is currently not registered for use in California wildlands. Foliage spraying is more effective in summer than in winter.

Many other herbicides have been used in efforts to control Himalayan blackberry with varying degrees of effectiveness. Fosamine can be effective (Shaw and Bruzzese 1979), and blackberry control has also been accomplished with amitrole-thiocyanate (Amor 1972), and triclopyr ester (as GarlonÂ®) (McCavish 1980). Not all of these are currently registered for use in California.

POTENTIAL CONTROL METHODS AND MATERIALS

Treatment methodologies will be based upon the best information available from pest management literature, professional expertise, and local experience. The most appropriate treatment for an infestation typically depends on the scale of the infestation and on the biology and ecology of the target species. Other considerations include effects of the treatments on desirable species. Desirable species are avoided whenever possible. In some cases, non-target species will be affected if determined that short-term negative impacts will be worth long-term habitat improvements from controlling invasive or undesirable species. Listed species receive special consideration, and will be completely avoided unless it can be shown that treatments will not result in any significant impacts. Invasive plant management techniques are expected to change and become more refined as more experience is gained. Presently, the following techniques are considered for use at the Complex. For additional information on control techniques refer to The Nature Conservancy Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas (Tu et al. 2001).

PRESCRIBED BURNING

Prescribed burning is used in both wetland and upland habitats to remove rank vegetation, control non-native invasive species, as well as to enhance and maintain habitat values. Burning in wetland areas is generally used to reduce perennial vegetation that has expanded to a point that decreased wildlife use and overall productivity has resulted. Examples include wetlands where long-term expansion of hard-stemmed bulrush and cattail growth have exceeded the optimum range of emergent vegetation and open water, or where Bermuda grass or jointgrass has replaced the majority of annual moist-soil food plants, thus reducing the use by many wildlife species (Mensik 1990). Prescribed burns can be applied to managed wetlands during various times of the year, but most occur from late spring through the fall. Depending on conditions and habitat objectives, both dry and overwater burning can be successful. Fire lines are disked around the burn area and buffers are disked around any trees to be saved. The firing pattern allows for an avenue or direction of escape for wildlife. In some cases, burning is conducted over water to increase controllability. Follow-up disking is often used to ensure that roots of target species (i.e. hard-stemmed bulrush, cattail, jointgrass, etc.) are killed and to enhance germination of desirable species (Mensik 1990; Mensik and Reid 1995). The result is a desirable mix of vegetation species, stature, and distribution, a recycling of nutrients, and a successional stage that is more productive. The frequency of burning wetland units depends on habitat type, vegetation species composition, soil type, and tendency for growth. In some cases, this may be as often as once every five years and in others it may be one in 20 to 30 years.

Prescribed burns in grasslands, alkali meadows, and vernal pools are used to reduce invasive species and to stimulate native plant species (Pollak and Kan 1998; Wight 2000). Resource benefits include maintaining biodiversity, especially native plant communities and the wildlife they support; providing browse for waterfowl; and general maintenance of habitat for short grass wildlife species. Burns may occur at any time of year, depending on specific objectives and condition of the habitat. Fall or winter burns are usually used when sensitive plants are present because they are dormant at that time. For optimal control of annual grasses, it is most effective to burn in the late spring/early summer when seeds remain on the plants and can easily be consumed by the fire.

Annually, 500 to 2,000 acres of upland and wetland habitats are burned on the five Refuges. Prescribed burns are consistent with the Fire Management Policy (621 FW 1-3 of the Service Manual). Prescribed burns are consistent with approved habitat and fire management plans for the Complex. Individual prescribed burn plans are written, reviewed, and approved for each unit as outlined in the Interagency Prescribed Fire Guide. They include a variety of information detailing how the burn will be conducted, considerations for safety, and measures to minimize impacts to sensitive species.

DISKING

Disking is an important management tool that has a variety of uses. It is most commonly used in managed wetlands to reduce vegetation that has exceeded beneficial quantities or distributions required for wildlife use objectives. Used by itself, or in combination with burning or spraying, disking helps control bulrushes, cattails, Bermuda grass, jointgrass, primrose, and other perennial plant species (Mensik 1990; Mensik and Reid 1995). In addition to controlling undesirable plants, disking also creates a seedbed conducive to both increased germination and seed production of desirable moist-soil plants in seasonal wetlands (Naylor 2002). Caution must be exercised in some wetlands, where disking can enhance or spread invasive species such as cocklebur and pepperweed. Disking is often used in thick vegetation to create openings that facilitate improved wildlife use, better visibility for disease monitoring and carcass removal, and increased wildlife viewing opportunities. Waterfowl loafing areas can be greatly enhanced by removing vegetation on islands and levees. As the use of prescribed burning has declined due to local air quality restrictions, disking has become a more frequent vegetation control option.

Disking is typically conducted during late spring, summer or early fall months when wetlands are dry. Target species/areas may be disked one or more times to ensure that roots are dead, reducing the need for more frequent treatments. Vegetation succession is set back in disked areas, and typically desirable moist-soil plants and open water areas replace the species that are removed. Multiple disk passes are sometimes necessary to break up large clods for optimal germination.

Circumstances dictate how much of an area will be disked. In most cases, a mosaic pattern is created, leaving equal proportions of emergent cover plants and open areas with annual moist-soil plants. The amount left undisked may be altered if special needs for certain species are identified (Mensik and Reid 1995). Examples include leaving more emergent vegetation in units that have historical use by colonial nesting birds such as tricolored blackbirds or white-faced ibis, or less vegetation in units that support large numbers of open water species such as pintails or shorebirds. In cases of widespread problem vegetation, sometimes the most cost-effective treatment is for the majority of a unit to be disked realizing that the benefits will last a minimum of 3-5 years (Mensik and Reid 1995).

Disking is rarely used in upland areas, as ground disturbance typically results in invasions or expansions of non-native species. However, it is sometimes used to prepare native habitat restoration sites, including riparian forest and perennial grasslands.

MOWING

Mowing is used to control a variety of invasive species, enhance wetlands, reduce fire risk, and to accomplish general weed maintenance around facilities. It is conducted with a tractor pulling a large mowing implement, but may also be accomplished with smaller equipment such as push mowers or string trimmers.

In wetlands, mowing is a primary tool for controlling cocklebur that can be invasive and overtake seasonal wetlands and crowd out more desirable species (Mensik and Reid 1995). By mowing prior to plants setting seed, or in combination with short-term irrigations afterwards, cocklebur can be kept under control. This treatment results in a greater diversity of desirable species, while reducing the need to use herbicides. Mowing is also used for keeping islands and selected sections of levees clear of vegetation to provide optimal loafing and resting sites for waterfowl, shorebirds, and other wildlife. Whenever possible, mowing is used instead of disking in order to minimize ground disturbance, erosion, and invasive species expansion.

Some invasive vegetation in upland habitats is also managed with mowing, although burning or grazing are preferred in most cases. Yellow starthistle and non-native grasses such as annual ryegrass can be significantly reduced by mowing, but timing is critical and multiple applications may be necessary (Thomsen et al. 1997).

A number of roads, levees, and areas around buildings and other facilities are mowed during the spring and summer to minimize risk of wildfires by allowing safer access for habitat management tasks (i.e. checking water control structures), conducting biological surveys, and general maintenance.

WATER MANAGEMENT

Water management is the most important tool for vegetation enhancement and control in managed wetlands. The timing, depth, and duration of flooding can be manipulated to enhance desirable moist-soil plants and also to reduce certain undesirable species. Short-term irrigations (7-10 days) conducted in the spring and summer can greatly increase the amount of moist-soil plant seed production (Naylor 2002) and vegetative stature in managed seasonal wetlands. One irrigation is usually all that is necessary to bring seedling plants to maturity in the Sacramento Valley.

Cocklebur, an undesirable and sometimes common species in seasonal wetlands, is particularly susceptible to control by flooding. As with many desirable species such as watergrass or smartweeds, cocklebur seedlings germinate on seasonal wetland pond bottoms as they dry in spring. By reflooding the wetlands when cocklebur plants are at the seedling stage, entire cohorts of cocklebur can be eliminated while at the same time encouraging the growth of desirable species that are better adapted to aquatic habitats (i.e. watergrass, smartweeds). The amount of time the water is held depends on when the cocklebur is blackened and disintegrating, indicating death. This can take one to three weeks, depending on the weather and how deep the seedlings are flooded. Considering annual climatic variation and wetland drawdown date, this technique can be used as early as March or late as June. It is extremely efficient and cost-effective when compared to other methods. However, prolonged irrigations (e.g. longer than necessary to kill the cocklebur), can cause species such as Bermuda grass, jointgrass, or cattails to expand, resulting in decreased overall productivity for wildlife, plus the need to control those species. An additional result can be potentially unacceptable levels of mosquito production, which may be a human health issue in some areas.

PRESCRIBED LIVESTOCK GRAZING

Historically, grazing by native wildlife species has shaped the botanical and zoological resources of the California landscape (Edwards 1992, 1996). Currently, well managed livestock grazing is an important method of vegetation management (Barry 2003; Griggs 2000) on the Refuges. Benefits associated with the grazing program include: the reduction of plant material; reduction in non-native invasive weeds (Thomsen et al. 1993); increases in native plants, including special status plant species due to reduced competition for sunlight, and with non-native annual grasses for water and nutrients (Coppoletta and Moritsch 2001; Davis and Sherman 1992; Menke 1992; Muir and Moseley 1994); increased primary production and resultant increases in plant biomass (McNaughton 1985); increases in native vernal pool and grassland wildflowers (Marty 2004, 2005), with consequent increases in macro-invertebrate populations, including native pollinators of native plants, and prey items for Refuge wildlife such as migratory land birds like the horned lark and savanna sparrow; and increases in the inundation period with habitat benefits to vernal pool crustaceans (Pyke and Marty 2005). Grazing provides optimal shorebird and sandhill crane foraging habitat by reducing grass height and contributing organic matter for the prey base (Colwell and Dodd 1995; Knopf and Rupert 1995) and also provides short, nutritious grasses for grazing migratory waterfowl (Buchsbaum et al. 1986) and local deer. Aquatic invertebrates, insects, and special status species associated with vernal pool and vernal pool/alkali meadow complexes benefit from grazed herbaceous habitats (Bratton 1990; Bratton and Fryer 1990; Panzer 1988; Germano et al. 2001), especially cattle grazing (Marty 2004, 2005). Grazed areas support increased numbers of primary burrowing mammals such as California ground squirrels and secondary burrowing animals such as burrowing owls and various snakes.

Long-term benefits from the grazing program include continued annual native plant production, non-native invasive plant species control, and maintenance of annual or seasonal use of Refuge habitat by migratory birds and resident deer herds. Periodic grazing can also lessen the threat of wildfire near rural structures and agricultural industrial facilities. Overall, the short-term impacts of seasonal grazing on local ground-nesting birds and some small mammals would be mitigated by the long-term improvements to Refuge plant species composition and structure, native plants and overall wildlife habitat quality that would benefit migratory birds, resident deer herds and nesting habitat condition.

Grazing is facilitated through a Cooperative Land Management Agreement (CLMA) or Refuge SUP with a local cooperator. Depending on species to control and wildlife objectives, cattle, sheep, or goats may be used. Benefits of the CLMA program are the cooperator's shared responsibilities in maintaining corals, fences, gates, water systems, and vegetation management/invasive weed control.

HERBICIDES

Due to differences in species susceptibility and the variety of habitats within the Complex, a number of potentially available herbicides are necessary in order to choose the one that is most effective for a particular species in a particular environment. Examples of considerations in making these choices are: 1) some herbicides are very effective on some species, but completely ineffective on others (this is often related to the growth form of the plant, such as a grass, shrub, or tree; or a perennial rhizomatous species versus a small annual species); 2) using a broad-spectrum (kills many species of grasses, other monocots, and broad-leaved plants) versus a broadleaf-specific herbicide; and 3) using a herbicide or herbicide formulation approved for use in aquatic areas versus those approved for use just on terrestrial sites.

There is a process for using herbicides on the Refuge that includes development and approval of PUPs. PUPs are developed by Refuge staff, and then reviewed by appropriate Service staff. Depending on the product/chemical proposed, PUPs can be approved at the Refuge Manager level, or some products require review and approval by Service IPM specialists at the regional or national level. PUPs must also be consistent with other Service and DOI policies, including National Environmental Policy Act (NEPA) and Endangered Species Act (ESA). Table 10 indicates the federally listed species and their habitats on the Complex. Conditions specified in PUPs include application methods, rates, and timing; maximum number of applications allowed per season; and measures to be taken to avoid sensitive areas. With an approved IPM plan, PUPs can be valid for up to five years.

Currently, seven herbicides have been approved for use at the Complex. Summarized below is specific information regarding each chemical, including product names, how they work, and potential risks to the environment. Appendix 2 summarizes properties, behaviors, persistence, and toxicities of commonly used herbicides. For a more in-depth discussion of the properties of these products, see The Nature Conservancy Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas – Chapter 7 (Tu et al. 2001) and the Herbicide Handbook Eighth Edition (Vencill 2002).

2,4-D

Common name: 2,4-D
Chemical name: 2,4-Dichlorophenoxyacetic acid
Common product names: Weedar 64, Weedone

2,4-D is the most widely used herbicide worldwide and has been used for over 50 years. 2,4-D is a plant hormone (auxin) mimic that kills the plant by causing rapid cell division and abnormal growth. It is a systemic herbicide and can be absorbed through the roots, although it is most often applied to foliage. Depending on the formulation, 2,4-D is recommended for control of terrestrial and aquatic broadleaf weeds with little or no activity against grasses. Salt formulations are registered for use against aquatic weeds, but ester formulations are toxic to fish and aquatic invertebrates. The World Health Organization (1984) concluded that 2,4-D does not accumulate or persist in the environment.

AMINOPYRLID

Common name: Aminopyrlid
Chemical name: 2-pyradine carboxylic acid, 4-amino-3,6-dichloro-2-pyradinecarboxylic acid
Common product names: Milestone

Aminopyrlid is an auxin growth regulator used to control susceptible broadleaf weeds, including Russian knapweed and yellow starthistle, at very low labeled use rates compared to other herbicides with the same mode of action. It translocates throughout the entire plant and accumulates in the meristematic tissues, including the roots, disrupting plant growth metabolic pathways and affecting the growth process of the plant. Broad-leaved species are controlled with little or no injury to cool- and warm-season grasses. It has great potential for use at the Complex due to its low toxicity to animals (practically non-toxic to birds, fish, honeybees, earthworms, and aquatic invertebrates), non-volatile formulation, and low use rates. Milestone™ is registered under the U.S. Environmental Protection Agency (EPA) Reduced Risk Pesticide Initiative. This program is reserved for compounds that demonstrate lower risk to humans and the environment than other available alternatives. It has also demonstrated a low risk of resistance development compared to herbicides with other modes of action.

CHLORSULFURON

Common name: Chlorsulfuron
Chemical name: 2-chloro-N-[(4-methoxy-6-methly-1,3,5-triazin-2-yl) aminocarbonyl] benzenesulfonamide
Common product names: Telar

Chlorsulfuron is used as a pre- and post-emergent herbicide to control a variety of weeds on cereal grains, pasture and rangeland, industrial sites, and turf grass. It controls many broadleaf weeds including Russian thistle, and mustards. It is the only herbicide that effectively controls perennial pepperweed (Young et al. 1998), which is a common invasive species of concern at the Complex. Chlorsulfuron is rapidly absorbed through both leaves and roots. It inhibits a key enzyme in the biosynthesis of certain amino acids. Plant death occurs from events that take place in response to the enzyme inhibition, but the actual sequence of processes is unclear.

Chlorsulfuron is likely to be persistent and highly mobile in the environment. It is not for use in aquatic sites. It is practically nontoxic to freshwater fish, birds, mammals, and honeybees on an acute exposure basis (Environmental Protection Agency 2005). The EPA determined ecological risks to be low except for non-target plants; and therefore, the agency requires that it be applied in a manner that minimizes spray drift.

CLOPYRALID

Common name: Clopyralid
Chemical name: 3,6-dichloro-2-pyridinecarboxylic acid, monoethanolamine salt
Common product names: Transline

Clopyralid is an auxin-mimic type herbicide. It is used to control broadleaf weeds, but is more selective than some other herbicides using the same mode of action. Clopyralid has little effect on grasses and other monocots, but also does little harm to mustards and several other groups of broadleaf plants. It is effective on members of the sunflower (Asteraceae), legume (Fabaceae), nightshade (Solanaceae), knotweed (Polygonaceae), and violet (Violaceae) families. Clopyralid has been used on yellow starthistle with excellent control at low rates when used on seedlings prior to bud stage.

Clopyralid is considered non-toxic to fish, birds, mammals, and other animals; however, it is relatively persistent in soil, water, and vegetation making it potentially highly mobile and a contamination threat to water. Although of low toxicity to mammals, direct contact with the eye can cause severe eye damage including permanent impairment.

GLYPHOSATE

Common name: Glyphosphate
Chemical name: N-(phosphonomethyl)glycine
Common product names: Rodeo, Aquamaster, Aquaneat, Roundup, Buccaneer, Alecto

Glyphosphate is a broad-spectrum, nonselective, systemic herbicide that kills or suppresses many grasses, herbaceous plants, brush, vines, shrubs, and trees. Applied to foliage, it is absorbed by leaves and rapidly moves through the plant. It can also be applied to green stems and cut-stems (cut-stumps), but cannot penetrate woody bark. It tends to accumulate in plant regions with actively dividing cells and acts by preventing the plant from producing several essential amino acids. This reduces the production of protein in the plant, and inhibits plant growth. Roundup and equivalent formulations are approved for terrestrial sites only. Rodeo and equivalent formulations are approved for aquatic use. Glyphosate by itself is essentially non-toxic to submersed plants. It is the adjuvants (surfactants) often sold with glyphosate that may be toxic to aquatic plants and animals and these formulations are not registered for aquatic use. Aquatic-approved glyphosate is used to control water primrose (*Ludwigia* sp.), non-native watermilfoils (*Myriophyllum* sp.), and other weeds in or near water. Application timing is critical for effectiveness on most broadleaf plant species.

Because glyphosate is a nonselective herbicide, extra care must be taken to prevent it from being applied to desirable, native plants. Glyphosate by itself is of low toxicity to mammals and earthworms; and is practically nontoxic to birds, fish, aquatic invertebrates, and honeybees. The chemical is essentially immobile in soil and is readily degraded by soil microbes (Environmental Protection Agency 1993). When used as an aquatic herbicide in non-flowing water (e.g. ponds, lakes), only ⅓ to ½ of the water body should be treated at any one time to prevent fish kills caused by dissolved oxygen depletion.

IMAZAPYR

Common name: Imazapyr
Chemical name: (±)-2-[4,5-dihydro-4-methyl-4-(1-methlyethly)-5-oxo-1*H*-imidazol-2-yl]-3-pyridinecarboxylic acid
Common product names: Habitat, Stalker

Imazapyr is a broad-spectrum herbicide that controls annual and perennial grasses, broadleaf weeds, and woody species. It kills plants by inhibiting the production of certain amino acids, which are necessary for protein synthesis and cell growth. It is relatively slow acting, does not readily break down in the plant; and therefore, is particularly good at killing large woody species such as saltcedar. It is also effective on giant reed. Some formulations (e.g., Habitat) are approved for aquatic use. Habitat is a low-volume herbicide; it is effective at low rates of the active ingredient, thereby reducing the chemical load on the environment.

Because imazapyr is a broad-spectrum herbicide that is relatively persistent in soil, care must be taken during application to prevent accidental contact with non-target species. A few studies have reported that imazapyr may be actively exuded from the roots of legumes (such as mesquite), likely as a defense mechanism by those plants and this exudate may therefore adversely affect the surrounding desirable vegetation. Imazapyr is of relatively low toxicity to mammals, birds, fish, and invertebrates, but some formulations (inert ingredients in Chopper and Stalker) can cause severe, permanent eye damage in humans.

TRICLOPYR

Common name: Triclopyr
Chemical name: 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethel ester
Common product names: Garlon 4, Garlon 3A

Triclopyr is a selective systemic herbicide used to control woody plants and broadleaf weeds. It has little or no effect on grasses, but is particularly effective on woody species like saltcedar with cut-stump or basal bark treatments. Triclopyr controls weeds by mimicking a plant hormone and causing uncontrolled growth that leads to plant death. It may be mixed with picloram, clopyralid, or with 2,4-D to extend its utility range.

There are two formulations of triclopyr – a salt and an ester. Both formulations are relatively non-toxic to terrestrial vertebrates and invertebrates, but the ester formulation is extremely toxic to fish and aquatic invertebrates. The ester is also highly volatile and must be applied at cool temperatures and on days with little wind. The salt formulation (e.g., Garlon 3A) cannot readily penetrate plant cuticles so is best used in a cut-stump treatment or with a surfactant. This formulation can also cause severe eye damage.

ADJUVANTS

An adjuvant is any compound that is added to a herbicide formulation or tank mix to facilitate the mixing, application, or effectiveness of that herbicide. Spray adjuvants often improve spray retention and absorption by reducing the surface tension of the spray solution, allowing the spray droplet to spread more evenly over the leaf surface. Herbicide absorption may be further enhanced by interacting with the waxy cuticle on the leaf surface. They are sometimes included in the formulations of herbicides (e.g. Roundup), or they may be purchased separately and added into a tank mix prior to use (Tu et al. 2001).

Adjuvants are chemically and biologically active, not chemically inert, compounds. Some adjuvants have the potential to be mobile and pollute water. The Material Safety Data Sheet (MSDS) for an adjuvant and the herbicide label (if the adjuvant is included in the formulation) should be checked for conditions in which the adjuvant should not be used. At the Complex, Agri-dex is a non-ionic adjuvant that is commonly used with glyphosate for some terrestrial and aquatic applications.

RESTORATION OF NATIVE SPECIES

Where appropriate, native vegetation is restored using a variety of grasses, forbs, shrubs, or tree species depending on habitat and wildlife objectives (USFWS 2005a, 2008). A combination of the above vegetation management techniques may be used for weed control in preparation for re-establishing (cultivating) native species. Planting seeds, plugs, and cuttings are the most common methods for establishing native vegetation that will, often with some management, out compete non-native species over the long-term. The use of local genetic stocks for any plantings helps to increase the chance of success. Restoration sites typically use farm-style irrigation systems for the first several years.

Table 14 summarizes current preferred treatments for initial control and maintenance control of selected invasive and undesirable species at the Complex.

Table 14. Potential control methods and order of preference considered for use on selected invasive species at Sacramento National Wildlife Refuge Complex.

	Control Method/General Order of Preference[1]					
	Initial Control			Maintenance Control		
Species	1	2	3	1	2	3
Annuals						
Yellow starthistle	herbicide - 2,4-D or clopyralid	burning	mowing	native species restoration	grazing	mowing/haying
Prickly lettuce	herbicide - 2,4-D or other broadleaf	-	-	native species restoration	grazing	-
Cocklebur	scalding	mowing	herbicide - 2,4-D or other broadleaf	scalding	mowing	-
Perennial pepperweed	herbicide - chlorosulfuron	-	-	grazing - cattle, sheep, or goats	herbicide - chlorosulfuron	-
Russian thistle	herbicide - glyphosate	-	-	Hand-pulling	herbicide - glyphosate	-
Bindweed	herbicide - 2,4-D	disking	-	native species restoration	herbicide - 2,4-D	-
Black locust	herbicide - glyphosate or triclopyr	-	-	native species restoration	herbicide - glyphosate or triclopyr	-
Parrot's feather	raking and removal	herbicide - glyphosate or 2,4-D	-	raking and removal	herbicide - glyphosate or 2,4-D	-
Black walnut hybrid	herbicide - triclopyr	-	-	native species restoration	herbicide - triclopyr	-

	Control Method/General Order of Preference[1]					
	Initial Control			Maintenance Control		
Species	**1**	**2**	**3**	**1**	**2**	**3**
Common fig	herbicide - triclopyr	-	-	herbicide - triclopyr	-	-
Red River gum	herbicide - triclopyr	herbicide - glyphosate	-	native species restoration	herbicide - triclopyr	herbicide - glyphosate
Water primrose - aquatic areas	herbicide - glyphosate	raking, excavating	-	herbicide - glyphosate	raking, excavating	-
Water primrose - dry areas	disking	herbicide - glyphosate	-	disking	herbicide - glyphosate	-
Giant reed	mechanical-for small infestations	herbicide - glyphosate or imazapyr	-	mechanical-for young infestations	herbicide - glyphosate or imazapyr	-
Swamp-timothy/ African pricklegrass (in vernal pools)	hand pulling prior to seed-set	-	-	maintain natural hydrology of vernal pools	hand pulling prior to seed-set	-
Tall wheatgrass	herbicide - glyphosate	-	-	native species restoration	herbicide - glyphosate	-
Perlagrass	herbicide - glyphosate	-	-	native species restoration	herbicide - glyphosate	-
Non-native annual grass - general, inc. *Lolium*, *Bromus*, and *Hordeum* sp.	burning or grazing	mowing	herbicide - glyphosate (pre-restoration planting)	native species restoration	burning or grazing	mowing

	Control Method/General Order of Preference[1]					
	Initial Control			Maintenance Control		
Species	1	2	3	1	2	3
Bermuda grass	burning followed by disking	herbicide - glyphosate	disking alone - may require multiple passes	disking/water management	herbicide - glyphosate	-
Jointgrass	burning followed by disking	herbicide - glyphosate	disking alone - may require multiple passes	disking/water management	herbicide - glyphosate	-
Johnsongrass	herbicide - glyphosate	-	-	native species restoration	herbicide - glyphosate	-
Medusahead	burning	-	-	grazing	burning	herbicide - glyphosate
Water hyacinth	raking and removal	herbicide - aquatic glyphosate	-	raking and removal	herbicide - aquatic glyphosate	-
Sharp-leaved fluellin	herbicide - 2,4-D or other broadleaf	herbicide - glyphosate	-	native species restoration	grazing	-
Tree-of-heaven	herbicide - triclopyr	-	-	native species restoration	herbicide - triclopyr	-
Tamarisk/salt cedar	herbicide - triclopyr	-	-	bio-control beetle	-	-

[1] Additional specific information on formulations, application rates and methods, etc. can be found in the text of this document.

INTEGRATED PEST MANAGEMENT STRATEGY

The components of a successful IPM program include:

- Identification of pests and natural enemies.
- A monitoring and record keeping system for regular sampling of pest and natural enemy populations. Monitoring is an ongoing activity throughout any IPM program.
- Setting injury levels, or determining the size of the pest population correlated with an injury sufficient to warrant treatment. Setting action levels, the pest population size, along with other variables such as weather, from which it can be predicted that injury levels will be reached within a certain time if no treatments are undertaken.
- An integration of treatment methods that are effective against the pest, least disruptive to natural controls, and least hazardous to human health and the environment.
- An evaluation system to determine the outcome of treatment actions.

The ongoing monitoring of treatments and results of an IPM program is critical to the adaptive management approach. Information provided by the monitoring component shall be used to evaluate the effectiveness of treatment methods in light of site conservation goals. Managers shall use this information to adjust priorities, modify treatments, and improve planning and budgeting.

ASSESSMENT PROTOCOL

A prioritization strategy is necessary to effectively utilize the limited funds available to eradicate or control the many non-native species found throughout the 36,000-acre Complex. The following criteria, based on An Invasive Species Assessment Protocol (Morse et al. 2004), a collaborative effort of NatureServe and TNC, will be considered when assessing invasive species impacts and prioritizing target species and treatment sites:

- Ecological impact: impacts on native plant and animal populations, ecosystem processes, ecological community structure and composition; and the significance of those species and communities that are affected (i.e., rare, endemic, keystone, or threatened and endangered species; unique ecosystems).
- Current distribution and abundance: size of infestation, proximity to valuable resources, and diversity of habitats or ecological systems invaded.
- Trend in distribution and abundance: the potential for spread, especially to new, uninfested areas; the rate of spread; reproductive characteristics.
- Management difficulty: susceptibility to treatment/difficulty to control, accessibility of sites, potential for control methods to impact non-target species.

A high impact rank does not always translate into a high priority for treatment. Other considerations such as Refuge operations or earmarked funding can change priorities. For instance, a species that is difficult to manage will have a greater chance of causing significant damage, giving it a high impact rank. However, it may be that the difficulty is such that attempting to eradicate it is not the best use of limited funds. On the other hand, a species that may rank low in these areas could be a high priority for treatment if it is a new or small infestation and can be readily eradicated.

SACRAMENTO REFUGE COMPLEX HABITAT MANAGEMENT SYSTEM

The above IPM Strategy components and Assessment Protocol are considered and included in the annual habitat management process at the Complex. Overall Refuge management is determined, guided, and tracked by this same process (USFWS 2002). Among other information, vegetation control in general, and the control of invasive species in particular, are included in detail in annual habitat management plans (AHMP) that are generated for each Refuge. Identification of target species, their location, specified control methods, and monitoring of treatments is included in the plans. The planning cycle starts in the late winter/early spring. Refuges are toured by staff, during which time each management unit is visited and evaluated. Staff includes the refuge manager, biologist, work leader, irrigator, outdoor recreation planner, fire management officer, and law enforcement officer. Each unit is evaluated based upon what was planned for the year vs. what actually was accomplished in terms of management activities (e.g. water regimes, vegetation control, public use improvements, etc.), repairs (e.g. levee construction or replacement of water control structures), and the resulting habitat condition, wildlife use, or other resource data. Data and observations collected by all refuge programs are presented and discussed. Nearly all of this data is collected by unit, so it can be compared and evaluated in relation to past years and/or other units. Examples include vegetation species composition, wildlife survey data, disease mortality, wetland drawdown and flood-up dates, vegetation control measures conducted (i.e. prescribed fire, grazing, mowing and disking, irrigation, herbicide application, etc.), quality of public use opportunities (i.e. wildlife observation on tour routes, hunting success, etc.), and law enforcement issues. Information gathered and decisions made on the tours are then used to generate the next year's AHMP for each Refuge. The decisions made during this process also involve a number of other considerations including, but not limited to, Refuge purposes, Service management directives (i.e. Improvement Act), historic habitat conditions, other regional habitat plans (i.e. Central Valley Joint Venture Implementation Plan), Flyway management plans, endemic species conservation, endangered species recovery plans, and specific resource needs.

The end result is a modestly sized document that is distributed to all staff members to provide direction, and furnish a reference, as well as a place to keep notes on their respective programs and responsibilities. The AHMP identifies physical attributes of the unit, habitat objectives, specifies management activities to make any necessary repairs or improvements; emphasizes positive results from previous years; and notes special management considerations (i.e. presence of special status species or other significant wildlife use). The AHMP also includes a prioritization of management activities and projects based on the overall condition of the unit, which would include the degree to which invasive species were present or threatening other priority species. Data is maintained in a computer database, which serves to generate the AHMPs and can also be queried to evaluate a variety of biological data that is collected on the Refuges. In summary, the AHMP facilitates the adaptive management process for controlling invasive species, as well as other resource objectives. It allows for modification within or between years based upon changing conditions, serves as a place to input current data from all refuge programs to be considered together, and helps to ensure that informed management decisions are made.

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Appendix G. Resource Inventory and Monitoring Plan for the Sacramento National Wildlife Refuge Complex

Table of Contents

Figures

Tables

Introduction

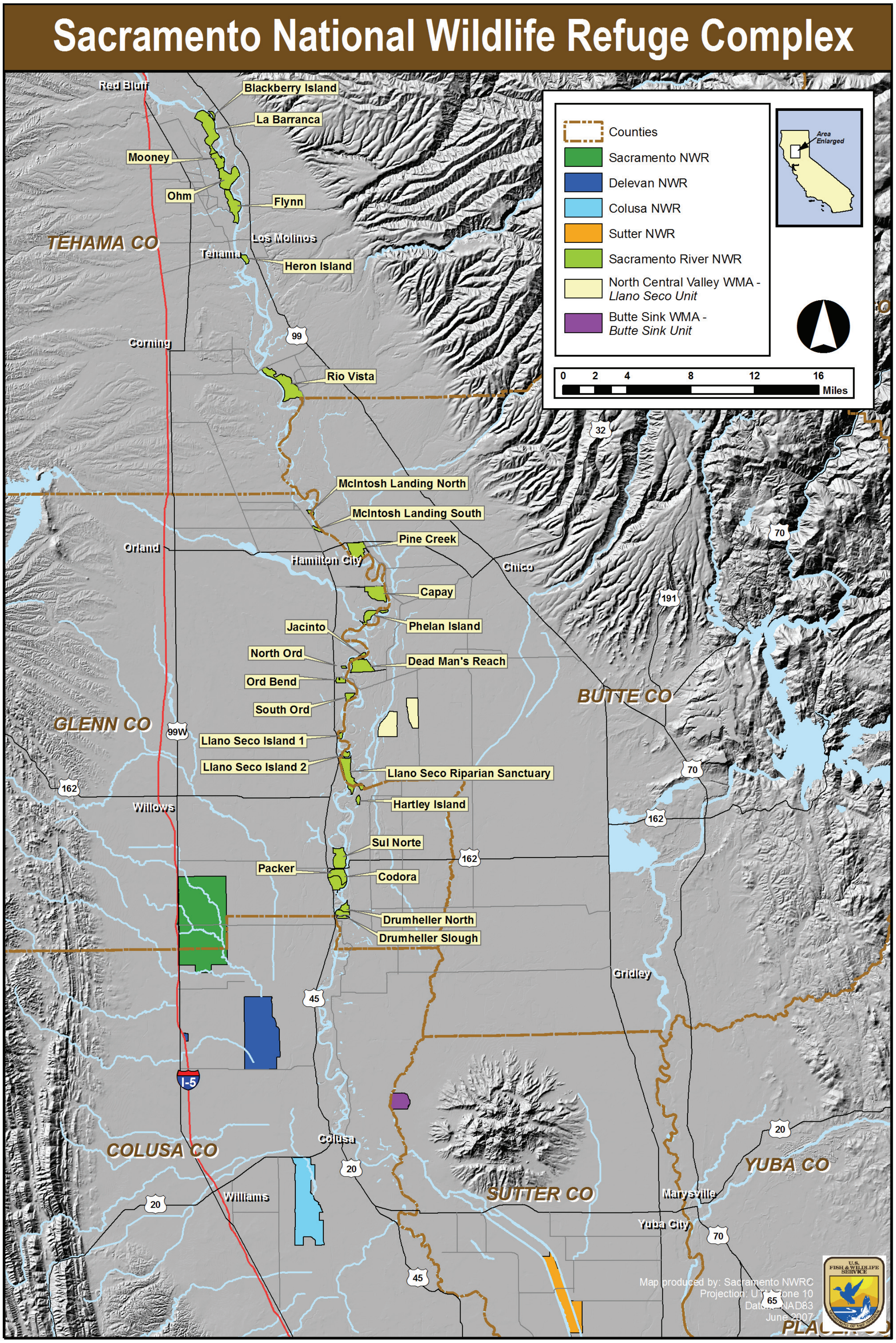
Sacramento National Wildlife Refuge Complex (Complex) includes five national wildlife refuges (Refuges) and three wildlife management areas (WMAs) in the northern Sacramento Valley. The Complex includes Sacramento, Delevan, Colusa, Sutter, and Sacramento River Refuges and Butte Sink, Willow Creek-Lurline, and North Central Valley WMAs (Figure 1). Wildlife and habitat resources at the Complex are inventoried or monitored through a variety of regular and special surveys and annual habitat management plans (AHMP). While some surveys are used to monitor resources on a Refuge or unit basis, others contribute to coordinated efforts to monitor populations on a Central Valley, State, Pacific Flyway, or National level. The objectives vary greatly, and, along with staff and available funding, determine the methodology, frequency, timing, and precision of the surveys. These may be coordinated with a number of agencies or other organizations, including but not limited to, other U.S. Fish and Wildlife Service (Service) offices, California Department of Fish and Game (CDFG), U.S. Geological Survey (USGS), Point Reyes Bird Observatory (PRBO), and universities. Some surveys or monitoring investigations are not regularly scheduled, but serve as important baseline data for management until new information becomes available. The objective of this document is to outline the current inventory and monitoring plan including the efforts that the Complex conducts, facilitates, or otherwise participates in. Table 1 summarizes the current surveys, schedules, geographic coverage, coordination, and reporting location of inventory and monitoring (I&M) surveys that the Complex participates in.

Regular Wildlife Surveys

Regular Wildlife Surveys (RWS) serve as an index to document wildlife population trends on the Complex (USFWS 1989-2007) and monitor wildlife use in relation to a variety of habitat management activities. Survey data for waterfowl or other relatively common species can be converted to density (i.e. ducks or geese per acre) and used to evaluate response to habitat management treatments (e.g. vegetation manipulation, water regime, water level management) or other factors that might affect bird use (e.g., disturbance levels from public use areas.).

RWS are conducted 1-2 times per month, depending on time of year. During September-April, when migratory bird populations are relatively great, surveys are conducted twice monthly. During May-August, when most wetlands are dry and migratory bird populations are relatively low, surveys are conducted once per month. On average, each Refuge takes about a day to complete. Surveys are conducted by experienced refuge biologists from a vehicle along standardized routes for each Refuge (Figure 1). When geese are present (i.e. September-April), surveys are started in mid- to late morning, after most geese have returned to roost on Refuges following morning foraging in agricultural fields. They are conducted from a pick-up or other full-size vehicle unless road conditions are wet, when an all-terrain vehicle (ATV) would then be used. The routes are designed to give viewing access to all management units within the Refuges. Numbers

Figure 1. Sacramento Refuge Complex map



of waterfowl, shorebirds, waterbirds, raptors, and a selection of other species are estimated and recorded for each unit (Figure 2 and 3). Depending on the magnitude of birds, totals for each unit are made by estimating numbers of individuals of each species or groups of like species (e.g. ducks, geese, or shorebirds) to the nearest 10,000, 5,000, 1000, 500, 100, 50, 10, or 1 bird. If estimates are made for groups of like species (e.g. total ducks), percentages of individual species are also estimated and applied to calculate numbers for each species. For each survey period, an attempt is made to complete a RWS for all individual Refuges within a week or less, ideally with consistent weather conditions. Waterfowl summary reports are generated for each Refuge and the Complex.

RWS data is maintained in hard copy in Refuge files and electronically as a component of the Complex Biological Database (see below).

Flyway-coordinated Waterfowl Surveys

These mostly annual surveys are conducted in coordination throughout the Pacific Flyway (Table 1). Depending on the individual survey, the Complex participates through conducting, coordinating, and/or summarizing results for various geographic segments. A combination of aerial and ground surveys are conducted. Currently, these surveys include the Special White-fronted Goose, Special Dark Goose, Special White Goose (including Snow/Ross's Species Composition every third year), Special Tule White-fronted Goose (both direct and indirect surveys), and Mid-winter Waterfowl Inventory. Aleutian Canada goose populations are also monitored annually on the Complex, but most specifically in the Colusa/Butte Sink area. In addition to population surveys, productivity surveys (ratios of juvenile and adults) are also conducted for Arctic-nesting geese, including lesser snow, Ross's, Pacific greater white-fronted, and tule greater white-fronted geese.

All surveys are summarized and submitted to the Service's Pacific Flyway Representative, for inclusion in the Pacific Flyway Data Book (Trost 2006), annual productivity reports (USFWS 2006), or other Flyway reports. Operational waterfowl banding efforts, both pre- and post-season, are conducted or facilitated annually, with all banding data kept in hard copy in Refuge files and reported to the USGS Bird Banding Lab.

Threatened and Endangered Species Surveys

Threatened and endangered (T&E) species are monitored through various surveys, depending on the species (Table 1). Population surveys for T&E vernal pool and alkali meadow plants are conducted by estimating the number of individuals at each vernal pool (or Refuge Tract or Pool for palmate-bracted bird's beak). Surveys occur in vernal pools, alkali meadows, and the tapered, shallow margins of some managed wetlands at Sacramento, Delevan, and Colusa National Wildlife Refuges (Refuges) (no suitable habitat exists on Sutter Refuge). Rare plant surveys are conducted up to four times annually to account for all T&E vernal pool and alkali meadow species (Silveira 1992-

2006a, b). Presence-absence surveys for vernal pool invertebrates are also conducted periodically (Silveira 2005). These data are maintained in Refuge files and are provided (annually) to the Sacramento Fish and Wildlife Office, Ecological Services, Endangered Species Division (T&E Permits, Sacramento Valley Branch, and Section 7) and the CDFG Habitat Conservation Planning Branch and, when new populations are discovered, California Natural Diversity Database in Sacramento.

Swainson's hawks, and greater sandhill cranes are monitored through RWSs (USFWS 1989-2007), but refuge staff also participate in periodic special coordinated surveys by CDFG and others (CDFG and UC Davis 2006). Yellow-billed cuckoos have only been monitored on Sacramento River and Sutter Refuges, which are the only Refuges with suitable habitat, through infrequent periodically coordinated surveys during the breeding season using tape-playback methodology (Isola 2000, Halterman et al. 2001).

Most of the monitoring information for giant garter snakes (GGS) was collected through USGS efforts between 1996 and 2005 (Wylie et al. 2006). A combination of mark-recapture and radio telemetry techniques was used to determine population estimates, habitat use, and response by GGS to wetland restoration at the Complex. These efforts have provided baseline information with associated management recommendations that are incorporated into annual habitat management plans. Incidental observations (see below) are recorded and site-specific surveys are conducted prior to projects that are planned to occur on or near GGS habitats.

Anadromous fish are not monitored on the Refuges on a regular basis. Salmon and steelhead use on Sutter Refuge is limited mostly to outmigrating juvenile salmon from Butte Creek or the Sacramento River during flood conditions within the Sutter Bypass. Adult fish migrate up the Sutter Bypass canals (considered part of lower Butte Creek), which are directly adjacent to the Refuge. There has been a very limited amount of sampling for juvenile salmonids in Sutter Refuge wetlands within the Bypass. Otherwise, anadromous fish monitoring is conducted elsewhere for the Sacramento River and Butte Creek systems.

Shorebirds

Shorebirds are surveyed with RWSs (see above), but also with special surveys periodically. Spring shorebird use on Sacramento Refuge was intensively surveyed for two years in 1997 and 1998. The data indicated significant differences in Refuge use during wet and dry springs, identified management units with the greatest shorebird use, and provided detailed habitat use by species information (Wolder et al. 1999). Coordinated surveys for shorebirds in the Central Valley were also conducted during 1992-1995, including the Refuges (Shuford et al. 1998).

Colonial Nesting Birds

Colonial nesting birds are monitored annually, via RWSs (see above) and additional special surveys. An attempt is made to assess size, reproductive success, and any problems for each colony. Species include, but are not limited to, great blue heron, great egret, snowy egret, cattle egret, black-crowned night-heron, white-faced ibis, and tricolored blackbird. Colony size (i.e. number of adults associated with a colony) are estimated with direct ocular estimates of birds on nests or by using early morning fly-off counts (ibis). This data is mostly maintained in the Complex's Biological Database and Refuge files, with some published summary reports or publications.

Breeding Bird Survey (BBS) Routes

BBS Routes provide data for a long-term survey coordinated by USGS throughout the country. Refuge staff currently conducts the Orland BBS route annually. The Glenn BBS route was also conducted by refuge staff until 1999. These data are submitted annually to USGS, who maintains the data and generates trend reports and data analyses periodically (Sauer et al. 2005).

Non-game Bird Surveys

Non-game bird surveys were collected for eight years on standardized routes on the four Refuges during 1986-1993 and serve as a baseline (Gilmer et al. 1998). These surveys could be repeated at some point in the future to evaluate trends on the Refuges.

Incidental Wildlife Observations

These are observations recorded by refuge staff opportunistically to document rare or unusual species, unusual concentrations of wildlife or plants, or species occurring at atypical times of year or locations. Observations are included from both on and the general vicinity of Refuges. Where, when, and for which species these data are collected are subjective and the amount of annual effort is not standardized in any way. Data for these observations are recorded in binders and entered into the Incidental Wildlife Observations table with the Complex's Biological Database.

Annual Habitat Management Plans

AHMPs are produced for each Refuge (Appendix E of the CCP, USFWS 2008), with the purpose of prioritizing, implementing, tracking, and adapting habitat management activities to meet resource objectives. The plans contain basic parameters of individual management units, including their total acreage, the acreage of each habitat type, and primary habitat objective. The information is summarized in a series of tables, schedules, prioritized work plans, and Refuge maps. AHMPs identify planned management activities, including water management (i.e. drawdown, irrigation, and flood-up dates), prescribed habitat treatments, special management considerations, and specific projects for a “biological year,” which is generally spring to spring. In late winter, staff members from the various Refuge programs, including managers, biologists, work leaders, irrigators, recreation planners, and fire management personnel visit each unit on each Refuge to review the previous year’s management plan and initiate the development of the upcoming year’s plan. In addition to being planning and implementation documents, AHMPs also function as monitoring surveys, having embedded datasheets for the collection of information on actual (compared to planned) water and vegetation management, specific project completion, and anecdotal data for any notable comments (e.g. reasons for differences in actual vs. planned management activities) or problems. Data is provided by the respective staff members (e.g., irrigators provide water management data, biologists provide wildlife and vegetation response data from surveys, work leaders track project work accomplishments, recreation planner provides public use data, etc.). All of the information is evaluated by the group (e.g. what was/was not effective, which projects were or were not completed) and used to develop the upcoming year’s plan. Plans are ideally completed sometime in the spring although interim wetland drawdown schedules/implementation is sometimes necessary while plans are being completed. All of the above refuge staff receives a copy of the plan for their area(s) of responsibility. The AHMPs are maintained as hard copies in Refuge files and electronically as a component of the Complex’s Biological Database (see below).

Periodic Vegetation Surveys

Periodic vegetation surveys are conducted to evaluate habitat management treatments in managed wetland units at the Refuges. Due to time constraints of collecting vegetation data for the great number of management units, these surveys often involve very basic visual estimates of percentages of cover by species. These surveys involve driving around individual units and walking out to specific areas in the unit to gain a clear view of the species and/or to verify the plant species identity.

The Region 1 Fire Effects Monitoring Program has facilitated more rigorous evaluations of prescribed burning at specific Refuge locations. Investigations of the effects of prescribed burning in alkali meadow vegetation at Sacramento and Colusa Refuges have also been conducted (Wight 2000).

Geographic Information System (GIS)

The Complex also maintains a GIS system that consists of a series of shapefiles that reflect past and current habitat types and infrastructure systems. The original shapefiles were created from acetate overlays on aerial photos (1:7920) in 1997, with subsequent updates created on top of USGS Digital Ortho Quarter Quadrangles (1998) and custom ortho-rectified aerial coverages flown in April 2004 (AirPhotoUSA). The purposes of these data sets are to provide georeferenced base map layers outlining Refuge and unit boundaries, hydrography, roads, hunt areas, public use facilities, and habitat categories.

They provide an effective tool to evaluate use and distribution patterns of wildlife and plant species within the Complex and general vicinity. Examples of GIS products include analyses of resource response to habitat management and public use activities, accurate locations for species observations, calculation of habitat types and features available for different species, and maps for AHMPs, habitat restoration/enhancement projects, biological reports, public use areas, and a variety of publications.

Refuge Narratives

Prior to 1996, much of the inventory and monitoring information was summarized in annual narrative reports generated for each Refuge (USFWS 1937-1995). Narrative reports are maintained at the headquarters office at Sacramento Refuge.

Data Storage and Maintenance

The biological staff at the Complex is responsible for maintaining I&M data. Most current data is maintained in both hard copy and electronic versions. Hard copy files include sections J (Resource Management), K (Wildlife), and L (Habitat Management) of the general filing system, which are located in the supervisory wildlife biologist's office. Additional scientific literature, including research investigations, reference books, scientific journals, graduate theses, agency reports, and a variety of other publications are located on shelves in the public use room, and can be searched using the Sacramento Refuge Library database (Microsoft Access file). Biological staff members also maintain a significant amount of reports, literature, and references in their individual offices in both hard copy and electronic formats.

Electronic data is maintained in the Complex's Biological Database (currently a Microsoft Access file), GIS, and a number of other Microsoft Excel and Word files at the headquarters office at Sacramento Refuge. Electronic data files are backed up on at least a monthly basis on a large portable hard disk that resides with the supervisory wildlife biologist.

Table 1. Surveys and other monitoring efforts currently conducted by Sacramento Refuge Complex staff[1].

Survey/ Monitoring Effort	Species	Time of Year/ Frequency	Geographic Area	Purpose	Agency Coordination[2]	Product
REGULAR WILDLIFE SURVEYS						
Regular Wildlife Surveys	Waterfowl, shorebirds, waterbirds, raptors, selected other birds and mammals	Twice monthly September-April; once monthly May-August	All Refuge units	Document and evaluate Refuge habitat use and management	Refuge Staff	summary reports
Instream Wildlife Surveys	Waterfowl, shorebirds, waterbirds, raptors, selected other birds and mammals	Quarterly	Sacramento River NWR	Document and evaluate Refuge habitat use and management	Refuge Staff	summary reports
PACIFIC FLYWAY-COORDINATED SURVEYS						
Tule greater white-fronted goose direct	Tule greater white-fronted goose	September/annual	Sacramento NWR Complex	monitor PF[3] population	USFWS, CDFG	summary report
Tule greater white-fronted goose indirect	Tule greater white-fronted goose	Fall-Winter/four survey periods annually	Sacramento NWR Complex	monitor PF population	USFWS, CDFG	summary report
Special White-front	all greater white-fronted geese	October/annual	Sacramento Valley	monitor PF population distribution	USFWS, CDFG	summary report
Aleutian Canada Goose	Aleutian Canada goose	Fall-Spring/annual	Sacramento NWR Complex & vicinity	monitor PF population distribution	USFWS	summary report
Special Dark Goose	all white-fronted geese, all Canada geese	November/annual	Sacramento Valley	monitor PF population distribution	USFWS, CDFG	summary report
Special White Goose	lesser snow goose, Ross' goose	December/annual	Sacramento Valley	monitor PF population distribution	USFWS, CDFG	summary report
White Goose Species Composition	lesser snow goose, Ross' goose	December/once every 3 years	Sacramento Valley	determine proportions of snow and Ross' geese in "white goose" population	USFWS, CDFG	summary report

Survey/ Monitoring Effort	Species	Time of Year/ Frequency	Geographic Area	Purpose	Agency Coordination[2]	Product
Mid-winter Waterfowl Index	all waterfowl	January/annual	Sacramento Valley	monitor wintering waterfowl populations and distribution	USFWS, CDFG	summary report
Arctic Goose Productivity	tule white-fronted goose, pacific white-fronted goose, lesser snow goose, Ross' goose	Fall/annual	Sacramento NWR Complex and vicinity	monitor annual productivity	USFWS	Flyway Report
Waterfowl Banding	mallard, other waterfowl banded incidentally	summer/annual	Sacramento NWR Complex	monitor PF survival and harvest rates	USFWS	Flyway Report
THREATENED AND ENDANGERED SPECIES SURVEYS						
Vernal pool and alkali meadow plants	palmate-bracted bird's beak, hairy orcutt grass, Greene's tuctoria, Hoover's spurge	spring through early fall/up to four times annually	Sacramento, Delevan, and Colusa NWRs	monitoring annual production and population trends	Refuge Staff	summary table
Vernal pool invertebrates	Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp	late winter-early spring/periodically-not every year	Sacramento, Delevan, and Colusa NWRs	determine presence/absence in particular pools	Refuge Staff	summary table
Regular wildlife surveys	Swainson's hawk, Greater sandhill crane	Twice monthly September-April; once monthly May-August	All Refuge units	Document and evaluate use of Refuge habitats and their management	Refuge Staff	summary reports
Yellow-billed cuckoo monitoring	Yellow-billed cuckoo and associated species	no regular survey schedule	Sutter NWR & Sacramento River NWR	Document occurrence and habitat use	USFWS, USGS	summary and status reports-see Isola 2000 and Halterman et al. 2001
Giant garter snake monitoring	Giant garter snake	no regular survey schedule	Sacramento NWR Complex	Document and evaluate use of Refuge habitats and their management	USFWS, USGS	summary report - see Wylie et al. 2006

Survey/ Monitoring Effort	Species	Time of Year/ Frequency	Geographic Area	Purpose	Agency Coordination[2]	Product
Bank Swallow monitoring	Bank swallows	June	Sacramento River NWR	Document and evaluate use of Refuge habitats	Refuge Staff CDFG	summary reports
OTHER SURVEYS						
Special surveys for colonial birds	white-faced ibis, herons/egrets, cormorants	May-August/variable based on occurrence	Sacramento NWR Complex	monitor reproductive effort and success on Refuges	USFWS	summary report
Special surveys for shorebirds	shorebirds, white-faced ibis	variable	Sacramento NWR Complex	monitor habitat use on Refuges or Central Valley	Refuge Staff, PRBO	see Shuford et al. 1998, Wolder et al. 1999
Special Tri-colored Blackbird	tri-colored blackbird	April-August/variable based on occurrence	Sacramento NWR Complex	monitor state population/ distribution, reproductive effort and success	USFWS, CDFG, PRBO	state summary report
Non-game birds	non-game bird species	no regular survey schedule	Sacramento NWR Complex	document relative abundance, habitat use, and population trends	USGS PRBO	summary report - see Gilmer et al. 1998, Small et al 2000.
Breeding Bird Survey-Orland Route	all birds	June/annual	specified route in Glenn County	monitor national bird trends	USGS	USGS report
Resighting Marked Birds	various waterfowl, shorebirds, or other waterbirds	variable	Sacramento NWR Complex and vicinity	indirect pop. estimates, survival rates, habitat use, migration patterns, etc.	USFWS, USGS, CDFG, CWS, PRBO, various universities	various
Additional surveys/research discussed in the Appendix O of CCP (USFWS 2005)	various	various	Sacramento River NWR	various	various	various

Survey/ Monitoring Effort	Species	Time of Year/ Frequency	Geographic Area	Purpose	Agency Coordination[2]	Product
HABITAT MANAGEMENT SURVEYS AND MONITORING						
Periodic Vegetation	various wetland and upland plants	variable	Sacramento NWR Complex	evaluation of vegetation response to management activities and target plant species composition and wildlife use objectives	Refuge Staff	annual habitat management plans
Water management	flood-up, irrigation, and drawdown dates; water level management[4]	year-round/periodic	Sacramento NWR Complex	monitor and refine strategies to meet vegetation composition and wildlife objectives in managed wetlands	Refuge Staff	annual habitat management plans
Vegetation management	mowing, disking, burning, spraying, or other vegetation management treatments[4]	year-round/periodic	Sacramento NWR Complex	monitor and refine strategies to meet vegetation composition and wildlife objectives in managed wetlands	Refuge Staff	annual habitat management plans

[1] Includes surveys that Refuge conducts, coordinates, facilitates, or otherwise participates in.
[2] USFWS=U.S. Fish and Wildlife Service, CDFG=California Department of Fish and Game, USGS=U.S. Geological Survey, CWA=Canadian Wildlife Service, PRBO=Point Reyes Bird Observatory.
[3] PF=Pacific Flyway.

Figure 2. Example of Standardized Wildlife Survey Route

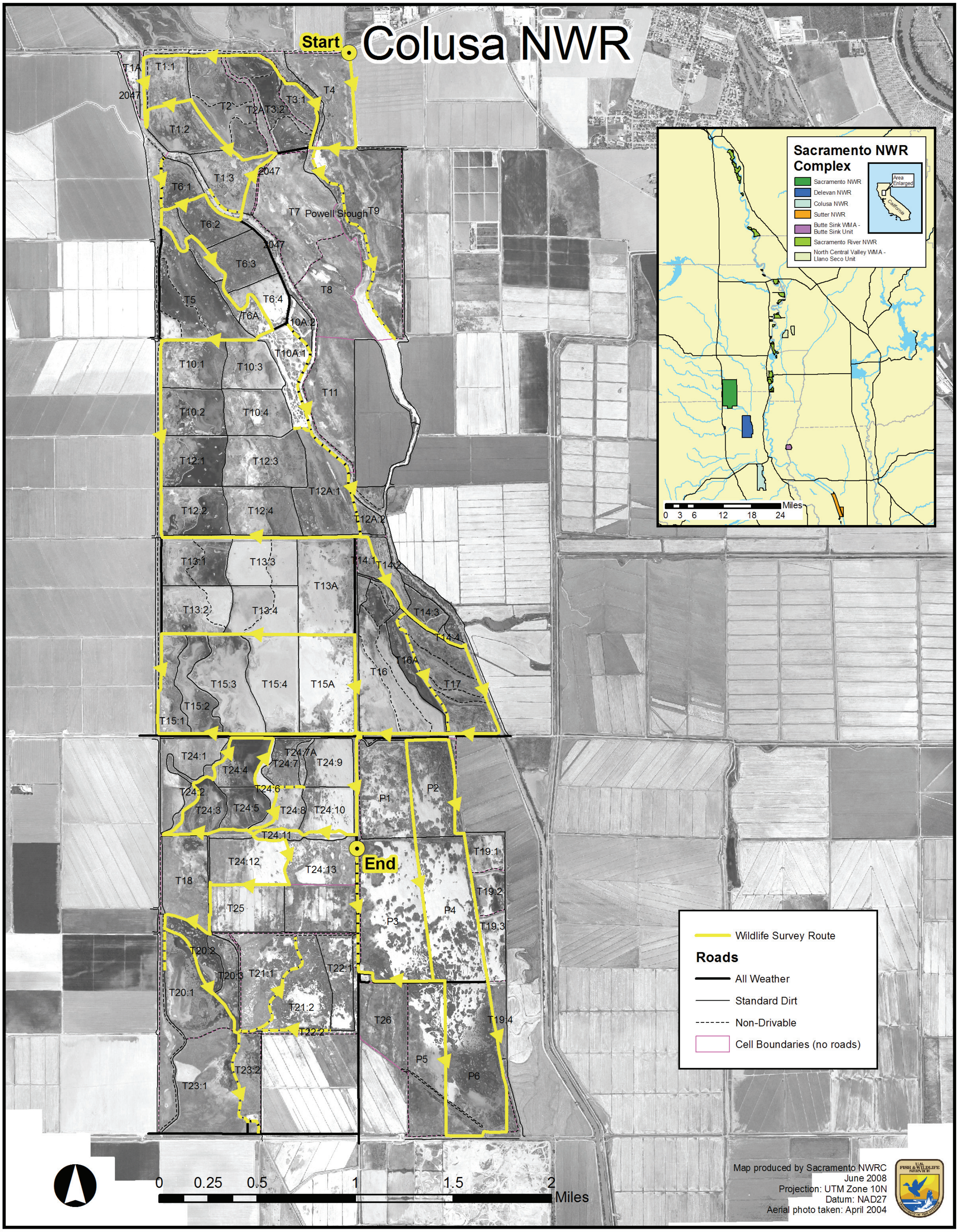


Figure 3. Example Waterfowl Survey Data Sheet

Colusa NWR Waterfowl Survey Data

Date____________ Time Start_______ End_______ Hunt Day?_____ Observer_____________

Temp.(F)_____ % Cloud_______ Wind Speed______ Direction________ Precip.________

Unit #	%FL	MAL	PIN	GAD	WIG	GWT	CT	SHOV	RN	RUD	OTH	CACK	WFT	SNOW/ ROSS	OTH	COOT
T1.1																
T1.2																
T1.3																
T2																
T2A																
T3.1																
T3.2																
T4																
T5																
T6.1																
T6.2																
T6.3																
T6.4																
T6A																
T7																
T8																
T9																
T10.1																
T10.2																
T10.3																
T10.4																
T10A.1																
T10A.2																
T11																
T12.1																
T12.2																
T12.3																
T12.4																
T12A.1																
T12A.2																
T13.1																
T13.2																
T13.3																
T13.4																
T13A																

Figure 3. Example Waterfowl Survey Data Sheet (continued)

Unit #	%FL	MAL	PIN	GAD	WIG	GWT	CT	SHOV	RN	RUD	OTH	CACK	WFT	SNOW/ ROSS	OTH	COOT
P4																
P5																
P6																
Powell Slough																
2047 Canal																
West Lateral																
J-Drain																
Total																
Page 1																
Page 2																
GRAND TOTAL																
%'s																

TOTAL DUCKS:________________ TOTAL GEESE: ________________

NOTES: ____

Figure 3. Example Waterfowl Survey Data Sheet (continued)

Unit #	%FL	MAL	PIN	GAD	WIG	GWT	CT	SHOV	RN	RUD	OTH	CACK	WFT	SNOW/ ROSS	OTH	COOT
P4																
P5																
P6																
Powell Slough																
2047 Canal																
West Lateral																
J-Drain																
Total																
Page 1																
Page 2																
GRAND TOTAL																
%'s																

TOTAL DUCKS:__________________ TOTAL GEESE: __________________

NOTES: ____

Figure 4. Example Wildlife Survey

Colusa NWR
Wildlife Survey Data

Date:______

T13.3	T13.2	T13.1	T12A.2	T12A.1	T12.4	T12.3	T12.2	T12.1	T11	T10A.2	T10A.1	T10.4	T10.3	T10.2	T10.1	T9	T8	T7	T6A	T6.4	T6.3	T6.2	T6.1	T5	T4	T3.2	T3.1	T2A	T2	T1.3	T1.2	T1.1	Unit
																																	killdeer
																																	black-necked stilt
																																	a. avocet
																																	greater yellowlegs
																																	whimbrel
																																	long-billed curlew
																																	western sandpiper
																																	least sandpiper
																																	dunlin
																																	dowitcher
																																	pied-billed grebe
																																	d-crested cormorant
																																	white pelican
																																	white-faced ibis
																																	great blue heron
																																	great egret
																																	snowy egret
																																	bl-cr. night-heron
																																	a. bittern
																																	herring gull
																																	turkey vulture
																																	white-tailed kite
																																	n. harrier
																																	cooper's hawk
																																	red-shouldered hawk
																																	red-tailed hawk
																																	a. kestrel
																																	peregrine falcon
																																	great horned-owl
																																	loggerhead shrike
																																	mourning dove
																																	black-tailed deer

Figure 4. Example Wildlife Survey (continued)

Colusa NWR
Wildlife Survey Data

Date:________

Unit	T13.4	T13A	T14.1	T14.2	T14.3	T14.4	T15.1	T15.2	T15.3	T15.4	T15A	T16	T16A	T17	T18	T19	T20.1	T20.2	T20.3	T21.1	T21.2	T22	T23.1	T23.2	T24.1	T24.2	T24.3	T24.4	T24.5	T24.6	T24.7	T24.7A	T24.8	T24.9
killdeer																																		
black-necked stilt																																		
a. avocet																																		
greater yellowlegs																																		
whimbrel																																		
long-billed curlew																																		
western sandpiper																																		
least sandpiper																																		
dunlin																																		
dowitcher																																		
pied-billed grebe																																		
d-crested cormorant																																		
white pelican																																		
white-faced ibis																																		
great blue heron																																		
great egret																																		
snowy egret																																		
bl-cr. night-heron																																		
a. bittern																																		
herring gull																																		
turkey vulture																																		
white-tailed kite																																		
n. harrier																																		
cooper's hawk																																		
red-shouldered hawk																																		
red-tailed hawk																																		
a. kestrel																																		
peregrine falcon																																		
great horned-owl																																		
loggerhead shrike																																		
mourning dove																																		
black-tailed deer																																		

Figure 4. Example Wildlife Survey (continued)

Colusa NWR
Wildlife Survey Data

Date:________

Unit	T24.10	T24.11	T24.12	T24.13	T25	T26	P1	P2	P3	P4	P5	P6	PS	2047	WL	JD	Total	Page 1	Page 2	GRAND TOTAL
killdeer																				
black-necked stilt																				
a. avocet																				
greater yellowlegs																				
whimbrel																				
long-billed curlew																				
western sandpiper																				
least sandpiper																				
dunlin																				
dowitcher																				
pied-billed grebe																				
d-crested cormorant																				
white pelican																				
white-faced ibis																				
great blue heron																				
great egret																				
snowy egret																				
bl-cr. night-heron																				
a. bittern																				
herring gull																				
turkey vulture																				
white-tailed kite																				
n. harrier																				
cooper's hawk																				
red-shouldered hawk																				
red-tailed hawk																				
a. kestrel																				
peregrine falcon																				
great horned-owl																				
loggerhead shrike																				
mourning dove																				
black-tailed deer																				

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Appendix H. Waterfowl Disease Contingency Plan

Table of Contents

Figures

Tables

Appendices

INTRODUCTION

Diseases in migratory and non-migratory avian species can be significant causes of mortality. Because of bird movement, disease can spread rapidly between areas and populations. Early detection and diagnosis of disease mortality is essential to initiating appropriate disease control to minimize bird loss during an outbreak. Because avian species do not recognize political boundaries, close communication between State and Federal agencies such as the California Department of Fish and Game (CDFG) and U.S. Fish and Wildlife Service (Service) is important in accomplishing the objectives of disease detection, diagnosis and control. Because of greatly reduced habitat acreage in the Central Valley, the Sacramento National Wildlife Refuge Complex (Complex) is an area of wildlife concentration. With peak wintering migratory bird populations of over three million, it has the potential for high transmission rates of some avian diseases.

The purpose of this plan is to outline surveillance and control operations that detect and address a number of wildlife diseases on the Complex. The Complex includes Sacramento, Delevan, Colusa, Sutter, and Sacramento River National Wildlife Refuges (Refuge or NWR) and Butte Sink, Willow Creek-Lurline, and North Central Valley Wildlife Management Areas (WMA) located in Tehama, Butte, Glenn, Colusa, and Sutter counties (Figure 1). Ultimate goals are to reduce wildlife disease losses and address any associated human health risks.

The Refuges consist mostly of managed wetlands, with much smaller areas of unmanaged wetlands, vernal pools, alkali meadows, grasslands, riparian forest, and other habitats (Table 1). Most Refuge wetlands are “artificially created and maintained”. That is to say, they are created using a series of levees and water control structures to maintain impoundments that are flooded and maintained with water delivered or diverted under various water rights. The delivered water on Sacramento, Delevan, and Colusa Refuges is provided by the Bureau of Reclamation (BOR) from the Sacramento River via the Glenn-Colusa Irrigation District (GCID) under the authority of the Central Valley Project Improvement Act (CVPIA). The majority of wetlands are seasonally flooded, with 10-15 percent managed as summer wetlands (Figures 6-9 of the Comprehensive Conservation Plan (CCP)(USFWS 2008)). A comprehensive list of plant and animal species can be found in Appendix K of the CCP. Descriptions of the habitats and their associated plant/wildlife species can be found in Chapter 3 of the CCP.

Figure 1. Sacramento National Wildlife Refuge Complex Map.

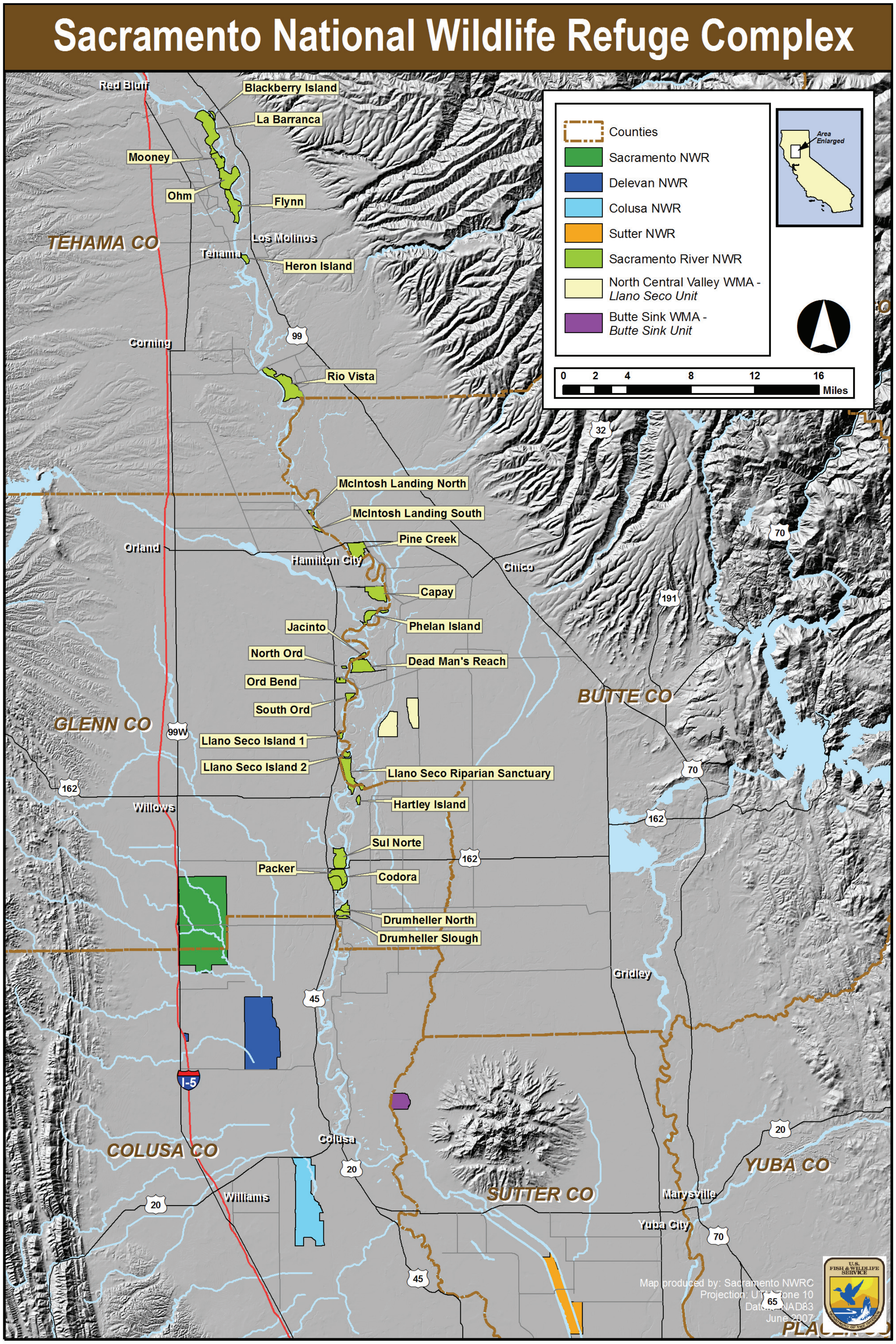


Table 1. Acreage and habitats of Sacramento National Wildlife Refuge Complex.

Refuge	Total[1]	Managed Wetlands[2]		Unmanaged Wetlands[2]	Vernal Pool/Alkali Meadow[2]	Irrigated Pasture	Grasslands[2,5]	Riparian Forest[2,6]	Other[2,7]
		Seasonally Flooded Wetlands[3]	Summer Wetlands[4]						
Sacramento	10,819	6,305	781	163	2,941	0	139	117	373
Delevan	5,877[8]	3,939	661	13	461	0	464	46	293
Colusa	4,686[9]	2,957	390	119	619	0	438	15	148
Sutter	2,591	1,708	173	45	0	0	226	403	36
Butte Sink	733	610	35	1	0	0	29	15	43
Llano Seco Unit	1,732	667	93	2	6	184	611	116	53
TOTAL	**26,438**	**16,186**	**2,133**	**343**	**4,027**	**184**	**1,907**	**712**	**946**

[1] Official Refuge acres.
[2] Acres calculated with GIS from 2006-07 annual habitat management plans.
[3] Includes irrigated and non-irrigated seasonally-flooded wetlands.
[4] Includes semi-permanent and permanent wetlands.
[5] Includes annual and perennial grasslands
[6] Includes mixed riparian forest, cottonwood, willow, willow scrub, and valley oak riparian forest.
[7] Includes roads, facilities, and other miscellaneous areas.
[8] Includes the 80-acre Rennick property.
[9] Includes 646 acres acquired under North Central Valley Wildlife Management Area.

Diseases

Avian botulism (Type C) and avian cholera are currently the two most common wildlife diseases that affect migratory birds on the Refuges. Botulism is generally a warm weather disease that usually occurs between July and October. Botulism spores from the bacteria *Clostridium botulinum* occur naturally in wetlands and can reproduce under the right environmental conditions including low oxygen levels and warm temperatures (Sandler et al. 1993, Rocke and Samuel 1999). These bacteria produce a powerful neurotoxin that affects the central nervous system of waterfowl and other waterbirds, resulting in paralysis and eventually death. During warm months, the disease can be spread rapidly through a carcass-maggot cycle involving maggots that have fed on carcasses, which concentrates botulism toxin in their bodies, and then are consumed readily by other birds to their demise (USGS 1999). Outbreaks during winter or spring months are possible, but are much less common and less severe in terms of mortality.

Avian cholera is typically a cold weather disease that occurs between the months of November and March. With cholera, the bacteria *Pasturella multocida* infects and directly attacks birds' internal organs and respiratory system. Recent studies indicate that cholera does not persist long in the environment, therefore, it is an unlikely reservoir for the bacteria (Samuel et al. 2004). Outbreaks are more likely started via carrier birds and transmitted primarily from bird-to-bird (Mensik and Samuel 1995, Samuel et al. 1999). While a wide variety of other wildlife diseases have been documented, or could potentially occur on the Refuges, botulism and avian cholera account for the majority of disease management operations.

For the last decade in the Sacramento Valley, reported annual mortality from botulism and avian cholera has decreased. This decrease may be related to wetland habitat restoration efforts, as well as increases in other waterfowl habitat (flooding of rice for straw decomposition) that have significantly changed waterfowl distribution in the Central Valley (Eddings and Eadie 2003, Fleskes et al. 2005).

Other diseases of significance and concern that have not yet been detected or have not been documented to affect many animals at the Refuges include West Nile Virus (WNV), Duck Viral Enteritis (DVE) and Avian Influenza (AI). WNV is a mosquito-borne disease commonly found in Africa, Asia, and the Middle East. It spread rapidly across North America beginning in 1999 and was first reported in California in 2002. It has been detected in 48 species of mosquitoes, over 250 species of birds, and at least 18 species of mammals, including humans.

DVE, or duck plague, affects only ducks, geese and swans and is caused by a herpes virus. Transmission can occur through direct contact with infected birds and by ingestion of contaminated food or water. Although DVE outbreaks have occurred in captive and feral waterfowl throughout North America, the only known duck plague outbreaks in wild waterfowl took place in Lake Andes, South Dakota in 1973 and the Finger Lakes in New York in 1993 (USGS 1999).

Avian Influenza (AI), or bird flu, is a disease caused by a virus that infects birds, including pets, domestic poultry, and wild birds. Since 2005, there have been specific concerns about one particular strain, the highly pathogenic Asian H5N1 (HPAI H5N1), based on outbreaks in Asia, Europe, Africa and the Philippines. There is concern that avian influenza could potentially reach North America from either Asia or Europe, possibly via inter-Flyway movements of migratory birds. Because of the potential for this disease to affect people, surveillance of migratory birds and their habitats throughout North America, has increased significantly since 2005 (Interagency Asian H5N1 Early Detection Working Group 2006, Pacific Flyway Council 2006, CDFG et al. 2006). Refuge staff have facilitated on-going HPAI H5N1 surveillance in live wild birds (primarily pintails), hunter-harvested birds, environmental sampling (fecal samples from loafing sites), and mortality events. To date, collectively over 250,000 samples have been collected and tested in North America, with no detections of HPAI H5N1. A HPAI H5N1 response plan flowchart is included in Appendix 1.

Additional information on wildlife diseases can be found in the Field Manual of Wildlife Diseases – General Field Procedures and Diseases of Birds (USGS 1999).

Past History of Disease

To some degree, botulism and avian cholera occur nearly every year on the Complex (Table 2). Typically, botulism losses are most numerous from August through October and avian cholera losses are more prevalent beginning in November and continuing through February. Table 3 shows the most common species affected by avian cholera and botulism on the Complex.

Table 2. Sacramento National Wildlife Refuge Complex disease carcass totals between 1980-2007.

Year	Avian Botulism									Avian Cholera								
	# Botulism Carcasses Collected									# Cholera Carcasses Collected								
	Sacra-mento NWR	Delevan NWR	Colusa NWR	Sutter NWR	Butte Sink NWR	Sacra-mento River NWR	Sac NWR Complex Totals	Outbreak Start	Outbreak End	Sacra-mento NWR	Delevan NWR	Colusa NWR	Sutter NWR	Butte Sink NWR	Sacra-mento River NWR	Sac NWR Complex Totals	Outbreak Start	Outbreak End
1980-81	1800	5900	0	0	0	-	7700	8/12/80	1/31/81	800	350	20	40	800	-	2010	11/3/80	2/25/81*
1981-82	185	43	0	0	0	-	228	8/10/81	11/15/81	832	975	182	550	47	-	2586	11/9/81	2/18/82
1982-83	46	369	0	409	0	-	824	7/29/82	12/30/83	450	437	220	198	143	-	1448	12/1/82	1/31/83
1983-84	14791	210	355	5549	45	-	20950	8/10/83	3/31/84	683	736	221	661	0	-	2301	12/1/83	3/31/84
1984-85	2806	19	31	31	0	-	2887	6/22/84	10/30/84	2238	262	86	627	960	-	4173	11/14/84	3/13/85
1985-86	590	7	19	9	0	-	625	7/16/85	10/31/85	2164	887	112	215	137	-	3515	11/14/85	1/21/86
1986-87	870	1184	6	0	0	-	2060	8/15/86	11/13/86	1262	222	138	87	1216	-	2925	11/1/86	3/2/87
1987-88	5633	46	0	4311	0	-	9990	8/8/87	4/13/88	1212	171	4	488	1454	-	3329	11/8/87	2/8/88
1988-89	83	0	71	0	0	-	154	7/26/88	11/3/88	1113	1291	359	359	315	-	3437	11/8/88	3/11/89
1989-90	1156	6	3	9	0	0	1174	7/7/89	11/9/89	1876	602	391	346	1618	0	4833	11/7/89	2/27/90
1990-91	13	768	0	5	1385	0	2171	8/10/90	11/20/90	1994	2146	1289	1917	1430	0	8776	11/8/90	2/19/91
1991-92	7	2	8	0	161	0	178	9/12/91	11/7/91	699	349	451	294	760	0	2553	10/24/91	2/6/92
1992-93	1	6	0	410	0	0	417	8/26/92	10/21/92	131	240	543	186	133	0	1233	11/16/92	2/10/93
1993-94	5	2	0	2280	3	0	2290	9/5/93	11/23/93	259	837	411	472	2412	0	4391	11/3/93	3/30/94
1994-95	6	21	256	41	16	0	340	8/24/94	11/7/94	121	448	78	179	3481	0	4307	9/23/94	3/7/95
1995-96	6	4	0	38	16	0	64	9/7/95	10/24/95	337	959	957	591	1867	14	4725	11/6/95	2/14/96
1996-97	1012	2439	317	1007	6	0	4781	8/19/96	3/12/97	25	263	163	801	11	45	1308	11/14/96	3/18/97
1997-98	43	52	0	0	4	0	99	7/31/97	11/13/97	262	101	259	637	360	417	2036	11/25/97	1/22/98
1998-99	105	998	0	13	6	0	1122	8/6/98	10/27/98	2510	1751	1814	1126	4140	277	11618	11/17/98	2/23/99
1999-00	491	10	4	107	0	0	612	8/17/99	11/5/99	616	502	987	476	1879	940	5400	11/23/99	2/10/00
2000-01	34	10	0	110	15	0	169	8/7/00	10/13/00	5	54	419	208	190	0	876	11/14/00	2/6/01
2001-02	390	30	3	154	5	0	582	7/28/01	10/23/01	0	0	0	165	0	0	165	1/30/02	2/21/02
2002-03	1	0	0	274	0	0	275	7/6/02	10/12/02	0	22	76	3	36	0	137	12/3/02	1/16/03
2003-04	114	156	0	274	0	0	544	7/8/03	10/27/03	1	0	7	13	227	0	248	12/9/03	2/13/04
2004-05	21	1582	0	0	0	0	1603	7/28/04	10/18/04	0	0	0	0	0	0	0		
2005-06	48	324	90	0	0	0	462	7/12/05	10/25/05	0	0	0	0	0	0	0		
2006-07	737	16	0	1	0	0	754	7/19/06	10/19/06	97	0	0	472	3239	0	3808	1/4/07	2/12/07

[1] Regular font indicates data from Refuge narrative or regional annual reports; bold font indicates from Refuge's biological database.

Table 3. Most common species affected by avian cholera and avian botulism (Type C) at the Sacramento National Wildlife Refuge Complex.

	Avian Cholera			Avian Botulism (Type C)		
	#1	#2	#3	#1	#2	#3
Goose	Snow	Ross's	White-fronted	White-fronted	-	-
Duck	Wigeon	Pintail	Ruddy	Mallard	Pintail	Shoveler
Other birds	Grebe sp.[1]	Gull sp.[2]	Snowy egrets	White-faced Ibis	White pelican	Pied-billed grebe
Coots	Coots	-	-	Coots	-	-

[1] Mostly pied-billed, with some eared.
[2] Mostly herring, with some ring-billed.

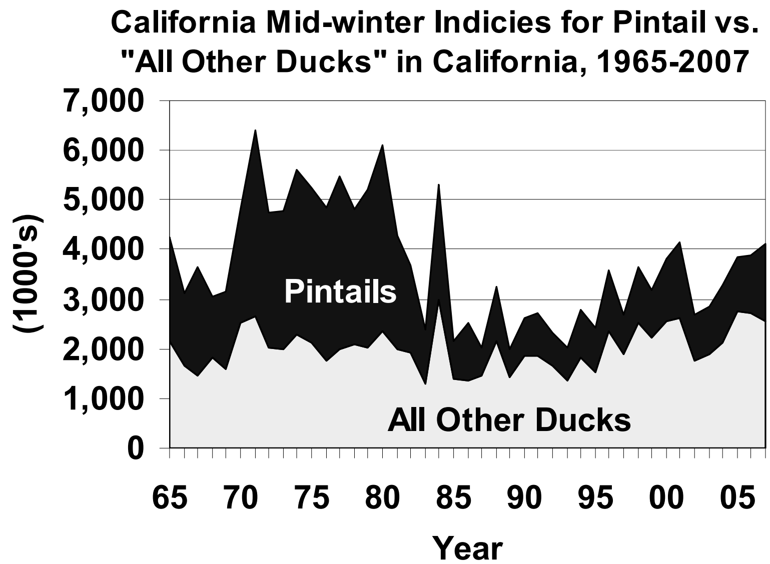
WILDLIFE POPULATIONS AND HABITAT USE

Pacific Flyway Waterfowl Populations

Historically, the Central Valley of California has been a major wintering area for Pacific Flyway waterfowl. Populations have fluctuated over the last century, with some species experiencing significant declines, others showing dramatic recoveries, and still others have shifted their distribution away from California. During the 1970s, California mid-winter waterfowl surveys, as indexed by the Mid-winter Indices, routinely estimated between 4 and 6 million ducks and 500,000 to 600,000 geese. Pintails comprised the majority of the ducks, outnumbering all other duck species combined.

Following the 1970s, extended droughts in the Canadian prairie breeding areas caused significant declines in breeding duck populations and duckling production. Changing agricultural practices in important Canadian prairie breeding areas was also likely responsible for decreased numbers of pintail following the 1970s droughts (CDFG et al. 2003). These declines were also reflected in wintering numbers in California's Central Valley. Comparatively, as indexed by the Mid-winter Indices (Figure 2), in the last 25 years wintering ducks in California (of which most are in the Central Valley) have fluctuated between 2 and 4 million ducks, including about 1 to 1.5 million pintails (USFWS 1955-2007).

Figure 2. California Mid-winter Indices (USFWS 1965-2007).



However, when the droughts in the prairies ended in the 1990s, while most other duck species showed significant increases, pintail showed only modest increases. There is evidence that changes in agricultural practices in the Canadian prairies initiated in the 1970s have negatively impacted the early nesting habitats of pintails, and are thought to be the primary reason for their lagging recovery (Miller et al. 2003).

In general, goose populations have undergone some significant changes and shifts in the last thirty years. Pacific white-fronted goose and cackling cackling goose (cackler) populations reached their lowest levels in the 1980s, due mainly to over harvest on both wintering and arctic breeding areas. Following the implementation of more restrictive harvest regulations, both these populations have rebounded dramatically. Recent estimates of Pacific white-fronts, on both their wintering and breeding grounds, indicate a population of over 500,000. Cackler populations have also increased and estimates now total 150,000-200,000 birds, but very few winter in California. Historically, about 90 percent wintered in the Central Valley and 10 percent in Oregon's Willamette Valley. Today, this distribution has essentially reversed, largely due to turf agriculture in Oregon attracting the bulk of wintering cacklers (Trost et al. 2007).

Aleutian cackling geese (Aleutian goose) represent another successful recovery story. On the brink of extinction with a population of approximately 800 birds in 1975, Aleutian goose numbers have rebounded to over 100,000 today (Trost et al. 2007). This has largely been the result of removing non-native predators and repopulating geese on their key breeding areas in the Aleutian Islands (Pacific Flyway Study Committee 1999, USFWS 1982). Once on the endangered species list, they were delisted in 2001.

"White goose" populations of lesser snow (snow) and Ross's geese in California have remained relatively stable to slowly increasing in recent years (Trost et al. 2007). Although the Pacific Flyway's wintering populations have not (yet) shown the dramatic increases seen in other goose species, there appears to be potential for future increases based on those occurring in most other North American white goose populations (USFWS 2001).

Populations at the Local Level

Despite both declines in waterfowl numbers and habitat, millions of waterfowl still concentrate in the Central Valley of California during the fall and winter. Duck and goose use during this period account for over 95 percent of all annual waterfowl use-days on the Refuges. Ducks breeding in areas to the north (mostly from Alaska and Western Canada) start migrating into the Sacramento Valley in August (initially pintails and green-winged teal), and by early October, hundreds of thousands of both ducks and geese are present. Many birds arrive via the Klamath Basin, one of the most important migration staging areas in the Pacific Flyway (Gilmer et al. 2004).

Presently, peak wintering waterfowl numbers in California occur during late November through January, when 3 to 4 million ducks and over a million geese have been present in recent years (USFWS 1955-2007). For perspective, together, the four Refuges have an average peak of over 1 million ducks and 300,000 geese. In some years, the four Refuges can exceed 1.5 million ducks and 300,000 geese (USFWS 1989-2007). The most common wintering duck species include northern pintail, mallard, American wigeon, green-winged teal, gadwall, northern shoveler, and ring-necked duck (Table 4). The most common goose species include lesser snow, Ross's, and Pacific and tule greater white-fronted geese. At certain times of the fall and winter, the majority of the Flyway's portion of the population of Pacific greater white-fronted geese will be present on the four Refuges (USFWS 1985-2006, Trost et al. 2007). Sacramento, Delevan, and Colusa Refuges comprise the core wintering area for tule greater white-fronted geese (Hobbs 1995).

Table 4. Regular waterfowl survey summary at Sacramento National Wildlife Complex, early December, 2006.

Refuge	Sacramento	Delevan	Colusa	Sutter	Butte Sink	Llano Seco	TOTALS
Coot	36,310	23,080	6,589	6,920	7,400	3,160	83,459
White-fronted goose	29,836	32,410	15,980	29,800	910	0	108,936
Snow/Ross's goose	147,460	78,600	39,940	68,830	68,000	0	402,830
Western Canada goose	30	160	0	0	0	185	375
Cackling Canada goose	8	0	222	0	0	0	230
Total Geese	**177,334**	**111,170**	**56,142**	**98,630**	**68,910**	**185**	**512,371**
Mallard	42,576	28,928	5,955	11,265	16,500	7,855	113,079
Pintail	426,060	169,780	32,478	41,540	387,375	80,335	1,137,568
Gadwall	38,919	30,354	8,574	3,615	16,675	1,985	100,122
Wigeon	50,595	59,810	24,426	8,725	197,650	45,770	386,976
Green-winged teal	64,700	94,450	14,480	4,784	64,825	980	244,219
Cinnamon teal	616	255	30	0	0	0	901
N. shoveler	34,899	37,555	17,446	6,151	17,575	3,195	116,821
Wood duck	2	0	64	352	0	0	418
Total Dabbling Ducks	**658,367**	**421,132**	**103,453**	**76,432**	**700,600**	**140,120**	**2,100,104**
Ring-necked duck	13,880	6,020	1,874	276	2,000	570	24,620
Ruddy duck	7,360	4,950	39	280	2,000	70	14,699
Bufflehead	273	390	184	191	20	155	1,213
Canvasback	30	0	0	0	0	0	30
other divers	0	0	0	2	0	0	2
Total Diving Ducks	**21,543**	**11,360**	**2,097**	**749**	**4,020**	**795**	**40,564**
Total All Ducks	**679,910**	**432,492**	**105,550**	**77,181**	**704,620**	**140,915**	**2,140,668**

Bird Movement Patterns

During the non-breeding period, there is a great deal of waterfowl movement from one basin to another within the Sacramento Valley, and even throughout the Central Valley (Fleskes et al 2005). The actual patterns vary from species to species and from month to month throughout the fall and winter. Hunting and weather influence these movement patterns.

Prior to the hunting season (August to mid-October), newly flooded and flooding habitat helps to hold birds on the Refuges, which helps to prevent depredation on private croplands. As private croplands are harvested and the food base on the Refuges (such as watergrass and smartweed) is consumed, birds begin to move off the Refuges to pick up leftover "waste" grain in rice fields. With the onset of the hunting season (mid-October - mid-January), most birds begin a pattern of resting and feeding on-Refuge sanctuaries during the day and feeding off-Refuge at night. Birds will start to disperse again following the hunting season.

Birds tend to disperse from the Refuges during periods of extensive precipitation, particularly if widespread flooding occurs. Fog also will alter distribution patterns of waterfowl throughout the Central Valley. When fog is present, generally birds will attempt to move into any areas where visibility remains, which can result in major local population decreases or increases on Refuges within a relatively short time span.

Weather Patterns

The region is characterized by mild wet winters and dry hot summers. Rainfall averages about 18 to 20 inches annually and occurs from November through April. Rain is unusual from June through September. A hard freeze is unusual and wetlands rarely ice up. Summer temperatures will frequently exceed 100 degrees and can reach up to 110-115 degrees. Droughts and extremely wet winters also occur, but it is unusual for these periods to extend beyond one or two consecutive years. In winter, valley fog is not unusual, sometimes persisting for several days at a time.

Habitat Use

Waterfowl use of the Refuges' habitat varies by species and includes many other factors such as water depth, ratio of open water to emergent vegetation, food availability, access to loafing sites, level of human disturbance, and tradition. Over 95 percent of the waterfowl that occur on the Refuges are dabbling ducks and geese, which all prefer relatively shallow water. Only 1 to 5 percent are diving duck species, which prefer deeper water. Species including pintail, wigeon, green-winged teal, and shovelers, prefer more open water, whereas mallards and gadwall will use wetlands with denser cover (Heitmeyer and Raveling 1988).

Seasonally flooded wetlands (including watergrass and smartweed units) contain abundant seeds and other vegetative food items (leaves, stems, tubers, etc.) produced from moist soil and other aquatic plants, and invertebrates (insects, spiders, crustaceans, etc.). They are diverse in the amount and distribution of emergent vegetation (bulrushes, cattails), and also contain bare islands, levees, and open shorelines that provide excellent waterfowl loafing sites. Not surprisingly, the majority of wintering waterfowl select this habitat type above all other managed wetlands (Table 1). Waterfowl survey data collected on the Complex indicates that seasonally flooded wetlands can support up to three times the densities of semi-permanent wetlands and ten times that of permanent wetlands (M. Wolder, unpublished data). Seasonal wetlands also support the greatest overall abundance and diversity of other migratory birds (shorebirds, wading birds, raptors, etc.). In managed wetland units with extensive emergent vegetation, it is typical that a series of lanes and openings are made prior to their scheduled fall flood-up. These openings are made by either disking or mowing, depending on the vegetation species, time of year, and available equipment. In addition to providing added habitat diversity and attractiveness for waterfowl in general, they allow for better visually monitoring and access to help detect sick or dead birds.

Semi-permanent and permanent (year-round) wetlands, while much less acreage, play an important role for breeding waterfowl, colonial nesting species (egrets, herons, ibis, tricolored blackbirds, etc.), giant garter snakes, western pond turtles, resident wildlife in general, and a number of other wetland dependent species during the summer months. They are also very important to molting waterfowl, single units sometimes supporting several thousand molting adult ducks. The wildlife that occurs on these units in the late spring and summer are very dependent on them since most other seasonal wetlands are dry. As a result, when disease outbreaks occur in these wetlands (usually botulism), there is little wildlife movement and certain species, sex, and age cohorts (such as molting adult female mallards) are vulnerable.

Managed wetland water supplies are mostly delivered (75 percent) and to a lesser degree diverted (25 percent) surface water by way of gravity flow through a network of delivery/drain ditches and series of water control structures. GCID delivers good quality CVPIA water from the Sacramento River to Sacramento, Delevan and Colusa Refuges under contract with the BOR. Additional supplies are diverted on both Sacramento and Colusa Refuges through various Refuge water rights. Sutter Refuge, the majority of which is located within the Sutter Bypass, has yet to receive any CVPIA water, and relies on diversions from a California Department of Water Resources weir in the east bypass channel for wetlands within the Bypass, and Sutter Extension Water District deliveries to wetlands outside the Bypass. Because the majority of the Sutter Refuge is located in a flood bypass channel, winter runoff and river overflows sometimes flood Sutter more than 10 feet deep for days or weeks at a time. According to studies in the 1980s, there is some degradation of water quality related to agricultural drainage in the region for diverted water supplies on all except Delevan Refuge (which has only delivered water). Additionally, elevated concentrations of some chemical constituents were detected in water, sediment and biological samples. These elevated concentrations were only slightly greater than Service guidelines for possible effects on wildlife (Dileanis et al. 1992).

Vernal pools are naturally flooded wetlands that are also heavily used once they fill during the winter and spring, especially by mallards, wigeon, green-winged teal, shovelers, and a variety of shorebirds (Bogiatto and Karnegis 2006, Silveira 1998). In addition, geese and wigeon will readily forage in adjacent alkali meadows and short grass uplands as soon as green browse is available in the fall (Silveira 1998, USFWS 1989-2007). Typically, disease outbreaks have not been an issue in these areas.

DISEASE PREVENTION, SURVEILLANCE, & MANAGEMENT

Knowing the history and patterns of disease outbreaks on the Complex helps focus efforts to minimize their risk and/or detect them at an early stage to minimize wildlife losses. Data from regular wildlife surveys (Chapter 3 of the CCP, USFWS 2008) indicate current populations and use by waterfowl and other species at the Refuge and management unit level. In addition, disease surveillance and carcass pick-up data is collected at the same level and summarized annually. Data from past years can be summarized to indicate outbreak histories for specific management units (i.e. outbreak detection and cessation dates, total losses, and effort spent monitoring/managing outbreaks), and thus, can be used to help predict future outbreaks and direct surveillance operations.

The following proactive prevention and management options are recommended to minimize outbreak risk or waterfowl mortality once an outbreak occurs:

Water Circulation

Increase water circulation in managed wetlands, especially those with disease outbreak histories. Water circulation may be increased during late spring through early fall to prevent stagnation and moderate high water temperatures that may be conducive to botulism outbreaks. The Refuges shall budget for this water in annual and monthly water delivery scheduling and requests.

Maintenance of Lanes in Heavily Vegetated Wetlands

Create lanes, areas where vegetation has been cleared, in at least 10 percent of heavily vegetated managed wetland units. Create lanes throughout the perimeter and interior areas that are evenly spaced, evenly distributed, and connected to each other. This is a standard management practice identified in Annual Habitat Management Plans. In some cases, construction of channels and potholes during habitat enhancement projects will "naturally" maintain these openings at a result of differences in water depth, and will not require annual disking or mowing.

Wetland Drainage

This option is for use only in extreme cases or when conditions are such that the impact to local wildlife populations is minimal and the disease loss potential is relatively great. An example of such a condition would be a permanent wetland that is receiving very little wildlife use and has had repeated botulism outbreaks in July. The risk of stranding a small number of animals (that may eventually succumb to botulism anyway) must be weighed by refuge staff against the impact of an ongoing outbreak spreading into newly flooded seasonal wetlands in the fall and potentially killing many more migrant birds (i.e. thousands of pintails and green-winged teal typically show up in early August). When considering long-term management of specific management units with frequent summer botulism outbreaks, maintaining them as semi-permanent wetland regime may be more beneficial than a permanent (year round) regime. Again, this option is not common, but has some use in specific situations.

Proactive Disease Monitoring in Wetlands

Wildlife disease monitoring shall be conducted throughout the year. Wetland units and other areas shall be inspected both regularly (specific surveys) and opportunistically (while conducting other field activities) for dead or sick animals. During months of greater outbreak probability, certain wetland types or even specific units with notable disease histories shall be surveyed by airboat to facilitate early detection (usually summer/early fall for botulism and by December for cholera). For example, summer botulism outbreaks commonly start in semi-permanent and permanent wetlands; as a result, monitoring efforts are focused there during the months of July and August. Cholera outbreaks typically do not occur prior to November and often follow or are associated with extended periods of cold weather. Presence and locations of increased numbers of scavengers such as turkey vultures, raptors, and herring gulls may also be used as indications of potential disease outbreaks, and are investigated as part of routine surveillance. Earlier detection of outbreaks give management response activities, such as carcass removal and habitat manipulations (which increase water circulation), a greater chance for success to slow an outbreak's rate of spread and minimize overall losses. Areas of waterfowl and coot population concentrations are vulnerable to outbreaks, and are monitored on a more frequent basis. During outbreaks, dead birds shall be located and removed using airboats, as necessary, to systematically cover all areas within a unit. Standard safety precautions shall be followed when picking up carcasses or conducting other disease surveillance (USGS 1999, USFWS 2006). Areas with historic outbreaks and those with relatively high bird concentrations (such as major day or night roost sites) shall be monitored closely. Species susceptibility shall also be considered. For example, white geese (both lesser snow and Ross's) and coots are more susceptible to avian cholera compared to other species. There is evidence that wood ducks are more susceptible to HPAI H5N1 relative to other duck species (Brown et al. 2006); therefore, areas with wood ducks concentrations shall be monitored regularly.

Disease monitoring visits are documented by management unit, recording date, disease type, number and condition of dead and sick animals observed and/or picked up (or not), and hours of effort used. Data is collected on special weatherproof data cards (Figure 3) and entered into the Complex's biological database. Surveillance continues until carcasses are no longer present.

In the event of an outbreak, the supervisory wildlife biologist and refuge manager are notified immediately. He/she initiates carcass removal operations and shipment of diagnostic specimens as appropriate. Based on the type and severity of the disease outbreak, appropriate contacts outside the Refuge-level are made (Appendix 2).

Carcass Removal

Once an outbreak has been detected and the causative agent confirmed, prompt pick-up and disposal of carcasses is essential in helping to control the potential spread of infectious disease by pathogens or toxins that may be present in or on carcasses. Botulism can spread rapidly through the well-documented maggot-cycle, and cholera from bird-to-bird contact; this is especially true in areas of high bird concentrations. Depending on severity, outbreak sites (management units) and adjacent areas are typically visited at least weekly until mortality ceases.

For small outbreaks confined to discrete easily viewed areas, carcasses are often removed by wading out and retrieving them. For areas of heavy vegetation, an airboat is usually the most efficient method to search for and pick up carcasses.

Diagnostic Specimens

When outbreaks are first detected, a sample of diagnostic specimens will be saved and shipped to the U.S. Geological Survey National Wildlife Health Center, in Madison, Wisconsin, where the carcasses are necropsied and tested to confirm the cause of death (USGS 1999). When appropriate, results are shared with other Service divisions (e.g. Regional Office, Law Enforcement, National Forensics Laboratory in Ashland, Oregon) and CDFG (e.g. Wildlife Investigations Laboratory at Rancho Cordova, game wardens). Confirming the disease at hand helps determine how the outbreak will be managed. There are reliable standard signs in the field that can indicate probable cause of mortality for several diseases (USGS 1999).

The most common diseases have been botulism and cholera, which continue to be managed annually with standard procedures (mentioned above). However, should an outbreak of HPAI H5N1 or like disease occur (to date there has not been an outbreak in North America), human health considerations would be much more intensive, and the situation would be handled very differently (Appendix 1). It is likely that the Incident Command System (ICS) would be used and personnel from a variety of agencies would be involved.

Carcass removal also offers opportunities to save (freeze) specimens for appropriate scientific or educational activities. Sometimes specimens of relatively rare species can be salvaged. Outbreaks during winter period can provide very high quality specimens in full breeding plumage. Local universities, the National Forensics Laboratory, or other sources may have beneficial uses for these otherwise destroyed carcasses. The remainder of the carcasses that are not used for diagnostic or educational specimens are incinerated.

Figure 3. Disease surveillance data card (front side).

DISEASE PICK-UP DATA

Refuge_______________ Unit____________ Cell___________ Date______________

Crew_______________________________ Start Time__________ Stop___________

Method of pick-up (check one): **Boat___ ATV___ Incidental___ Other_________**

CONDITION:

Diseases	**% Old**	**% Maggot**	**% Fresh**	**% Flopper**

Diseases >>			
Pintail			
Shoveler			
Mallard			
Wigeon			
G-W Teal			
Gadwall			
Ruddy			
Ring-necked			
Unident.			
Coot			
Whitefront			
Snow			
Ross's			
Cackler			
Others:			

Figure 3 (cont.). Disease surveillance data card (backside).

COMMENTS: (Include unusual events or conditions that influenced pick-up, i.e. weather, thick vegetation, or breakdowns. Also should include any unusual characteristics of the outbreak. Please note current bird use of the unit by <u>healthy and sick birds</u>.) **Include band #'s, band colors, band tyes (i.e. leg, neck, tarsal), species, and sexes of any banded birds.**

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INSTRUCTIONS:

1. Be sure and fill out **<u>all</u>** of the site/time information, **<u>even if no birds are picked up</u>**. Use the below abbreviations for refuge and disease. Fill out **<u>one card for each separately managed unit/cell</u>**.

2. Use a tally system to record birds picked up.

3. After completing pick-up, fill in **stop time**, **disease(s)**, and **condition <u>for each disease separately</u>**. Write **<u>and circle</u>** the total for each species for each disease beside the tally within the appropriate box.

4. For disease(s) indicate your best judgment on which diseases are most likely to be affecting the birds. If you are not reasonably sure, leave this entry blank and consult with a biologist **<u>before</u>** destroying the carcasses.

5. Count lead-poisoned birds and crippled/hunter-killed birds as **<u>separate diseases</u>**. Lead poisoned birds will often be very thin, have swollen heads, and no injuries. Crippled/hunter-killed birds should be identified by obvious trauma (i.e. broken wings, blood-shot areas under wings, breast, or other areas). **<u>Do not assume dead birds have died from disease.</u>**

6. For **condition**, estimate the percentage (to the nearest 5%) of birds picked up in each category. If possible, tally birds in the condition boxes as well as species boxes for a better estimate. Use the following criteria for determining condition: **OLD**- decomposed past maggot infestation (summer/fall) or water-logged/algae-covered (winter/spring); **MAGGOT**- maggot infested; **FRESH**- no obvious maggots, includes scavenged fresh birds; **FLOPPER** - live but sick or wounded birds.

7. Save several fresh carcasses of **<u>each species</u>** picked up for lab analysis. Notify a biologist to bag, tag, and freeze each bird individually. The tag information should include **date, location (refuge, unit, cell), species, suspected cause of death, and whether the bird was euthanized.**

ABBREVIATIONS:
Sacramento**-SAC,** Delevan**-DEL,** Colusa**-CLS,** Sutter**-SUT,** Butte Sink**-BTS,** Llano Seco**-LS;**
Botulism-**BO**, Cholera-**CH**, Lead Poisoning-**PB**, Cripple/Hunter-killed-**CR**, Others-**write out**.

Logistics

Supplies and lodgings are located in several towns within a short distance of the Refuges (Figure 1). Willows is most convenient for Sacramento and Delevan Refuges and Colusa is most convenient for the Colusa and Butte Sink Refuges. Yuba City may be most convenient for Sutter Refuge. Sacramento River Refuge units are distributed along 77 miles of the Sacramento River from Red Bluff to Colusa. Depending on the unit, the following cities may be the closest: Chico, Corning, and Hamilton City.

Working Areas

The principal command post for a disease outbreak on the Sacramento Complex is at Sacramento Refuge Headquarters located seven miles south of Willows. Most necessary facilities are at the Refuge Headquarters as well as the Sacramento disease laboratory. (The disease lab is currently in a standby status so the Refuge Headquarters would serve as command post pending activation of the disease lab). A large shop and garage area with running water and a telephone line is available at the Delevan, Colusa, Sutter, and Sacramento River Refuges. No facilities are present at Butte Sink WMA. A water tender is located at Sacramento Refuge that could be used as a portable supply of water.

Current procedures for botulism and avian cholera are decontamination on site to the extent possible and transport of carcasses (in plastic bags) to the incinerators at Sacramento or Colusa Refuge for disposal. For an outbreak of a more virulent disease, decontamination on site will be enhanced as much as feasible. To the extent possible, exposed equipment, such as clothing will be put in plastic bags and transported to Sacramento Refuge (washing machine is available in the disease lab). Carcasses will be disposed of in one of the incinerators or in on-site pits, if necessary.

Personnel

A number of refuge staff maintain qualifications (e.g. boat operation certification, respirator fit testing, etc) and personal protective equipment (PPE)(e.g. floatation vest, ear and eye protection, disposable nitrile gloves, waders, etc.) in order to safely participate in avian disease surveillance and outbreak cleanup/control efforts. Currently, there are about 10 staff members that are qualified to operate airboats and another 10 that have been certified for using respirators.

In addition to refuge staff, the CDFG has personnel stationed at Gray Lodge, Upper Butte Basin and Oroville Wildlife Areas, and in other communities in this region. CDFG will lend support to the Service when needed and the Service will reciprocate. CDFG is the primary agency responsible for addressing disease events on private lands. However, depending on the situation, Refuge staff may assist with addressing mortality events on private lands near the Complex.

At times, volunteers are used to help with disease monitoring efforts. They are required to use the same PPE as Service employees.

Appendix 2 contains a list of the principle and regional contacts for State and Federal agency personnel.

Communications

A media contact list is attached in Appendix 3.

The refuge staff can communicate via a network of cell phones, and are also connected by a radio network with a base station on the Sutter Buttes. In addition, most refuge vehicles are equipped with mobile units, and there are a number of hand-held radios available, all of which are on the same frequency for transmitting (171.6750) and receiving (172.6750)

Equipment

The Refuges have equipment to address significant disease outbreaks. Table 5 indicates the number of vehicles and heavy equipment, as well as disease-specific equipment that are located at individual Refuge shop/office areas.

Table 5. Vehicles and other large equipment available for use in disease operations at the Sacramento National Wildlife Refuge Complex.

	Refuge				
Equipment	**Sacramento**	**Delevan**	**Colusa**	**Sutter**	**Llano Seco Unit**
4-wheel drive pick-ups	12	1	2	2	1
2-wheel drive pick-ups	1	0	0	0	1
Airboats	2	0	1	1	0
All-terrain vehicles	8	1	1	1	1
Heavy Equipment[1]	present	present	present	present	present
Propane Incinerators	1	0	1	0	0
Pressure washers	1	1	1	1	1
Freezers for diagnostic specimens	2	0	1	0	0

[1] Heavy equipment includes bulldozers, backhoes/excavators and tractors.

Disease problems on other Refuges, both within the Complex and throughout California, may require moving airboats to other locations. In all, about 20 State and Federal airboats are available at various locations (many at Refuges and Wildlife Areas) in California. Other all-terrain vehicles as well as airboats, incinerators, and bird disposal equipment are located on other Federal and State areas in California.

There are no aircraft on the Complex, but a Service Flyway Biologist and airplane are stationed at nearby Placerville and could be available for additional surveillance needs. In addition, CDFG also has pilots and aircraft available in case of emergency or large outbreaks requiring additional surveillance. Should it become necessary, there are also Office of Aircraft Safety approved pilots and airplanes available to be contracted in the local area.

There is a cache of equipment and PPE located in the disease lab at Sacramento Refuge (Table 6). This cache was established as part of statewide AI preparedness on Federal Refuges in 2006. It is stocked with basic disease operations supplies (e.g. nitrile gloves, goggles, hand sanitizer, large plastic bags, hearing protection, etc.), but also contains special equipment to be used in the event of an outbreak of HPAI H5N1 (e.g. disposable respirators, tyvech coveralls, portable tank sprayers and bleach for decontamination operations). Smaller quantities are available at the individual shops/offices at Delevan, Colusa, and Sutter Refuges, and the Llano Seco Unit for immediate and short-term use.

Table 6. Personal protective and other equipment for disease control operations located in cache at Sacramento National Wildlife Refuge, January 2008.

Equipment	Quantity
Nitrile gloves (5 ml)	55 boxes (3,400 pair)
Goggles	10
N-99 disposable respirators	85 boxes (850 total)
Tyvech coveralls	8 boxes (200 total)
Disposable ear plugs	1 box (100 pair)
Hand Sanitizer	5 boxes (60 12-oz. containers)
Large plastic bags	12 boxes (1500 bags)
2-gal. portable tank sprayers	5
Bleach	5 boxes (30 1-gallon jugs)

Supply Sources

Limited supplies are available at Messick Ace Hardware in Colusa and Willows Hardware in Willows. Other large retail stores (Lowe's, Orchard Supply Hardware, etc.) exist in nearby larger cities including Yuba City and Chico.

Lodging

The Complex has the ability to house some temporary personnel in the bunkhouse located on Sacramento Refuge. Housing is available at motels in Willows, Colusa, and Williams. The following motels are available in these communities (Table 7).

Table 7. Local lodging.

Town	Hotel Name	Phone Number
Willows	Baymont Inn & Suites	530-934-9700
	Best Western Golden Pheasant Inn	530-934-4603
	Days Inn	530-934-4444
	Economy Inn	530-934-4224
	Motel 6	530-934-7026
	Super 8	530-934-2871
Colusa	Colusa Motel	530-458-4906
	Riverside Motel/Hotel	530-458-5880
Williams	Granzella's Inn	530-473-3310
	Comfort Inn	530-473-2381
	Holiday Inn Express	530-473-5120
	Motel 6	530-473-5337

Food

There is a kitchen in the bunkhouse on Sacramento Refuge. There are a number of restaurants in Willows and Colusa and other nearby towns. Restaurants in Willows that are open 24 hours include Nancy's Airport Café, Dennys, and the Arco Mini-Mart.

SUPPLEMENTAL INFORMATION

In addition to the disease laboratory at Sacramento Refuge, CDFG maintains a Wildlife Investigations Lab in Rancho Cordova, just outside the city of Sacramento, (916) 355-0124.

The Refuges hold a Federal collecting permit that enables refuge employees to take and possess migratory birds. When collection involves federally-listed species protected by the Endangered Species Act (ESA), refuge employees are required by the ESA to hold a valid permit for the particular species involved before salvaging or capturing sick or diseased animals. Contact the Sacramento Fish and Wildlife Office (916-414-6600) regarding requirements and permit applications. Except for a small capacity live animal room in the disease lab, there are no facilities for holding live animals.

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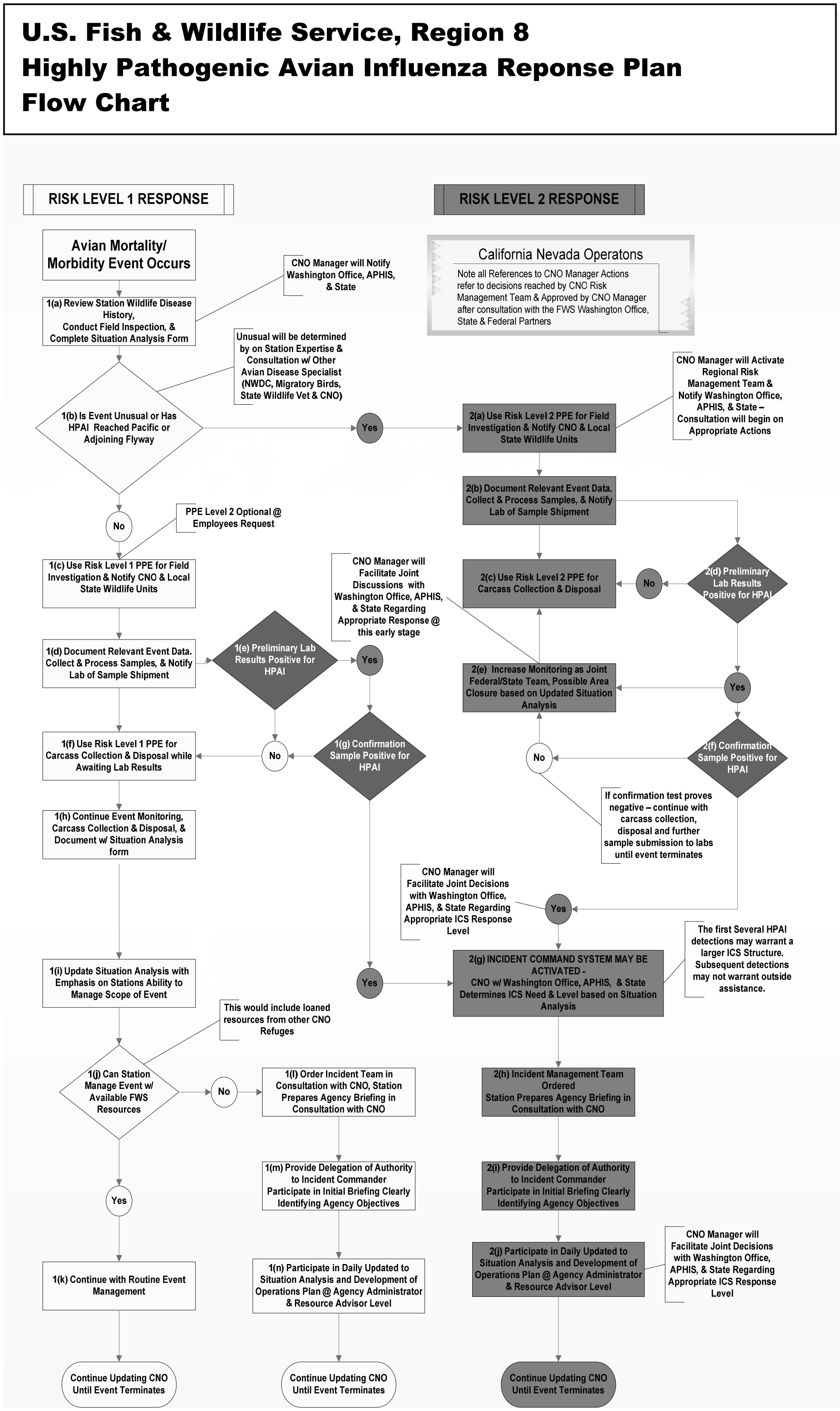
Appendix 1. Highly Pathogenic Avian Influenza Response Plan



Refuge HPAI Contact List (March 2008)

Contact	Name	Phone	Cell Phone	E-mail
R8 HPAI Coordinator	Richard Hadley	916-414-6483	916-769-3918	Richard_hadley@fws.gov
Alternate	Dan Walsworth	916-414-6472	916-717-0365	Dan_walsworth@fws.gov
R8 HPAI Media Coordinator	Jane Hendron	760-431-9440 x205	760-271-6487	Jane_hendron@fws.gov
Alternate	Alex Pitts	916-414-6619	916-804-4967	Alexandra_pitts@fws.gov
Other Local FWS Offices				
Sac F&W Office	Susan Moore	319-414-6700		Susan_moore@fws.gov
Red Bluff F&W Office	Jim Smith	530-527-3043		Jim_smith@fws.gov
Coleman NFH	Scott Hamelberg	530-365-8622		Scott_hamelberg@fws.gov
Stone Lakes NWR	Tom Harvey	916-775-4426		Tom_harvey@fws.gov
Local State Fish & Game Offices (CNO will contact State Office):				
Willows	Paul Hofmann	530-934-9309		phofmann@dfg.ca.gov
Gray Lodge WA	Mike Womack	530-846-7500		mwomack@dfg.ca.gov
Upper Butte Basin WA	Pete Blake	530-982-2169		dblake@dfg.ca.gov
Oroville WA	Andy Atkinson	530-538-2236	530-624-8656	aatkinson@dfg.ca.gov
Local Warden Lieutenants	Sam Castillo	530-895-4240	530-624-8279	
	Kent Harrison	530-899-1806	530-624-8277	
Local APHIS Offices				
North District	Jim Shuler	530-336-5623		
Sacramento District	Jack Pariott	916-434-0663		
USGS Wildlife Life Health Lab	Krysten Schuler	608-270-2447		kschuler@usgs.gov
State Diagnostic Lab	Pam Swift	916-358-1462	916-590-8916 (pager)	pswift@dfg.ca.gov
Local Refuge User Groups				
CA Waterfowl Association	Bill Gaines	916-648-1406	916-275-1018	bill_gaines@calwaterfowl.org
Altacal Audubon Chapter	Phil Johnson	503-893-3222		pjohnsonhardwood@sunset.net
USGS- Dixon Field Station	Joe Fleskes	707-678-0682 x628		Joe_fleskes@usgs.gov
County Public Health Officers				
Butte County	Mark Lundberg	530-538-7581		mlundberg@buttecounty.net
Colusa County	Phil Reinheimer	530-458-0250		rreinheimer@colusadhhs.org
Glenn County	Grinnell Norten	530-934-6588		gnorton@glenncountyhealth.net
Sutter County	Mike Kinnison	530-822-7215		mkinnison@cc.sutter.ca.us
Tehama County	Sydnei Wilby	530-527-6824		wilbys@tcha.net

Appendix 2. Principal Local and Regional Contacts (March 2008)

US Fish and Wildlife Service
USFWS Region 8
Marge Kolar, Assistant Regional Director, Refuges
2800 Cottage Way, Suite W-2606
Sacramento, CA 95825
916-414-6476

USFWS Region 8
Dan Walsworth, Refuge Supervisor
2800 Cottage Way, Suite W-2606
Sacramento, CA 95825
916-414-6472

USFWS Region 8
Nancy Hoffman, Assistant Refuge Supervisor
2800 Cottage Way, Suite W-2606
Sacramento, CA 95825
916-414-6473

USFWS Region 8
Richard Hadley, HPAI Media Coordinator
2800 Cottage Way, Suite W-2606
Sacramento, CA 95825
916-414-6483

USFWS Region 8
Alex Pitts, External Affairs
2800 Cottage Way, Suite W-2606
Sacramento, CA 95825
916-414-6619

State of California
California Department of Fish and Game
Waterfowl Program
Dan Yparraguirre
1812 9th Street
Sacramento, CA
(916) 445-3685

California Department of Fish and Game
Wildlife Investigations Lab
Dr. Pam Swift
Rancho Cordova, CA
(916) 358-1462

California Department of Fish and Game
Gray Lodge Wildlife Area
Mike Womack or Andy Atkinson
530-846-7500

California Department of Fish and Game
Glenn and Colusa County Unit Manager
Paul Hofmann
530-934-9309

California Department of Food and Agriculture
1220 N Street
Sacramento, CA 95814-5607
(916) 654-0462 (office)
(916) 654-0466 (recorded info)
866-922-2473 (Bird Illness Hotline)

California Department of Public Health
744 P Street
Sacramento, CA 95814
(916) 558-1784
877-968-2473 (West Nile Virus Hotline)

Federal Agencies
Federal Information Center
800-333-4636

U.S.D.A. Animal and Plant Health Inspection Service
10365 Old Placerville Road, Suite 210
Sacramento, CA 95827-2518
(916) 854-3950

U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, CA 94105
(415) 556-6695

U.S. Department of Health and Human Services, Region 9
90 Seventh Street
Federal Building, Suite 5-100
San Francisco, CA 94103
(415) 437-8500

Appendix 3. Media Contact List (March 2008)

Organization Name	Address	City	State	Zip Code	Phone Number	Contact Name/Title	Fax Number	Email
USFWS	2800 Cottage Way, Suite W-2606	Sacramento	CA	95825	916-414-6464	Alexandra Pitts, External Affairs	916-414-6486	alexandra_pitts@fws.gov
USFWS	2800 Cottage Way, Suite W-2606	Sacramento	CA	95825	916-414-6566	Al Donner, ES External Affairs	916-414-6712	al_donner@fws.gov
Newspapers								
Appeal-Democrat	PO Box 431	Marysville	CA	95901	530-749-4715	Todd Hansen, Sports	503-741-0140	thansen@appeal-democrat.com
Appeal-Democrat	PO Box 431	Marysville	CA	95901	530-749-4722	Leticia Gutierrez, Community Edit.	503-741-0140	lgutierrez@appeal-democrat.com
Chico Enterprise Record	PO Box 9	Chico	CA	95927	530-891-1234	Heather Hacking, reporter	530-342-3617	hhacking@chicoer.com
Chico Enterprise Record	PO Box 9	Chico	CA	95927	530-891-1234	Steve Carson, sports	530-342-3617	scarson@sunset.net
Chico News & Review	3536 2nd Street	Chico	CA	95928	530-894-2300	Tom Gascoyne	530-894-0143	tomg@newsreview.com
Colusa Sun Herald					530-458-2121	James Nair	530-458-5711	sunherald@frontiernet.net
Corning Observer	PO Box 558	Corning	CA	96021	530-824-5473	Diane	530-824-4804	corningobserver@dm-tech.net
Davis Enterprise	315 G Street	Davis	CA	95616	530-756-0800	Debbie Davis (Ed.)	530-756-6707 (newsrm)	newsroom@davisenterprise.net

Organization Name	Address	City	State	Zip Code	Phone Number	Contact Name/Title	Fax Number	Email
Fishing & Hunting News					206-624-3845	Joel Shangle, California Editor	206-695-8512	awalgamott@fishingandhuntingnews.com
Oakland Tribune					510-208-6450	Steve Herendeen (sports)	510-208-6477 (newsrm)	sherendeen@angnewspapers.com
Oakland Tribune					510-208-6450	Mario Dianda (Editor)	510-208-6477 (newsrm)	mdianda@angnewspapers.com
Red Bluff Daily News	PO Box 220	Red Bluff	CA	96080	530-527-2151	Newsroom	530-527-3719	Newsdesk@redbluffdailynews.com
Redding Record Searchlight	1101 Twin View Blvd.	Redding	CA	96003	530-225-8230	Tom Gabrukiewicz	530-225-8212	tgabrukiewicz@redding.com
S.F. Chronicle	901 Mission Street	San Francisco	CA	94013	415-777-7201	Paul McHugh, Outdoors	415-543-3754	pmchugh@sfchronicle.com
Sacramento Bee	PO Box 15779	Sacramento	CA	95852	916-321-1000	William Enfield (Editor) Chris Bowman (Enviro)	916-326-5503	benfield@sacbee.com cbowman@sacbee.com
Tri-County Newspapers	PO Box 731	Willows	CA	95988	530-934-6800	Susan, Reporter	530-934-6815	editor@tcnpress.com
Tri-County Newspapers	PO Box 731	Willows	CA	95988	530-934-6800	Mike Griffin	530-934-6815	
Valley Mirror	PO Box 290	Artois	CA	95913	530-934-9511	Tim Crews	530-934-9208	valleymirror@pulsarco.com
Western Outdoor News	1054 Elmwood Avenue	Stockton	CA	95204	209-468-4809	Pete Ottesen	209-468-9232	pottesen@sjcoe.net
		Magalia	CA		530-343-2981	Ed Migale	530-343-2981	emigale@comcast.net
Western Outdoor News	PO Box 1536	Placerville	CA	95667	530-642-0870	Bill Karr	530-642-0873	EDITORS@wonews.com

Organization Name	Address	City	State	Zip Code	Phone Number	Contact Name/Title	Fax Number	Email
Western Outdoor News, N. CA	3197 East Airport Loop Drive	Costa Mesa	CA	92626	714-546-4370 ext 33	Pat McDonald	714-662-3486	EDITORS@wonews.com
Woodland Daily Democrat	711 Main Street	Woodland	CA	95695	530-662-5421	Jim Smith	530-662-1288	ddnews@dailydemocrat.com
Radio Broadcasters								
KALF-FM - 95.7	1459 Humboldt Road, Suite D	Chico	CA	95928-9100	530-899-3600	Scott Michaels, Program Mgr	916-343-0243	scottkalf@yahoo.com
KBLF-AM - 1490	Box 1490, Suite 54, 645 Antelope Blvd.	Red Bluff	CA	96080	530-527-1490	Donna Hunter, News Director	530-527-3525	
KCHO	California State University Chico	Chico	CA	95929-0500	530-898-5896	Todd Thorton, News Director	530-898-4348	joleksiewicz@csuchico.edu
KEWB-FM - 94.7	1588 Charles Drive	Redding	CA	96003	530-244-9700	Rick Healey. Program Mgr	530-244-9707	
KFBK-FM - 1530	11352 Gold Country Blvd.	Gold River	CA	95670	916-852-6310	Bob Simms	916-921-5555	bsimms43@aol.com
KFMF-FM - 93.9	1459 Humboldt Rd., Ste. D	Chico	CA	95928	916-899-3600	Marty Griffin, Program Director	916-343-0243	
KHSL-FM - 103.5	2654 Cramer Lane	Chico	CA	95928-8838	530-345-0021	Michael Wessels, Program Director	530-893-2121	
KIQS-AM - 1560	118 West Sycamore, Box 118	Willows	CA	95988	530-934-4654 530-934-1212	Damian Hunter Newsline	530-934-4656	
KKCY-FM - 103.1	Box 7568	Chico	CA	95927	530-342-2200	Jan Baker, Station Manager	530-342-2260	

Organization Name	Address	City	State	Zip Code	Phone Number	Contact Name/Title	Fax Number	Email
KLRS-FM - 92.7	Box 7568	Chico	CA	95927	530-342-2200	Ron Woodward, Program Mgr	530-342-2260	
KMJE-FM - 101.5	Box 7568	Chico	CA	95927	530-342-2200		530-342-2260	
KMXI-FM - 95.1	2654 Cramer Lane	Chico	CA	95928-8838	530-345-0021	Larry Scott, Prgram Mgr	530-893-2121	
KNCQ-FM - 97.3	1588 Charles Drive	Redding	CA	96003	530-244-9700	Bob Thomas, News Director	530-244-9707	
KPAY-AM - 1290	2654 Cramer Lane	Chico	CA	95928-8838	530-345-0021	Veronica Carter	530-893-2121	vcarter@deercreekbroadcasting.com
Television Broadcasters								
KHSL Ch 12	3460 Silver Bell	Chico	CA	95973-0388	530-342-0141	Newsroom	530-342-2405	news@khsltv.com
KNVN Ch 24	180 E. 4th Street	Chico	CA	95928	530-893-2424	Newsroom	530-342-2405	news@khsltv.com
KOVR Ch 13	2713 KOVR Drive	West Sacramento	CA	95605	916-374-1301	Newsroom	916-374-1304	news@kovr13.com
KRCA Ch 3	3 Television Circle	Sacramento	CA	95814-0794	916-446-3333	Frank Wolff	916-441-4050	fwolff@hearst.com
KRCR Ch 7	Box 992217, 755 Auditorium Dr.	Redding	CA	96001	530-343-7706	Donna Stiles	530-345-2165	dstiles@krcrtv.com
KRCR Ch 7	Box 992217, 755 Auditorium Dr.	Redding	CA	96001	530-243-7777	Diane Chestnut	530-243-0217	info@krcrtv.com
UPN-FOX 30	300 Main Street	Chico	CA	95928-5438	530-893-1234	Christy Wallace	530-899-5475	spotlight@fox30.com

Appendix I. Water Management Plan

Annual Water Management Plans are prepared for Sacramento, Delevan, and Colusa Refuges. The development of these plans is a requirement of the Central Valley Project Improvement Act (CVPIA), which requires the Bureau of Reclamation to purchase and deliver water to these Refuges. The plan outlines water management goals and objectives and inventories existing facilities, water quality monitoring, water inventory, and best management practices.

Copies of the water management plans are available for review at the Sacramento National Wildlife Refuge Complex, 752 County Road 99W, Willows, California 95988. (530) 934-2801.

Copies are also available via the internet at the following address http://sacramentovalleyrefuges.fws.gov

Appendix J. Fire Management Plan

The Department of the Interior (DOI) fire management policy requires that all refuges with vegetation that can sustain fire must have a Fire Management Plan that details fire management guidelines for operational procedures and values to be protected/enhanced. The Fire Management Plan (FMP) for the Sacramento National Wildlife Refuge Complex (Complex) provides guidance on preparedness, prescribed fire, wildland fire, and prevention. Values to be considered in the FMP include protection of Refuge resources and neighboring private properties, effects of burning on refuge habitats/biota, and firefighter safety. Refuge resources include properties, structures, cultural resources, trust species including Endangered, Threatened, and species of special concern, and their associated habitats. The FMP will be reviewed periodically to ensure that the fire program is conducted in accordance and evolves with the U.S. Fish and Wildlife Service (USFWS) mission and the Refuge's goals and objectives.

The FMP is written to provide guidelines for appropriate suppression and prescribed fire programs at Sacramento Refuge Complex. Prescribed fires may be used to reduce hazard fuels, restore the natural processes and vitality of ecosystems, improve wildlife habitat, remove or reduce non-native species, and/or conduct research.

This plan will help achieve resource management objectives by enabling the Refuge to utilize prescribed fire, as one of several tools, to control non-native vegetation and reduce fire hazards in grassland and riparian habitats. It will be used in conjunction with other management tools that are currently applied on Refuge properties (i.e., grazing, mowing and herbicide applications) to meet resource objectives.

It is the intent of the USFWS to conduct wildland fire suppression and prescribed fire operations within the Sacramento Refuge Complex.

Copies of the plan are available for review at the Sacramento National Wildlife Refuge Complex, 752 County Road 99W, Willows, California 95988. (530) 934-2801.

Copies are also available via the internet at the following address http://sacramentovalleyrefuges.fws.gov

Appendix K. Wildlife and Plant List for Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges

Table 1. Birds that occur on Sacramento, Delevan, Colusa, or Sutter Refuges.
(* -non-native species; [1] B-breeding, NB-nonbreeding, A-accidental, M-migrant, SR-summer resident, WR-wintering resident, YR-year-round resident; 2 w-wetland, fr-forested/riparian, g-grassland)

ORDER/COMMON NAME	SCIENTIFIC NAME	BREEDING/ MIGRATORY STATUS[1]	HABITAT TYPES[2]
Gaviiformes (loons)			
Red-throated loon	*Gavia stellata*	NB/A	w
Common loon	*Gavia immer*	NB/A	w
Podicipediformes (grebes)			
Pied-billed grebe	*Podilymbus podiceps*	B/YR	w
Horned grebe	*Podiceps auritus*	NB/A	w
Red-necked grebe	*Podiceps grisegena*	NB/A	w
Eared grebe	*Podiceps nigricollis*	B/WR	w
Western grebe	*Aechmophorus occidentalis*	B/YR	w
Clark's grebe	*Aechmophorus clarkii*	B/YR	w
Pelicaniformes (pelicans and cormorants)			
American white pelican	*Pelecanus erythrorhynchos*	NB/YR	w
Double-crested cormorant	*Phalacrocorax auritus*	B/YR	w
Ciconiiformes (ibis, herons, and egrets)			
American bittern	*Botaurus lentiginosus*	B/YR	w
Least bittern	*Ixobrychus exilis*	B/YR	w
Great blue heron	*Ardea herodias*	B/YR	w
Great egret	*Casmerodius albus*	B/YR	w
Snowy egret	*Egretta thula*	B/YR	w
Little blue heron	*Egretta caerulea*	B/A	w
Cattle egret	*Bubulcus ibis*	B/YR	w
Green heron	*Butorides striatus*	B/YR	w
Black-crowned night heron	*Nycticorax nycticorax*	B/YR	w
White-faced ibis	*Plegadis chihi*	B/YR	w
Turkey vulture	*Cathartes aura*	B/YR	g
Anseriformes (ducks, geese, and swans)			
Black-bellied whistling-duck	*Dendrocygna autumnalis*	NB/A	w
Fluvous whistling-duck	*Dendrocygna bicolor*	NB/A	w
Greater white-fronted goose	*Anser albifrons*	NB/WR	w,g
Emperor goose	*Chen canagica*	NB/A	w
Snow goose	*Chen caerulescens*	NB/WR	w
Ross's goose	*Chen rossii*	NB/WR	w
Brant	*Branta bernicla*	NB/A	w
Aleutian cackling goose	*Branta hutchinsii leucopareia*	NB/WR	w,g

Cackling cackling goose	*Branta hutchinsii minima*	NB/WR	w,g
Lesser Canada goose	*Branta canadensis parvipes*	NB/WR	w,g
Taverner's Canada goose	*Branta canadensis taverneri*	NB/WR	w,g
Western Canada goose	*Branta canadensis moffitti*	B/YR	w,g
Trumpeter swan	*Cygnus buccinator*	NB/A	w
Tundra swan	*Cygnus columbianus*	NB/WR	w
Wood duck	*Aix sponsa*	B/YR	w
Gadwall	*Anas strepera*	B/YR	w
American wigeon	*Anas americana*	NB/WR	w,g
Eurasian wigeon	*Anas penelope*	NB/WR	w
American black duck	*Anas rubripes*	NB/A	w
Mallard	*Anas platyrhyncos*	B/YR	w
Blue-winged teal	*Anas discors*	B/YR	w
Cinnamon teal	*Anas cyanoptera*	B/YR	w
Northern shoveler	*Anas clypeata*	B/WR	w
Northern pintail	*Anas acuta*	B/WR	w
Baikal teal*	*Anas formosa**	NB/A	w
Green-winged teal	*Anas crecca*	NB/WR	w
Canvasback	*Aythya valisineria*	B/WR	w
Redhead	*Aythya americana*	B/YR	w
Ring-necked duck	*Aythya collaris*	B/WR	w
Greater Scaup	*Aythya marila*	NB/A	w
Lesser scaup	*Aythya affinis*	NB/WR	w
Harlequinn duck	*Histrionicus histrionicus*	NB/A	w
Surf scoter	*Melanitta persoicillata*	NB/A	w
White-winged scoter	*Melanitta fusca*	NB/A	w
Long-tailed duck	*Clangula hyernalis*	NB/A	w
Bufflehead	*Bucephala albeola*	NB/WR	w
Common goldeneye	*Bucephala clangula*	NB/WR	w
Barrow's goldeneye	*Bucephala islandica*	NB/A	w
Hooded merganser	*Lophodytes cucullatus*	NB/WR	w
Common merganser	*Mergus merganser*	B/WR	w
Red-breasted merganser	*Mergus serrator*	NB/A	w
Ruddy duck	*Oxyura jamaicensis*	B/YR	w
Mandarin duck*	*Aix galericulata**	NB/A	w
Falconiformes (vultures, hawks, eagles, and falcons)			
Osprey	*Pandion haliaetus*	B/YR	r
White-tailed kite	*Elanus leucurus*	B/YR	g,w
Bald eagle	*Haliaeetus leucocephalus*	NB/WR	w,fr
Northern harrier	*Circus cyaneus*	B/YR	w,g

Sharp-shinned hawk	*Accipiter striatus*	NB/WR	fr,w
Cooper's hawk	*Accipiter cooperii*	NB/WR	fr,w
Red-shouldered hawk	*Buteo lineatus*	B/YR	fr
Swainson's hawk	*Buteo swainsoni*	B/SR	g,fr
Red-tailed hawk	*Buteo jamaicensis*	B/YR	g,fr
Ferruginous hawk	*Buteo regalis*	NB/M	g
Rough-legged hawk	*Buteo lagopus*	NB/WR	g
Golden eagle	*Aquila chrysaetos*	NB/WR	g,fr
American kestrel	*Falco sparverius*	B/YR	g,fr
Merlin	*Falco columbarius*	NB/WR	w,g
Prairie falcon	*Falco mexicanus*	NB/WR	g
Peregrine falcon	*Falco peregrinus*	NB/WR	w,fr
Galliformes (turkey, quail, and pheasants)			
Ring-necked pheasant*	*Phasianus colchicus**	B/YR	g,w,fr
Wild turkey*	*Meleagris gallopavo**	B/YR	g,fr
California quail	*Callipepla californica*	B/YR	g,fr
Gruiformes (cranes and rails)			
Yellow rail	*Coturnicops noveboracensis*	NB/A	w
Black rail	*Laterallus jamaicensis*	NB/A	w
Virginia rail	*Rallus limicola*	B/YR	w
Sora	*Porzana carolina*	B/YR	w
Common moorhen	*Gallinula chloropus*	B/YR	w
American coot	*Fulica americana*	B/YR	w
Sandhill crane	*Grus canadensis*	NB/WR	w,g
Charadriiformes (shorebirds and gulls)			
Black-bellied plover	*Pluvialis squatarola*	NB/M	w
American golden plover	*Pluvialis dominica*	NB/A	w
Snowy plover	*Charadrius alexandrinus*	NB/A	w
Semipalmated plover	*Charadrius semipalmatus*	NB/M	w
Killdeer	*Charadrius vociferus*	B/YR	w,g
Black-necked stilt	*Himantopus mexicanus*	B/YR	w
American avocet	*Recurvirostra americana*	B/YR	w
Greater yellowlegs	*Tringa melanoleuca*	NB/YR	w
Lesser yellowlegs	*Tringa flavipes*	NB/M	w
Solitary sandpiper	*Tringa solitaria*	NB/M	w
Willet	*Catoptrophorus semipalmatus*	NB/M	w
Spotted sandpiper	*Actitis macularia*	NB/M	w
Whimbrel	*Numenius phaeopus*	NB/M	w
Long-billed curlew	*Numenius americanus*	NB/M	w,g
Marbled godwit	*Limosa fedoa*	NB/M	w
Ruddy turnstone	*Arenaria interpres*	NB/A	w

Red knot	*Calidris canutus*	NB/A	w
Sanderling	*Calidris alba*	NB/A	w
Semipalmated sandpiper	*Calidris pusilla*	NB/A	w
Western sandpiper	*Calidris mauri*	NB/M	w
Least sandpiper	*Calidris minutilla*	NB/M	w
Baird's sandpiper	*Calidris bairdii*	NB/A	w
Pectoral sandpiper	*Calidris melanotos*	NB/M	w
Dunlin	*Calidris alpina*	NB/WR	w
Ruff	*Philomachus pugnax*	NB/A	w
Short-billed dowitcher	*Mimnodromus griseus*	NB/M	w
Long-billed dowitcher	*Limnodromus scolopaceus*	NB/M	w
Jack snipe	*Lymnocryptes minimus*	NB/A	w
Wilson's snipe	*Gallinago gallinago*	NB/M	w
Wilson's phalarope	*Phalaropus tricolor*	NB/M	w
Red-necked phalarope	*Phalaropus lobatus*	NB/M	w
Red phalarope	*Phalaropus fulicarius*	NB/A	w
Franklin's gull	*Larus pipixcan*	NB/A	w
Bonaparte's gull	*Larus philadelphia*	NB/M	w
Mew gull	*Larus canus*	NB/A	w
Ring-billed gull	*Larus delawarensis*	NB/YR	w
California gull	*Larus californicus*	NB/WR	w
Herring gull	*Larus argentatus*	NB/WR	w
Glaucous-winged gull	*Larus glaucescens*	NB/A	w
Sabine's gull	*Xema sabini*	NB/A	w
Black-legged kittiwake	*Rissa tridactyla*	NB/A	w
Caspian Tern	*Sterna caspia*	NB/SR	w
Forster's tern	*Sterna forsteri*	NB/M	w
Black tern	*Childonias niger*	B/SR	w
Columbiformes (pigeons and doves)			
Rock pigeon*	*Columba livia**	B/YR	g,fr
Band-tailed pigeon	*Patagioenas fasciata*	NB/A	fr
Mourning dove	*Zenaida macroura*	B/YR	g,fr
Cuculiformes (cuckoos and roadrunners)			
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	B/SR	fr
Greater roadrunner	*Geococcyx californicius*	NB/A	g
Strigiformes (owls)			
Barn owl	*Tyto alba*	B/YR	fr
Western screech owl	*Otus kennicottii*	B/YR	fr
Great horned owl	*Bubo virginianus*	B/YR	fr,g
Snowy owl	*Bubo scandiacus*	NB/A	g

Northern pygmy-owl	*Glaucidium gnoma*	NB/A	fr
Burrowing owl	*Athene cunicularia*	B/YR	g
Long-eared owl	*Asio otus*	NB/A	fr
Short-eared owl	*Asio flammeus*	B/WR	g
Northern saw-whet Owl	*Aegolius acadicus*	NB/A	fr
Caprimulgiformes (goatsuckers and nighthawks)			
Lesser nighthawk	*Chordeiles acutipennis*	NB/A	fr,g
Common nighthawk	*Chordeiles minor*	NB/A	fr,g
Common poorwill	*Phalaenoptilus nuttallii*	NB/A	g
Apodiformes (swifts and hummingbirds)			
Black swift	*Cypseloides niger*	NB/A	g
Vaux's swift	*Chaetura vauxi*	NB/A	g
White-throated swift	*Aeronautes saxatalis*	NB/A	g
Black-chinned hummingbird	*Archilochus alexandri*	B/M	r
Anna's hummingbird	*Calypte anna*	B/M	r
Rufous hummingbird	*Selasphorus rufus*	NB/M	r
Allen’s hummingbird	*Selasphorus sasin*	NB/M	r
Coraciiformes (kingfishers)			
Belted kingfisher	*Ceryle alcyon*	B/YR	w, fr
Piciformes (woodpeckers)			
Lewis' woodpecker	*Melanerpes lewis*	NB/A	fr
Acorn woodpecker	*Melanerpes formicivorous*	NB/A	fr
Red-breasted sapsucker	*Sphyrapicus ruber*	NB/A	fr
Nuttall's woodpecker	*Picoides nuttallii*	B/YR	fr
Downy woodpecker	*Picoides pubescens*	NB/M	fr
Hairy woodpecker	*Picoides villosus*	NB/M	fr
Northern flicker	*Colaptes auratus*	B/YR	fr
Passeriformes			
Flycatchers			
Olive-sided flycatcher	*Contopus cooperi*	NB/A	fr
Western wood pewee	*Contopus sordidulus*	B/SR	fr
Willow flycatcher	*Empidonax traillii*	B/SR	fr
Hammond's flycatcher	*Empidonax hammondii*	NB/A	fr
Gray flycatcher	*Empidonax wrightii*	NB/A	fr
Dusky flycatcher	*Empidonax oberholseri*	NB/A	fr
Pacific-slope flycatcher	*Empidonax difficilis*	NB/M	fr
Black phoebe	*Sayornis nigricans*	B/YR	fr,w
Say's phoebe	*Sayornis saya*	NB/M	g
Ash-throated flycatcher	*Myiarchus cinerascens*	B/SR	fr
Western kingbird	*Tyrannus verticalis*	B/SR	fr,g

Shrikes			
Loggerhead shrike	*Lanius ludovicianus*	B/YR	g
Northern shrike	*Lanius excubitor*	NB/A	g
Vireos			
Cassin's vireo	*Vireo cassinii*	NB/M	fr
Hutton's vireo	*Vireo huttoni*	NB/M	r
Warbling vireo	*Vireo gilvus*	NB/M	r
Corvids			
Western scrub jay	*Aphelocoma californica*	B/YR	fr
Clark's nutcracker	*Nucifraga columbiana*	NB/A	fr
Yellow-billed magpie	*Pica nuttalli*	B/YR	fr
American crow	*Corvus brachyrhynchos*	B/YR	fr
Common raven	*Corvus corax*	B/YR	g,fr
Larks, Swallows and Chickadee			
Horned lark	*Eremophila alpestris*	NB/WR	g
Purple martin	*Progne subis*	NB/M	w,fr
Tree swallow	*Tachycineta bicolor*	B/SR	fr, w
Violet-green swallow	*Tachycineta thalassina*	NB/M	fr, w
Northern rough-winged swallow	*Stelgidopteryx serripennis*	NB/M	w,g
Cliff swallow	*Hirundo pyrrhonota*	B/SR	w
Barn swallow	*Hirundo rustica*	B/SR	fr, w
Mountain chickadee	*Poecile gambeli*	NB/A	fr
Wrentit, Titmice and Bushtit			
Wrentit	*Chamaea fasciata*	NB/M	fr
Oak titmouse	*Baeolophus inornatus*	B/YR	fr
Bushtit	*Psaltriparus minimus*	B/YR	fr
Nuthatches and Creeper			
Red-breasted nuthatch	*Sitta canadensis*	NB/M	fr
White-breasted nuthatch	*Sitta carolinensis*	NB/YR	fr
Brown creeper	*Certhia americana*	NB/M	fr
Wrens			
Rock wren	*Salpinctes obsoletus*	NB/A	g
Bewick's wren	*Thryomanes bewickii*	B/SR	fr
House wren	*Troglodytes aedon*	B/SR	fr
Winter wren	*Troglodytes troglodytes*	NB/A	fr
Marsh wren	*Cistothorus palustris*	B/YR	w
Golden-crowned kinglet	*Regulus satrapa*	NB/M	fr
Ruby-crowned kinglet	*Regulus calendula*	NB/WR	fr
Blue-gray gnatcatcher	*Polioptila caerulea*	NB/M	fr
Western bluebird	*Sialia mexicana*	NB/M	fr, g

Mountain bluebird	*Sialia currucoides*	NB/A	g
Swainson's thrush	*Catharus ustulatus*	NB/M	fr
Hermit thrush	*Catharus guttatus*	NB/M	fr
American robin	*Turdus migratorius*	NB/WR	fr
Varied thrush	*Ixoreus naevius*	NB/M	fr
Northern mockingbird	*Mimus polyglottos*	B/YR	fr
Sage thrasher	*Oreoscoptes montanus*	NB/A	g
European starling*	*Sturnus vulgaris**	B/YR	fr
American pipit	*Anthus rubescens*	NB/WR	g,w
Cedar waxwing	*Bombycilla cedrorum*	NB/WR	fr
Bohemian waxwing	*Bombycilla garrulus*	NB/A	fr
Phainopepla	*Phainopepla nitens*	NB/A	fr
Orange-crowned warbler	*Vermicora celata*	NB/M	fr
Nashville warbler	*Vermivora ruficapilla*	NB/M	fr
Northern parula	*Parula americana*	NB/A	fr
Yellow warbler	*Dendroica petechia*	NB/M	fr
Chestnut-sided warbler	*Dendroica pensylvanica*	NB/A	fr
Magnolia warbler	*Dendroica magnolia*	NB/A	fr
Yellow-rumped warbler	*Dendroica coronata*	NB/WR	fr
Black-throated gray warbler	*Dendroica nigrescens*	NB/M	fr
Townsend’s warbler	*Dendroica townsendi*	NB/M	fr
Hermit warbler	*Dendroica occidentalis*	NB/M	fr
Palm warbler	*Dendroica palmarum*	NB/A	fr
Prothonotary warbler	*Protonotaria citrea*	NB/A	fr,w
Ovenbird	*Seiurus aurocapilla*	NB/A	fr,w
Northern waterthrush	*Seiurus noveboracensis*	NB/A	fr,w
MacGillivray's warbler	*Oporornis tolmiei*	NB/M	fr
Common yellowthroat	*Geothlypis trichas*	B/YR	fr,w
Wilson's warbler	*Wilsonia pusilla*	NB/M	fr
Yellow-breasted chat	*Icteria virens*	B/SR	fr
Summer tanager	*Piranga rubra*	NB/A	fr
Western tanager	*Piranga ludoviciana*	NB/M	fr
Spotted towhee	*Pipilo maculatus*	B/YR	fr
California towhee	*Pipilo crissalis*	B/YR	fr
American tree sparrow	*Spizella arborea*	NB/A	fr
Chipping sparrow	*Spizella passerina*	NB/M	r
Brewer's sparrow	*Spizella breweri*	NB/A	g
Vesper sparrow	*Pooecetes gramineus*	NB/A	g
Lark sparrow	*Chondestes grammacus*	B/SR	fr,g
Sage sparrow	*Amphispiza belli*	NB/A	g
Savannah sparrow	*Passerculus sandwichensis*	NB/YR	g

Grasshopper sparrow	*Ammodramus savannarum*	NB/A	g
Fox sparrow	*Passerella iliaca*	NB/M	fr
Song sparrow	*Melospiza melodia*	NB/M	fr, w
Lincoln's sparrow	*Melospiza lincolnii*	NB/WR	fr
Swamp sparrow	*Melospiza georgiana*	NB/A	w
White-throated sparrow	*Zonotrichia albicollis*	NB/A	fr,g
Harris's sparrow	*Zonotrichia querula*	NB/A	fr,g
White-crowned sparrow	*Zonotrichia leucophrys*	NB/WR	fr,g
Golden-crowned sparrow	*Zonotrichia atricapilla*	NB/WR	fr,g
Dark-eyed junco	*Junco hyemalis*	NB/WR	fr
Chestnut-collared longspur	*Calcarius ornatus*	NB/A	g
Snow bunting	*Plectrophenax nivalis*	NB/A	g
Black-headed grosbeak	*Pheucticus melanocephalus*	B/SR	fr
Blue grosbeak	*Guiraca caerulea*	B/SR	g
Lazuli bunting	*Passerina amoena*	B/SR	fr
Indigo bunting	*Passerina cyanea*	NB/A	fr
Red-winged blackbird	*Agelaius phoeniceus*	B/YR	w,g
Tricolored blackbird	*Agelaius tricolor*	B/YR	w,g
Western meadowlark	*Sturnella neglecta*	B/YR	g
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	B/YR	w
Brewer's blackbird	*Euphagus cyanocephalus*	B/YR	fr,g
Great-tailed grackle	*Quiscalus mexicanus*	B/YR	w
Brown-headed cowbird	*Molothrus ater*	B/YR	fr,g
Hooded oriole	*Icterus cucullatus*	NB/A	fr
Bullock’s oriole	*Icterus bullockii*	B/SR	fr
Purple finch	*Carpodacus purpureus*	NB/A	fr
Cassin's finch	*Carpodacus cassinii*	NB/A	fr
House finch	*Carpodacus mexicanus*	B/YR	fr
Red crossbill	*Loxia curvirostra*	NB/A	fr
Pine siskin	*Carduelis pinus*	NB/M	fr
Lesser goldfinch	*Carduelis psaltria*	B/YR	fr
Lawrence's goldfinch	*Carduelis lawrencei*	NB/M	fr
American goldfinch	*Carduelis tristis*	B/YR	fr
Evening grosbeak	*Coccothraustes vespertinus*	NB/A	fr
House sparrow*	*Passer domesticus**	B/YR	fr

Table 2. Mammal species occurring on Sacramento, Delevan, Colusa, or Sutter Refuges
(* - non- native species).

ORDER/COMMON NAME	SCIENTIFIC NAME
Marsupalia (opossums)	
Virginia opossum*	*Didelphis virginiana**
Insectivora (shrews and moles)	
Broad-footed mole	*Scapanus latimanus*
Chiroptera (bats)	
Pallid bat	*Antrozous pallidus*
Big brown bat	*Eptesicus fuscus*
Silver-haired bat	*Lasionycteris noctivagans*
Western red bat	*Lasiurus blossevilli*
Hoary bat	*Lasiurus cinereus*
California myotis	*Myotis californicus*
Western small footed bat	*Myotis ciliolabrum*
Western long-earred bat	*Myotis evotis*
Little brown bat	*Myotis lucifugus*
Fringed bat	*Myotis thysanodes*
Yuma myotis	*Myotis yumanensis*
Western pipistrelle	*Pipistrellus hesperus*
Townsend's big-eared bat	*Pletocus townsendii*
Western mastiff bat	*Eumops perotis*
Brazilian free-tailed bat	*Tadarida brasiliensis*
Lagomorpha (rabbits and hares)	
Desert cottontail	*Sylvilagus audubonii*
Black-tailed hare	*Lepus californicus*
Rodentia (rodents)	
California ground squirrel	*Spermophilus beecheyi*
Western gray squirrel	*Sciurus griseus*
Botta's pocket gopher	*Thomomys bottae*
Beaver	*Castor canadensis*
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**
Carnivora (carnivores)	
Coyote	*Canis latrans*

Red fox*	*Vulpes vulpes**
Gray fox	*Urocyon cinereoargenteus*
Ringtail	*Bassariscus astutus*
Raccoon	*Procyon lotor*
Mink	*Mustela vison*
Striped skunk	*Mephitis mephitis*
River otter	*Lontra canadensis*
Feral house cat*	*Felis silvestris**
Artiodactyla (hoofed mammals)	
Black-tailed deer	*Odocoileus hemionus hemionus*

Table 3. Amphibian and reptile species occurring on Sacramento, Delevan, Colusa, or Sutter Refuges.
(* - non-native species)

FAMILY/COMMON NAME	SCIENTIFIC NAME
AMPHIBIANS	
Hylidae (treefrogs)	
Pacific treefrog	*Pseudacris regilla*
Ranidae (true frogs)	
Bullfrog*	*Rana catesbeiana**
REPTILES	
Emydidae (turtles)	
Slider*	*Trachemys scirpta**
Northwestern pond turtle	*Clemmys marmorata marmorata*
Phrynosomatidae (iguanid lizards)	
Western fence lizard	*Sceloporus occidentalis*
Colubridae (Colubrid snakes)	
Western yellow-bellied racer	*Coluber constrictor*
Gopher snake	*Pituophis catenifer*
Common kingsnake	*Lampropeltis getulus*
Common garter snake	*Thamnophis sirtalis*
Giant garter snake	*Thamnophis gigas*
Viperidae (vipers)	
Western rattlesnake	*Crotalis viridis*

Table 4. Fish species occurring on Sacramento, Delevan, Colusa, or Sutter Refuges.
(* - non- native species; A-anadromous, R-resident)

FAMILY/COMMON NAME	SCIENTIFIC NAME	MIGRATORY STATUS
Petromyzontidae (lamprey)		
Pacific lamprey	*Lampetra tridentata*	A
River lamprey	*Lampetra ayresi*	A
Western brook lamprey	*Lampetra richardsoni*	A
Acipenseridae (sturgeon)		
White sturgeon	*Acipenser transmontanus*	A
Green sturgeon	*Acipenser medirostris*	A
Clupeidae (herring)		
Threadfin shad*	*Dorosoma petenense**	A
American shad*	*Alosa sapidissima**	A
Salmonidae (salmon and trout)		
Chinook salmon, Central Valley fall- and late-fall-run ESU	*Oncorhynchus tshawytscha*	A
Chinnook salmon, Sacramento River winter-run ESU	*Oncorhynchus tshawytscha*	A
Chinook salmon, Central Valley spring-run ESU	*Oncorhynchus tshawytscha*	A
Central Valley Steelhead ESU	*Oncorhynchus mykiss*	A
Rainbow Trout*	*Salmo gairdneri**	A
Brown trout*	*Salmo trutta**	A
Cyprinidae (minnow)		
Tui chub	*Gila bicolor*	R
Thicktail chub	*Gila crassicauda*	R
Lahontan redside	*Richardsonius egregius*	R
Hitch	*Lavinia exilicauda*	R
California roach	*Hesperoleucus symmetricus*	R
Sacramento blackfish	*Orthodon microlepidotus*	R
Sacramento splittail	*Pogonichthys macrolepidotus*	R
Hardhead	*Mylopharodon conocephalus*	R
Sacramento squawfish	*Ptychocheilus grandis*	R
Speckled dace	*Rhinichthys osculus*	R
Golden shiner*	*Notemigonus crysoleucas**	R
Fathead minnow*	*Pimephales promelas**	R
Goldfish*	*Carassius auratus**	R
Carp*	*Cyprinus carpio**	R
Catostomidae (sucker)		

Sacramento sucker	*Catostomus occidentalis*	R
Ictaluridae (catfish)		
Black bullhead*	*Ictalurus melas**	R
Brown bullhead*	*Ictalurus nebulosus**	R
Yellow bullhead*	*Ictalurus natalis**	R
White catfish*	*Ictalurus catus**	R
Channel catfish*	*Ictalurus punctatus**	R
Poeciliidae (livebearer)		
Mosquitofish*	*Gambusia affinis**	R
Atherinidae (silverside)		
Mississippi silverside*	*Menidia audens**	R
Gasterosteidae (stickleback)		
Threespine stickleback*	*Gasterosteus aculeatus**	R
Percichthyidae (temperate basses)		
Striped bass*	*Morone saxatilis**	A
Centrarchidae (sunfish)		
Sacramento perch	*Archoplites interruptus*	R
Bluegill*	*Lepomis macrochirus**	R
Redear sunfish*	*Lepomis microlophus**	R
Pumpkinseed*	*Lepomis gibbosus**	R
Green sunfish*	*Lepomis cyanellus**	R
Warmouth*	*Lepomis gulosus**	R
White crappie*	*Pomoxis annularis**	R
Black crappie*	*Pomoxis nigromaculatus**	R
Largemouth bass*	*Micropterus salmoides**	R
Smallmouth bass*	*Micropterus dolomieui**	R
Spotted bass*	*Micropterus punctulatus**	R
Percidae (perch)		
Bigscale logperch*	*Percina macrolepida**	R
Embiotocidae (surfperch)		
Tule perch	*Hysterocarpus traski*	R
Cottidae (sculpin)		
Prickly sculpin	*Cottus asper*	R
Riffle sculpin	*Cottus gulosus*	R
Staghorn sculpin	*Leptocottus armatus*	R

Table 5. Plant species occurring on Sacramento, Delevan, Colusa, or Sutter Refuges.
(* - non- native species)

FAMILY/COMMON NAME	SCIENTIFIC NAME
VASCULAR PLANTS	
FERN ALLIES	
Equisetaceae (Horsetail Family)	
Large mosquito fern	*Azolla filiculoides*
Hairy water-clover	*Marsilea vestita*
American pill-wort	*Pilularia americana*
GYMNOSPERMS	
Cupressaceae (Cypress Family)	
Arizona cypress	*Cupressus arizonica*
Monterey cypress	*Cupressus macrocarpa*
DICOT FLOWERING PLANTS	
Aceraceae (Maple Family)	
Box elder	*Acer negundo californicum*
Aizoaceae (Fig-marigold Family)	
Slender-leaved iceplant*	*Mesembryanthemum nodiflorum**
Amaranthaceae (Amaranth Family)	
Tumbleweed*	*Amaranthus albus**
California amaranth	*Amaranthus californicus*
Red-rooted amaranth*	*Amaranthus retroflexus**
Anacardiaceae (Sumac Family)	
Western poison-oak	*Toxicodendron diversilobum*
Apiaceae (Carrot Family)	
Bur-chervil*	*Anthriscus caucalis*
Poison-hemlock*	*Conium maculatum**
Coyote thistle	*Eryngium vaseyi*
Fennel*	*Foeniculum vulgare**
Alkali-parsnip	*Lomatium caruifolium denticulatum*
Knotted hedge-parsley*	*Torilis nodosa**
Asclepiadaceae (Milkweed Family)	
Narrow-leaved milkweed	*Asclepias fascicularis*
Showy milkweed	*Asclepias speciosa*
Asteraceae (Sunflower Family)	
Blow-wives	*Achyrachaena mollis*
Western ragweed	*Ambrosia psilostachya*
Mayweed*	*Anthemis cotula**
Mugwort	*Artemisia douglasiana*
California aster	*Aster chilensis*

Annual saltmarsh aster	*Aster subulatus ligulatus*
Coyote-brush	*Baccharis pilularis*
Sticktight	*Bidens frondosa*
Yellow-carpet	*Blennosperma nanum nanum*
Italian plumeless-thistle*	*Carduus pycnocephalus**
Yellow star-thistle*	*Centaura solstitialis**
Valley pineapple-weed	*Chamomilla occidentalis*
Common pineapple-weed	*Chamomilla suaveolens*
Chicory*	*Cichorium intybus**
Bull thistle*	*Cirsium vulgare**
South American horseweed*	*Conyza bonariensis**
Canadian horseweed	*Conyza canadensis glabrata*
Many-flowered horseweed*	*Conyza floribunda**
Common brass-buttons*	*Cotula coronopifolia**
Western goldenrod	*Euthamia occidentalis*
California cudweed	*Gnaphallium californicum*
Weedy cudweed*	*Gnaphallium luteo-album**
Western marsh cudweed	*Gnaphallium palustre*
Cotton-batting plant	*Gnaphallium stramineum*
Great valley gumplant	*Grindelia camporum*
Common sunflower	*Helianthus annuus*
Hayfield tarweed	*Hemizonia congesta*
Pappose spikeweed	*Hemizonia parryi*
Common spikeweed	*Hemizonia pungens*
Smooth cat's ear*	*Hypochoeris glabra**
Willow-leaved lettuce*	*Lactuca saligna**
Prickly lettuce*	*Lactuca serriola**
California goldfields	*Lasthenia californica*
Fremont's goldfields	*Lasthenia fremontii*
Woolly goldfields	*Lasthenia minor*
Alkali goldfields	*Lasthenia platycarpha*
Smooth tidytips	*Layia chrysanthemoides*
Sierra foothills microseris	*Microseris acuminata*
Douglas' microseris	*Microseris douglasii*
Elegant microseris	*Microseris elegans*
Bristly oxtongue*	*Picris echioides**
Dwarf wooly-marbles	*Psilocarphus brevissimus brevissimus*
Oregon woolly marbles	*Psilocarphus oregonus*
Old-man-in-the-spring*	*Senecio vulgaris**
Milk-thistle*	*Silybum marianum**
Spiny-leaved sow-thistle*	*Sonchus asper asper**

Common sow-thistle*	*Sonchus oleraceus**
Salsify*	*Tragopogon porrifolius**
Spiny cocklebur	*Xanthium spinosum*
Cocklebur	*Xanthium strumarium*
Bignoniaceae (Bignonia Family)	
Trumpet-creeper*	*Campsis radicans**
Boraginaceae (Borage Family)	
Bugloss fiddleneck	*Amsinckia lycopsoides*
Common fiddleneck	*Amsinckia menziesii*
Wild heliotrope	*Heliotropium curassavicum*
Smooth-stemmed popcorn-flower	*Plagiobothrys leptocladus*
Scribe's popcorn-flower	*Plagiobothrys scriptus*
Large-flowered stipitate popcorn-flower	*Plagiobothrys stipitatus stipitatus*
Small-flowered stipitate popcorn-flower	*Plagiobothrys stipitatus micranthus*
Brassicaceae (Mustrad Family)	
Black mustard*	*Brassica nigra**
Shepherd's purse*	*Capsella bursa-pastoris**
Lens-podded hoary-cress*	*Cardaria chalepensis**
Western bitter-cress	*Cardamine oligosperma*
Wormseed mustard*	*Erysimum cheiranthoides**
Mediterranean hoary-mustard*	*Hirschfeldia incana**
Alkali pepper-grass	*Lepidium dictyotum dictyotum*
Sharp-toothed pepper-grass	*Lepidium dictyotum acutidens*
Broad-leved mustard*	*Lepidium latifolium**
Dwarf pepper-grass	*Lepidium latipes latipes*
Heckard's dwarf pepper-grass	*Lepidium latipes heckardii*
Shining pepper-grass	*Lepidium nitidum nitidum*
Clasping pepper-grass*	*Lepidium perfoliatum**
Pinnatifid pepper-grass*	*Lepidium pinnatifidum**
Radish*	*Raphanus sativus**
Oriental hedge-mustard*	*Sisymbrium orientale**
Slender tropidocarpum	*Tropidocarpum gracile*
Callitrichaceae (Water-starwort Family)	
Winged water-starwort	*Callitriche marginata*
Campanulaceae (Bellflower Family)	
Hoover's downingia	*Downingia bella*
Harlequin downingia	*Downingia insignis*
Folded downingia	*Downingia ornatissima*

Caprifoliaceae (Honeysuckle Family)

Blue elderberry	*Sambucus mexicana*

Caryophyllaceae (Pink Family)

Sticky mouse-eared chickweed*	*Cerastium glomeratum**
Herniaria*	*Herniaria hirsuta hirsuta**
Western pearlwort	*Sagina decumbens*
White-flowered sandspurry	*Spergularia macrantha*
Salt-marsh sandspurry	*Spergularia marina*
Ruby sandspurry*	*Spergularia rubra**
Common chickweed*	*Stellaria media**

Ceratophyllaceae (Hornwort Family)

Hornwort	*Ceratophyllum demersum*

Chenopodiaceae (Goosefoot Family)

Iodine-bush	*Allenrolfea occidentalis*
Silverscale	*Atriplex argentea*
Heartscale	*Atriplex cordulata*
Crownscale	*Atriplex coronata coronata*
Brittlescale	*Atriplex depressa*
Ball saltbush	*Atriplex fruticulosa*
Variable seeded saltbush*	*Atriplex heterosperma**
San Joaquin spearscale	*Atriplex joaquiniana*
Big saltbush	*Atriplex lentiformis*
Vernal-pool saltbush	*Atriplex persistens*
Many-fruited saltbush	*Atriplex polycarpa*
Tumbling oracle*	*Atriplex rosea**
Australian saltbush*	*Atriplex semibaccata**
Spearscale	*Atriplex triangularis*
Hyssop-leaved bassia*	*Bassia hyssopifolia**
Lamb's-quarters*	*Chenopodium alnum**
Mexican tea*	*Chenopodium ambrosioides**
Nettled-leaved goosefoot*	*Chenopodium murale**
Parish's pickleweed	*Salicornia subterminalis*
Woody pickleweed	*Salicornia virginica*
Russian thistle*	*Salsola tragus**
Fleshy-leaved Russian-thistle*	*Salsola soda**
Horned seablite	*Suaeda calceoliformis*
Bush seepweed	*Suaeda moquinii*

Convolvulaceae (Morning-glory Family)

Bindweed*	*Convolvulus arvensis**
Alkali-weed	*Cressa truxillensis*

Crassulaceae (Stonecrop Family)

Water pygmyweed	*Crassula aquatica*
Pygmyweed	*Crassula connata*
Mossy pigmyweed*	*Crassula tillaea**
Cuscutaceae (Dodder Family)	
California dodder	*Cuscuta californica*
Alkaline dodder	*Cuscuta salina*
Dipsacaceae (Teasel Family)	
Wild teasel*	*Dipsacus fullonum**
Fuller's teasel*	*Dipsacus sativus**
Elatinaceae (Waterwort Family)	
Texas bergia	*Bergia texana*
Ricefield waterwort*	*Elatine ambigua**
California waterwort	*Elatine californica*
Chilean waterwort	*Elatine chilense*
Euphorbiaceae (Spurge Family)	
Hoover's spurge	*Chamaesyce hooveri*
Spotted spurge*	*Chamaesyce maculata**
Thyme-leaved spurge	*Chamaesyce serpyllifolia*
Turkey-mullein	*Eremocarpus setigerus*
Fabaceae (Legume Family)	
Ferris's milk-vetch	*Astragalus tener*
Bird's-foot-trefoil*	*Lotus corniculatus**
Spanish lotus	*Lotus purshianus purshianus*
Wrangel lotus	*Lotus wrangelianus*
Pink-flowered lupine	*Lupinus microcarpus microcarpus*
Small-flowered lupine	*Lupinus polycarpus*
Common bur-clover*	*Medicago polymorpha**
White sweet-clover*	*Melilotus alba**
Indian sweet-clover*	*Melilotus indica**
Indian clover	*Trifolium albopurpureum*
Deceptive notch-leaved clover	*Trifolium bifidum decipiens*
Foothill clover	*Trifolium cioliolatum*
Involucrate cowbag clover	*Trifolium depauperatum amplectens*
Sour clover	*Trifolium fucatum*
Rose clover*	*Trifolium hirtum**
Small-headed clover	*Trifolium microcephalum*
White-tipped clover	*Trifolium variegatum*
Red-flowered vetch*	*Vicia benghalensis**
Garden vetch*	*Vicia sativa sativa**
Winter vetch*	*Vicia villosa varia**
Fagaceae (Beech Family)	

Valley oak	*Quercus lobata*
Frankeniaceae (Frankenia Family)	
Alkali sea-heath	*Frankenia salina*
Gentianaceae (Gentian Family)	
June centaury	*Centaurium muehlenbergii*
Geraniaceae (Geranium Family)	
Long-beaked stork's-bill*	*Erodium botrys**
Short-fruited stork's-bill*	*Erodium brachycarpum**
Red-stemmed filaree*	*Erodium cicutarium**
White-stemmed filaree*	*Erodium moschatum**
Cut-leaved geranium*	*Geranium dissectum**
Hydrophyllaceae (Water-leaf Family)	
Great valley phacelia	*Phacelia ciliata*
Juglandaceae (Walnut Family)	
Northern California black walnut	*Juglans californica hindsii*
Lamiaceae (Mint Family)	
Giraffehead*	*Lamium amplexicaule**
Cut-leaved bugleweed	*Lycopus americanus*
Horehound*	*Marrubium vulgare**
American wild mint	*Mentha arvensis*
Pennyroyal*	*Mentha pulegium**
Sacramento pogogyne	*Pogogyne zizyphoroides*
Rigid hedge-nettle	*Stachys ajugoides rigida*
Sonoma hedge-nettle	*Stachys stricta*
Lentibulariaceae (Bladderwort Family)	
Humped bladderwort*	*Utricularia gibba**
Limnanthaceae (Meadowfoam Family)	
Rosy meadowfoam	*Limnanthes douglasii*
Lythraceae (Loosestrife Family)	
Valley redstem	*Ammannia coccinea*
Robust redstem	*Ammannia robusta*
California loosestrife	*Lythrum californicum*
Hyssop loosestrife*	*Lythrum hyssopifolium**
Slender-fruited loosetrife*	*Lythrum tribracteatum**
Malvaceae (Mallow Family)	
Velvetleaf*	*Abutilon theophrasti**
Rose mallow (California hibiscus)	*Hibiscus lasiocarpus*
Bull mallow*	*Malva nicaeensis**
Little mallow*	*Malva parviflora**
Alkali mallow	*Malvella leprosa*

Fringed checker-mallow	*Sidalcea diploscypha*
Hairy checkerbloom	*Sidalcea hirsute*
Martyniaceae (Unicorn-plant Family)	
Common unicorn-plant*	*Proboscidea louisianica louisinica**
Molluginaceae (Carpet-weed Family)	
Glinus*	*Glinus lotoides**
Indian chickweed*	*Mollugo verticillata**
Moraceae (Mulberry Family)	
Edible fig*	*Ficus carica**
White mulberry*	*Morus alba*
Myrtaceae (Myrtle Family)	
Red river gum*	*Eucalyptus camaldulensis**
Oleaceae (Olive Family)	
Oregon ash	*Fraxinus latifolia*
Olive	*Olea europaea*
Onagraceae (Evening-primrose Family)	
Purple clarkia	*Clarkia purpurea quadrivulnera*
Tall annual willowherb	*Epilobium brachycarpum*
Fringed willowherb	*Epilobium ciliatum ciliatum*
Cleistogamous spike-primrose	*Epilobium cleistogamum*
Smooth spike-primrose	*Epilobium pygmaeum*
Yellow waterweed	*Ludwigia peploides peploides*
Montevideo waterweed	*Ludwigia peploides montevidensis*
Oxalidaceae (Wood-sorel Family)	
Creeping wood-sorel*	*Oxalis corniculata**
Plantaginaceae (Plantain Family)	
Cut-leaved plantain*	*Plantago coronopus**
Elongate plantain	*Plantago elongata*
Erect plantain	*Plantago erecta*
English plantain*	*Plantago lanceolata**
Common plantain*	*Plantago major**
Polemoniaceae (Phlox Family)	
Bicolored linanthus	*Linanthus bicolor*
White-flowered navarretia	*Navarretia leucocephala*
Polemoniaceae (Phlox Family)	
Tehama navarretia	*Navarretia heterandra*
Polygonaceae (Buckwheat Family)	
Swamp smartweed	*Polygonum amphibium emersum*
Common knotweed*	*Polygonum arenastrum**
Water-pepper*	*Polygonum hydropiper**
Mild water-pepper	*Polygonum hydropiperoides*

Willow-weed	*Polygonum lapathifolium*
Lady's thumb*	*Polygonum persicaria**
Prolific knotweed*	*Polygonum prolificum**
Dotted smartweed	*Polygonum punctatum*
Curly dock*	*Rumex crispus**
Toothed dock*	*Rumex dentatus**
Portulacaceae (Purslane Family)	
Redmaids	*Calandrinia ciliata*
Water montia	*Montia fontana*
Common purslane*	*Portulaca oleracea**
Ranunculaceae (Buttercup Family)	
Royal larkspur	*Delphinium variegatum*
Tiny mousetail	*Myosurus minimus*
Sessile moustetail	*Myosurus sessilis*
Rosaceae (Rose Family)	
Pyracantha*	*Pyracantha koidzumii**
California rose	*Rosa californica*
Rambler rose*	*Rosa mutiflora**
Himalayan blackberry*	*Rubus discolor**
California blackberry	*Rubus ursinus*
Rubiaceae (Madder Family)	
California button-willow	*Cephalanthus occidentalis californicus*
Wall bedstraw*	*Galium parisiense**
Tiny bedstraw*	*Galium murale**
Salicaceae (Willow Family)	
Fremont's cottonwood	*Populus fremontii*
Sandbar willow	*Salix exigua*
Goodding's black willow	*Salix gooddingii*
Red willow	*Salix laevigata*
Arroyo willow	*Salix lasiolepis*
Scrophulariaceae (Figwort Family)	
Snapdragon	*Antirrhinum spp.*
Round-leved water-hyssop*	*Bacopa rotundifolia**
Valley-tassels	*Castilleja attenuata*
Purple owl-clover	*Castilleja exserta*
Creamsacs	*Castilleja rubicundula*
Palmate bird's-beak	*Cordylanthus palmatus*
Sharp-leaved fluellin*	*Kickxia elatine**
Seep monkey-flower	*Mimulus guttatus*
Johnnytuck	*Triphysaria eriantha*

Moth mullein*	*Verbascum blattaria**
Water speedwell*	*Veronica anagallis-aquatica**
Purslane speedwell	*Veronica peregrina xalapensis*
Solanaceae (Nightshade Family)	
Tree tobacco*	*Nicotiana glauca**
Sharp-leaved ground-cherry	*Physalis acutifolia*
Lance-leaved ground-cherry*	*Physalis lanceifolia**
American black nightshade	*Solanum americanum*
White horsenettle*	*Solanum elaeagnifolium**
Tamaricaceae (Tamarisk Family)	
Small-flowered tamarisk*	*Tamarix parviflora**
Salt-cedar*	*Tamarix ramosissima**
Urticaceae (Nettle Family)	
Hoary creek nettle	*Urtica dioica holosericea*
Verbenaceae (Vervain Family)	
Creeping lippia	*Phyla nodiflora nodiflora*
Rosy lippia*	*Phyla nodiflora rosea**
South American vervain*	*Verbena bonariensis**
Halberd-leaved vervain	*Verbena hastata*
Western vervain	*Verbena lasiostachys scabrida*
Shore vervain	*Verbena litoralis*
Vitaceae (Grape Family)	
California wild grape	*Vitis californica*
Zygophyllaceae (Caltrop Family)	
Puncture-vine*	*Tribulus terrestris**
MONOCOT FLOWERING PLANTS	
Alismataceae (Water-plantain Family)	
Water-plantain	*Alisma plantago-aquatica*
Fringed water-plantain	*Damasonium californicum*
Burhead	*Echinodorus berteroi*
Long-lobed arrowhead	*Sagittaria longiloba*
Montevideo arrowhead	*Sagittaria montevidensis calycina*
Arecaceae (Palm Family)	
Canary Island date palm*	*Phoenix canariensis**
California fan palm	*Washingtonia filifera*
Cyperaceae (Sedge Family)	
Santa Barbara sedge	*Carex barbarae*
Clustered field sedge	*Carex praegracilis*
Small-flowered cyperus*	*Cyperus difformis**
Tall cyperus	*Cyperus eragrostis*
Red-rooted cyperus	*Cyperus erythrorhizos*

False nutsedge	*Cyperus strigosus*
Pale spike-rush	*Eleocharis macrostachya*
Engelmann's spike-rush	*Eleocharis obtusa engelmannii*
Little-headed spike-rush	*Eleocharis parvula*
Hard-stemmed tule	*Scirpus acutus occidentalis*
River bulrush	*Scirpus fluvialtilis*
Saltmarsh bulrush	*Scirpus maritimus*
Rough-seeded bulrush*	*Scripus mucronatus**
Tuberous bulrush*	*Scirpus tuberosus**
Hydrocharitaceae (Waterweed Family)	
Ricefield water-nymph*	*Najas graminea**
Juncaceae (Rush Family)	
Baltic Rush	*Juncus balticus balticus*
Common toad rush	*Juncus bufonius bufonius*
Congested toad rush	*Juncus bufonius congestus*
Pacific rush	*Juncus effusus pacificus*
Lemnaceae (Duckweed Family)	
Summer duckweed	*Lemna aequinoctialis*
Inflated duckweed	*Lemna gibba*
Common duckweed	*Lemna minor*
Least duckweed	*Lemna minuta*
Turion duckweed	*Lemna turionifera*
Common duckmeat	*Spirodela polyrhiza*
Liliaceae (Lily Family)	
Clasping onion	*Allium amplectens*
Garden asparagus*	*Asparagus officinalis**
Harvest brodiaea	*Brodiaea coronaria coronaria*
Elegant brodiaea	*Brodiaea elegans elegans*
Yellow mariposa-lily	*Calochortus luteus*
Muilla	*Muilla maritima*
Ithuriel's spear	*Triteleia laxa*
Fremont's death-camas	*Zigadenus fremontii*
Poaceae (Grass Family)	
Avnes bentgrass*	*Agrostis avenacea**
Pacific meadow foxtail	*Alopecurus saccatus*
Giant-reed*	*Arundo donax**
Barbed oat*	*Avena barbata**
Wild oat*	*Avena fatua**
Lesser quaking-grass*	*Briza minor**
Ripgut brome*	*Bromus diandrus**
Soft chess*	*Bromus hordeaceus**

Red brome*	*Bromus madritensis rubens**
Uruguayan pampasgrass*	*Cortaderia selloana**
Swamp pricklegrass*	*Crypsis schoenoides**
African pricklegrass*	*Crypsis vaginiflora**
Bermuda grass*	*Cynodon dactylon**
Annual hairgrass	*Deschampsia danthonioides*
Hairy crabgrass*	*Digitaria sanguinalis**
Saltgrass	*Distichlis spicata*
Jungle-rice*	*Echinochloa colona**
Water-grass*	*Echinochloa crus-galli**
Blue wild-rye	*Elymus glaucus glaucus*
Tall wheatgrass*	*Elytrigia pontica**
Tall fescue	*Festuca arundinacea*
Barbgrass*	*Hainardia cylindrica**
Meadow barley	*Hordeum brachyantherum brachyantherum*
Low barley	*Hordeum depressum*
Foxtail barley	*Hordeum jubatum*
Mediterranean barley*	*Hordeum marinum gussoneanum**
Glaucous barley*	*Hordeum murinum glaucum**
Hare wall*	*Hordeum murinum leporinum**
Rice cutgrass	*Leersia oryzoides*
Bearded sprangletop	*Leptochloa fascicularis*
Mexican sprangletop	*Leptochloa uninervia*
Annual ryegrass*	*Lolium multiflorum**
Alkali ryegrass	*Leymus triticoides*
Hairy orcuttgrass	*Orcuttia pilosa*
Cultivated rice*	*Oryza sativa**
Smooth witchgrass*	*Panicum dichotomiflorum**
Sicklegrass*	*Parapholis incurva**
Dallisgrass*	*Paspalum dilatatum**
Knotgrass	*Paspalum distichum*
Harding-grass*	*Phalaris aquatica**
Lemmon's canarygrass	*Phalaris lemmonii*
Lesser canarygrass*	*Phalaris minor**
Paradox canarygrass*	*Phalaris paradoxa**
Annual bluegrass*	*Poa annua**
Mediterranean beardgrass*	*Polypogon maritimus**
Annual beardgrass*	*Polypogon monspeliensi**
Lesser alkaligrass	*Puccinellia simplex*
Perennial brstlegrass	*Setaria parviflora*

Yellow bristlegrass*	*Setaria pumial**
Johnsongrass*	*Sorghum halepense**
Greene's tuctoria	*Tuctoria greenei*
Foxtail fescue*	*Vulpia myuros hisuta**
Rattail fescue*	*Vulpia myuros myuros**
Potamogetonaceae (Pondweed Family)	
Crispate-leaved pondweed*	*Potamogeton crispus*
Leafy pondweed	*Potamogeton foliosus*
Sago pondweed	*Potamogeton pectinatus*
Long-leaved pond weed	*Potamogeton nodosus*
Typhaceae (Cattail Family)	
Narrow-leaved cattail	*Typha angustifolia*
Southern cattail	*Typha domingensis*
Broad-leaved cattail	*Typha latifolia*
Zannichelliaceae (Horned-pondweed Family)	
Horned-pondweed	*Zannichelliapalustris*

Appendix L. Compliance with Section 7 of the Endangered Species Act

An Intra-Service Section 7 Consultation has been initiated with the Sacramento Fish and Wildlife Office and will be completed prior to the final approval of this CCP. In addition, a letter has been forward to NOAA – Fisheries requesting a review and concurrence with the CCP for species under their jurisdiction.

Appendix M. Applicable Laws and Executive Orders and Relationships to Federal, State, and Local Policies and Plans

This appendix contains an overview of laws, executive orders, polices, and plans created by federal, state and local agencies with jurisdiction in the vicinity of Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges (Refuges). Table 1 contains a list of applicable laws and executive orders that may affect the Refuges' Comprehensive Conservation Plan (CCP) or the U.S. Fish and Wildlife Service's implementation of the CCP. A brief description of the law, executive order, policy, or plan is included as well as how it relates to the CCP.

1.0 Federal Government

Table 1. Applicable Laws and Executive Orders

Law, Regulation, or Guideline	Description	Relation to the CCP
Agency Coordination		
Executive Order No. 12372, Intergovernmental Review of Federal Programs.	Requires that Federal agencies afford other agencies review of documents associated with Federal programs.	Copies of this environmental assessment were sent to the California State Clearinghouse, Federal and State agencies, and local governments.
Human Rights Regulations		
Executive Order 12898, Environmental Justice. February 11, 1994 Americans with Disabilities Act of 1990	Requires Federal agencies to consider the effects of projects and policies on minority and lower income population. Provides for access to Federal facilities for the disabled.	The proposed action will not have a disproportionately high and adverse human health or environmental effect on minority populations and low-income populations. The proposed action promotes reasonable and appropriate uses of the land that preserve the natural character and protect the natural resources of the area.
Cultural Resources Regulations		
Antiquities Act of 1906	This act authorizes the scientific investigation of antiquities on Federal land. It prohibits and provides penalties for unauthorized search for or collection of artifacts or other objects of scientific interest. The Act also authorizes the president to establish national monuments and cultural areas on Federal lands.	The Service will continue to comply with this Act under the CCP.

Table 1. Applicable Laws and Executive Orders		
Law, Regulation, or Guideline	**Description**	**Relation to the CCP**
Executive Order No. 11593, Protection and Enhancement of the Cultural Environment	States that if the Service proposes any development activities that may affect archaeological or historical sites, the Service will consult with Federal and State Historic Preservation Officers to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.	The Service will continue to comply with this Order under the CCP.
Native American Graves Protection and Repatriation Act of 1990 (PL 101-601; 25 USC 3001 et seq.)	Regulations for the treatment of Native American graves, human remains, funeral objects, sacred objects, and other objects of cultural patrimony. Requires consultation with Native American Tribes during Federal project planning.	The Service will continue to comply with this Act under the CCP.
Archaeological Resources Protection Act of 1979 (PL 96-95; 93 STAT 722; 16 USC 470aa-47011), as amended	Protects materials of archeological interest from unauthorized removal or destruction and requires Federal managers to develop plans to locate archeological resources.	The Service will continue to comply with this Act under the CCP.
Executive Order 13007, Indian Sacred Sites. 24 May, 1996	Provides for access to, and ceremonial use of, Indian sacred sites on Federal lands used by Indian religious practitioners and direction to avoid adversely affecting the physical integrity of such sites.	The Service will continue to comply with this Order under the CCP.
American Indian Religious Freedom Act 1978 (PL 95-341; 92 STAT 469; 42 USC 1996)	Provides for freedom of Native Americans to believe, express, and exercise their traditional religion, including access to important sites.	The Service will continue to comply with this Act under the CCP.
Archaeological and Historic Preservation Act of 1974 (PL 93-291; 88 STAT 174; 16 USC 469)	Provides for the preservation of historical buildings, sites, and objects of national significance.	The Service will continue to comply with this Act under the CCP.
National Historic Preservation Act of 1966 (PL 89-665; 50 STAT 915; 16 USC 470 et seq.; 36 CFR 800), as amended	Requires Federal agencies to consider the effects of any actions or programs on historical properties.	The Service will continue to comply with this Act under the CCP.
Biological Resources Regulations		
Endangered Species Act of 1973 (16 USC 1531 et seq.), as amended	Provides for protection of plants, fish, and wildlife that have a designation as threatened or endangered.	An Intra-Service Section 7 will be completed with the Service and with NOAA-Fisheries for endangered and threatened species on the Refuges.
National Environmental Policy Act of 1969 (42 USC 4321 et seq)	Requires analysis, public comment, and reporting for environmental impacts of Federal actions.	The public has been notified of the availability of the draft Environmental Assessment and had a 45-day period to provide comments.

Table 1. Applicable Laws and Executive Orders		
Law, Regulation, or Guideline	**Description**	**Relation to the CCP**
Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds. Jan. 10, 2001.	Instructs Federal agencies to conserve migratory birds by several means, including the incorporation of strategies and recommendations found in Partners in Flight Bird Conservation Plans, the North American Waterfowl Plan, the North American Waterbird Conservation Plan, and the United States Shorebird Conservation Plan, into agency management plans and guidance documents.	The Service has incorporated the strategies and recommendations of the listed management plans into the CCP to conserve migratory birds. The Service will continue to comply with this Order under the CCP.
Fish and Wildlife Conservation Act of 1980 (16 USC 661-667e), as amended	Requires the Service to monitor non-game bird species, identify species of management concern, and implement conservation measures to preclude the need for listing under ESA.	The Service will continue to comply with this Act under the CCP.
The Bald and Golden Eagle Protection Act of 1940 (16 USC 668 et seq.)	Provides protection for bald and golden eagles.	The Service will continue to comply with this Act under the CCP.
Migratory Bird Treaty Act of 1918, as amended	Provides protection for bird species that migrate across state and international boundaries.	The Service will continue to comply with this Act under the CCP.
Anadromous Fish Conservation Act of 1965 (16 USC 757a-757g)	To conserve, develop, and enhance anadromous fish and the fisheries of the Great Lakes and Lake Champlain.	The Service will continue to comply with this Act under the CCP.
Clean Air Act of 1963, as amended (USC	Provides for the protection of air quality. Regulates air emissions from area, stationary, and mobile sources.	The Service will continue to comply with this Act under the CCP.
The Clean Water Act of 1972, Section 404 (33 USC 1344 et seq.), as amended	Provides for protection of water quality.	The Service will continue to comply with this Act under the CCP.
Fish and Wildlife Act of 1956 (16 USC 742a-743j)	Provides Secretary of Interior with authority to protect and manage fish and wildlife resources.	The Service will continue to comply with this Act under the CCP.
National Wildlife Refuge System Volunteer and Community Partnership Enhancement Act (1998)	Amends the Fish and Wildlife Act of 1956 to promote volunteer programs and community partnerships for the benefit of national wildlife refuges, and for other purposes.	The Service will continue to promote volunteer programs and community partnerships under the CCP.
Fish and Wildlife Coordination Act of 1958	Requires equal consideration and coordination of wildlife conservation with other water resource development programs.	The Service will continue to comply with this Act under the CCP.
Emergency Wetlands Resources Act of 1986	Promotes the conservation of migratory waterfowl and offsets or prevent the serious loss of wetlands by the acquisition of wetlands and other essential habitats.	The Service will continue to comply with this Act under the CCP.

Table 1. Applicable Laws and Executive Orders		
Law, Regulation, or Guideline	**Description**	**Relation to the CCP**
Federal Noxious Weed Act of 1990	Requires the use of integrated management systems to control or contain undesirable plant species, and an interdisciplinary approach with the cooperation of other Federal and State agencies.	The Service will continue to comply with this Act under the CCP.
Executive Order 13112, Invasive Species, 1999	Directs federal agencies to prevent introduction and provide control of invasive species.	The Service will continue to comply with this Act under the CCP.
Rivers and Harbor Act of 1899	Requires authorization by the U.S. Army Corps of Engineers prior to any work in, on, over, and under a navigable water of the U.S.	The Service will continue to comply with this Act under the CCP.
Hazardous Materials Regulations		
Oil Pollution Act of 1990 (PL 101-380; 33 USC 2701, et seq.)	Provides oil pollution policies and protections.	The Service will continue to comply with this Act under the CCP.
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (PL 96-510; 42 USC 9601, et seq.)	Provides mechanism for hazardous waste clean up.	No evidence of contaminants or hazardous waste was identified in the project area.
Land and Water Use Regulations		
The National Wildlife Refuge System Administration Act of 1966 (16 USC 668dd-668ee), National Wildlife Refuge System Improvement Act of 1997 (PL 105-57)	Administration, management, and planning for National Wildlife Refuges, Amends the National Wildlife Refuge System Administration Act of 1966. Requires development of CCPs for all refuges outside of Alaska.	The Service determined that hunting, wildlife observation, photography, environmental education, interpretation, research, grazing, plant gathering, bicycling, commercial photography, and mosquito and other vector control are compatible with the purposes for which the Refuges were established. This document will satisfy this Act.
Executive Order No. 11988, Floodplain Management	Provides for the support, preservation, and enhancement of the natural and beneficial values of floodplains.	No structure that could either be damaged by or significantly influence the movement of floodwater in the project area is planned for construction by the Service, thus the proposed action is consistent with this Order.

Table 1. Applicable Laws and Executive Orders		
Law, Regulation, or Guideline	**Description**	**Relation to the CCP**
Executive Order No. 11990, Protection of Wetlands	Provides for the conservation of the natural and beneficial values of wetlands and their associated habitats.	The Service plans no detrimental impacts to wetlands but plans to preserve wetlands in the project area, thus the proposed action is consistent with this Order.
The Refuge Recreation Act of 1962, as amended	Provides for recreation use that is compatible with the primary purpose of a refuge.	The Service determined that hunting, wildlife observation, photography, environmental education, interpretation, research, grazing, plant gathering, bicycling, commercial photography, and mosquito and other vector control are compatible with the purposes for which the Refuges were established. This document will satisfy this Act.
Fish and Wildlife Improvement Act of 1978	Improves administration of fish and wildlife programs and amends earlier laws including Refuge Recreation Act, NWRS Administration Act, and Fish and Wildlife Act of 1956. Authorizes the Secretary to accept gifts or real and personal property on behalf of the U.S. Also authorizes use of volunteers on Service projects and appropriations to carry out a volunteer program.	The Service will continue to comply with this Act under the CCP.
Refuge Revenue Sharing Act (16 U.S.C. 715s)	Section 401 of the Act of June 15, 1935, (49 Stat. 383) provided for payments to counties in lieu of taxes, using revenues derived from the sale of products from refuges.	The Service will continue to comply with this Act under the CCP.
Land and Water Conservation Fund Act of 1948	This act provides funding through receipts from the sale of surplus federal land, appropriations from oil and gas receipts from the outer continental shelf, and other sources of for land acquisition under several authorities. Appropriations from the fund may be used for matching grants to states for outdoor recreation projects and for land acquisition by various federal agencies, including the Fish and Wildlife Service.	The Service will continue to comply with this Act under the CCP.

Table 1. Applicable Laws and Executive Orders		
Law, Regulation, or Guideline	**Description**	**Relation to the CCP**
Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715d, 715e,715f-715r)	Established the Migratory Bird Conservation Commission. The Commission approves acquisition of land and water, or interests therein, and sets the priorities for acquisition of lands by the Secretary for sanctuaries or for other management purposes.	The Service will continue to comply with this Act under the CCP.
Wilderness Act of 1964 (16 U.S.C. 1131-1136; 78 Stat. 890)	Directs the Secretary of the Interior to review, within ten years, every roadless area of 5,000 acres or more and every roadless island regardless of size within the National Wildlife Refuge System and to recommend suitability of each such area.	The Refuges do not contain 5,000 acres of roadless land.

2.0 Fish and Wildlife Service Plans, Policies and Programs

Sacramento, Delevan, Colusa, and Sutter Refuges are managed as part of the National Wildlife Refuge System within a framework provided by legal and policy guidelines reviewed in Chapter 1 of this CCP. The role of the Service is introduced in Chapter 1, as well as the mission of the National Wildlife Refuge System. The Service's policies on Compatibility, Planning, and Biological Integrity, Diversity, and Environmental Health mandated by the National Wildlife Refuge System Improvement Act of 1977 are also discussed in Chapter 1, which also provides a general overview of regulatory context. The Comprehensive Conservation Planning process is discussed in Chapter 2.

The Service is actively involved in the development and implementation of a number of conservation plans for migratory bird species, including the Partners in Flight North American Landbird Conservation Plan, North American Waterfowl Management Plan, United States Shorebird Conservation Plan, and the North American Waterbird Conservation Management Plan. Regional step-down plans specific to the area are discussed below.

2.1 North American Waterfowl Management Plan

(U. S. Fish and Wildlife Service and Canadian Wildlife Service. 1986. North American Waterfowl Management Plan. U. S. Dept. of Int. Rep., Washington, D. C. 19 pp.)

The North American Waterfowl Management Plan documents the strategy between the United States, Canada and Mexico to restore waterfowl populations through habitat protection, restoration and enhancement. Implementation of the plan is at the regional level. The Sacramento, Delevan, Colusa, and Sutter Refuges are covered by the Central Valley Joint Venture. The Central Valley, from Red Bluff in the north to Bakersfield in the south, is the single most important waterfowl wintering area in the Pacific Flyway, supporting 60 percent of all the total migrating population. Hundreds of thousands of wintering and breeding shorebirds and a host of other migratory and resident birds also depend on the wetland and agricultural resources of this region for survival. The Central Valley Joint Venture is currently in the process of updating its implementation plan, and will include goals for the conservation of breeding and wintering waterfowl, breeding and wintering shorebirds, grassland and riparian birds, and other waterbirds.

North American Waterfowl Management Plan Goals

(U. S. Fish and Wildlife Service, Canadian Wildlife Service, and Mexican National Institute of Ecology. 1998. Expanding the vision: 1998 Update -North American Waterfowl Management Plan. U. S. Dept. of Int. Rep., Washington, D. C. 34 pp.)

- Enhance the capability of landscapes to support waterfowl and other wetland-associated species by ensuring that Plan implementation is guided by biologically based planning, which in turn is refined through ongoing evaluation.
- Define the landscape conditions needed to sustain waterfowl and benefit other wetland-associated species, and participate in the development of conservation, economic, management, and social policies and programs that most affect the ecological health of these landscapes.
- Collaborate with other conservation efforts, particularly migratory bird initiatives, and reach out to other sectors and communities to forge broader alliances in a collective search for sustainable uses of landscapes.
- Maintain the current diversity of duck species throughout North America and achieve a continental breeding population of 62 million ducks during years with average environmental conditions, which would support a fall flight of 100 million.
- Increase or reduce goose populations to sustainable levels listed in Appendix 1.
- Reduce Western tundra swan population to 60,000, and increase Pacific Coast trumpeter swan population to 43,200.
- In the Central Valley Habitat Joint Venture Area, protect 80,000 acres, restore 120,000 acres, and enhance 735,000 acres.

Central Valley Joint Venture 2006 Implementation Plan

(Central Valley Joint Venture (CVJV). 2006. Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat. U. S. Fish and Wildlife Service, Sacramento, CA.)

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 Implementation Plan.

Central Valley Objectives by habitat type:

- Protect seasonal wetlands
- Restore 108,527 acres of seasonal wetlands
- Enhance 23,884 acres of seasonal wetlands
- Restore 12,500 acres of semi-permanent wetlands
- Restore 10,000 acres of riparian areas

- Enhance 170,000 acres of rice cropland
- Enhance 307,000 acres of waterfowl-friendly agricultural crops.

2.2 Partners in Flight (PIF) Bird Conservation Plan

(Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Iñigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, and T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY.)

North American Landbird Conservation Plan (Rich et. al 2004) summarizes geographic and habitat priorities for 449 species of landbirds across the continent. This plan includes, for the first time anywhere, estimates of continental population sizes and future population objectives for all landbirds. This plan will not replace Bird Conservation Plans, but rather will initiate a new round of dialogue on population and habitat objectives at continental, national, regional, state and local levels. The highest priority birds (102 species) constitute the new PIF Watch List. Also included in the plan is a list of characteristic species, which include species that may not be rare or declining but which are integral to the biotic integrity of large habitats or regions. These species, along with the Watch List species, are addressed as species suites in the plan. PIF's objective is to help land managers use the PIF plans, along with those from other bird initiatives, to undertake effective habitat conservation actions in the proper geographic context in North America.

The California Partners in Flight (CalPIF) began in 1992 to promote the conservation of resident and migratory landbirds and their habitats in California through research, monitoring, education, and collaboration among public and private landowners and managers, government agencies, non-government organizations, and individuals and other bird conservation efforts. The California Partners in Flight program has completed six habitat and bioregion based Bird Conservation Plans (BCP's) for Riparian, Oak Woodlands, Coastal Scrub and Chaparral, Grasslands, Coniferous Forests, and the Sierra Nevada Bioregion. A Shrub steppe Plan is currently in review and a Desert Plan is in development.

CalPIF initiated the Riparian Habitat Joint Venture (RHJV) project in 1994. The goal of the RHJV is to conserve, increase, and improve riparian habitat in order to protect and enhance California's native resident birds and Neotropical migratory birds. The Riparian Bird Conservation Plan (RHJV 2004) emphasizes a suite of 17 bird species chosen because of their conservation interest and as focal species representative of riparian habitats in the state. This Conservation Plan focuses on data concerning bird species associated with riparian habitat, but conservation recommendations, if implemented, should benefit many riparian associated species.

The six objectives of the RHJV are: (1) Compile existing information on riparian habitat throughout the state to identify key riparian areas, as well as information gaps. Promote and coordinate efforts to obtain the information. (2) Develop guidelines for the protection of existing riparian habitat on public lands and recommend alternatives for protection of habitat on private lands. (3) Restore riparian habitat on public and private lands using commonly accepted, scientifically valid restoration techniques. (4) Enhance the productivity and biodiversity of riparian communities using appropriate management techniques. (5) Establish a network of high-quality riparian habitats throughout California to enhance and protect native birds. (6) Educate the general public and resource managers about the status and value of California's riparian habitat.

Riparian Bird Conservation Plan

(Riparian Habitat Joint Venture (RHJV). 2004. Version 2.0. The Riparian Bird Conservation Plan: a strategy for reversing the decline of riparian associated birds in California. California Partners in Flight. http://www.prbo.org/calpif/pdfs/riparian_v-2.pdf.)

- Increase the breeding range of native birds and safeguard healthy bird communities with high productivity.
- Maximize riparian ecosystem health, promote a self-sustaining functioning system, and maximize the cost-effectiveness of riparian conservation activities.
- Increase the overall breeding range and/or abundance of native riparian birds by designing and implementing horticultural restoration projects that mimic natural riparian plant diversity and "patchiness". Such plantings will most quickly support a diverse community of bird species that can successfully nest in the restored habitat.
- Increase the value of existing/ongoing habitat and restoration projects for bird species.
- Ensure that large landscape-scale management and flood control projects maximize benefits to wildlife in conjunction with benefits to agriculture and urban populations. Achieving numerous goals simultaneously would maximize the overall value of such projects to the people of California.
- Implement and time land-management activities with the goal of maximizing bird species productivity or "source" populations.
- Protect, recreate, or minimize interruptions of natural processes, particularly hydrology and associated high-water events to allow/promote/facilitate the natural cycle of channel movement, sediment deposition, and scouring that results in a diverse mosaic of riparian vegetation classes.

Draft Grassland Bird Conservation Plan

(California Partners in Flight (CPIF). 2000. Version 1.0. The draft grassland bird conservation plan: a strategy for protecting and managing grassland habitats and associated birds in California (B. Allen, lead author). Point Reyes Bird Observatory, Stinson Beach, CA. http://www.prbo.org/calpif/plans.html.)

The Draft Grassland Bird Conservation Plan was developed to guide conservation policy and action on behalf of grassland habitats and birds. The geographic scope of this plan is the distribution of annual and native perennial grasslands in the state, which are found predominantly along the coast and in California's Great Central Valley. The plan has focus on data concerning seven focal grassland bird species that are dependent on these habitat types.

Conservation Action Recommendations include:

- Monitoring/Research
  - Initiate statewide point count project.
  - Develop methods to monitor productivity and survivorship for grassland birds.
  - Determine sensitivity of California's grassland birds to grassland patch size.
  - Determine grassland bird response to various grazing, burning, mowing, and disking regimes that occur in California.
  - Determine benefits / drawbacks of various agricultural regimes.
  - Determine if grassland birds select for or have increased productivity /survivorship in native grasslands vs. non-native grasslands. "Do native grass restorations restore native grassland birds?"
- Habitat Restoration/Management
  - Avoid mowing and disking during the breeding season.
  - Avoid burning during the breeding season.

- Habitat Protection
  - Identify remaining grassland areas of large patch size that have high species abundance and productivity for grassland birds.
  - Target unprotected areas that have been identified for protection as priority areas for (a) land purchases when possible, (b) conservation easements, and (c) the forging of partnerships with private landowners to create win-win situations.
  - Target areas with quality grassland habitat for protection status before targeting at-risk or degraded habitat.

2.3 United States Shorebird Conservation Plan

(Brown, S., Hickey, C., Harrington, B., and Gill, R. 2001. United States Shorebird Conservation Plan, Second Edition. Manomet Center for Conservation Sciences, Manomet, MA. 64 pp.)

The United States Shorebird Conservation Plan was developed through a partnership effort by State and Federal agencies, non-government organizations (NGOs), academic institutions, and individuals committed to restoring and maintaining stable shorebird populations in the U.S. and throughout the Western Hemisphere (Brown et al. 2001). The Southern Pacific Coast Regional Shorebird Management Plan (Hickey et. al 2003) establishes regional goals and objectives for the western California Coast and Central Valley. Important shorebird habitats identified under this plan in the Central Valley include managed wetlands, agricultural fields and vernal pool rangelands.

Southern Pacific Coast Regional Shorebird Plan

(Hickey, C., W. D. Shuford, G. W. Page, and S. Warnock. 2003. Version 1.1. The Southern Pacific Shorebird Conservation Plan: A strategy for supporting California's Central Valley and coastal shorebird populations. PRBO Conservation Science, Stinson Beach, CA.)

- Increase the wintering population of the Mountain Plover in the Central Valley. Create suitable open foraging habitat by managing for giant kangaroo rats (*Dipodomys ingens*) and using fire and grazing, as appropriate.
- Increase populations of breeding and wintering Snowy Plovers and wintering Long-billed Curlews in the Central Valley.
- Increase breeding and wintering populations of other shorebirds in the Central Valley.
- Restore, enhance, and manage wetlands with integrated wetland management goals, which accommodate the needs of a greater diversity of birds, including shorebirds.
- Ensure the availability of high quality water for wetlands.
- Resist fragmentation or loss of existing wetland complexes by urban encroachment.
- Promote management practices in agricultural lands and vernal pool rangelands that will provide for a greater diversity of birds, including shorebirds. Also, promote easements and other options for maintaining wildlife-friendly agricultural lands and vernal pool rangelands.
- Reduce the use of contaminated agricultural evaporation ponds by shorebirds and other waterbirds while creating alternative uncontaminated habitats that will mimic historic saline playa wetlands thereby maintaining the current mix of waterbird communities.
- Increase shorebird use of sewage ponds or wetlands using treated sewage effluent if issues of disease transmission and contaminants can be addressed.

2.4 North American Waterbird Conservation Plan

(Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, M. Acosta Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1. Waterbird Conservation for the Americas, Washington, DC, U.S.A., 78 pp)

North American Waterbird Conservation Plan (NAWCP) provides an overarching continental framework and guide for conserving waterbirds. It sets forth goals and priorities for waterbirds in all habitats from the Canadian Arctic to Panama, from Bermuda through the U.S. Pacific Islands, at nesting sites, during annual migrations, and during non-breeding periods. It advocates continent-wide monitoring; provides an impetus for regional conservation planning; proposes national, state, provincial and other local conservation planning and action; and gives a larger context for local habitat protection.

The vision of the NAWCP is the distribution, diversity, and abundance of breeding, migratory, and non-breeding waterbirds are sustained or restored throughout North America, Central American, and the Caribbean. Four goals were established in the plan (Kushlan et. al 2002) to accomplish this vision (1) species and population goal, (2) habitat goal, (3) education and information goal, and (4) coordination and integration goal. A regional step-down plan for the Pacific Coast will focus on key species and habitats and develop specific goals and objectives for management, monitoring, research and outreach.

Species and Population Strategies

- Determine population status for all species of waterbirds throughout North America, Central America, and the Caribbean.
- Institute a large scale, dispersed, partnership-based population monitoring system.
- Initiate monitoring of demography, habitats, wintering range, and important threats, such as seabird bycatch, as appropriate for species and areas.
- Develop analytical tools and analytical schemes to determine and assess population trends against trend thresholds for each species.
- Define sustainable population goals for all species, at regional scales as possible and as needed, and eventually at the continental scale.
- Determine the extent and root causes of public perception of waterbirds, particularly locally abundant species, and develop programs that help bring public perception in line with scientific and economic findings.
- Energize Joint Ventures and agencies to take responsibility for setting and achieving population goals through appropriate management.
- Develop a global perspective on populations to aid in interpretation of population trends.
- Synthesize information to identify key factors affecting populations in order to take appropriate conservation action.

Habitat Strategies

- Identify key marine, freshwater, and terrestrial habitats for waterbirds, including breeding, wintering, migratory, roosting, and foraging habitats.
- Implement conservation and management actions that secure important habitats.
- Increase understanding of waterbird habitat requirements, threats to habitat quality, and habitat interaction at different scales.
- Develop and implement habitat management plans for waterbirds for each planning unit.
- Identify, inventory and document key sites that potentially qualify as global, continental, national, or state Important Bird Areas (IBAs) and other key sites for waterbirds.
- Refine and continually update the list and description of IBAs for waterbirds.

Education and Information Strategies

- Ensure that information on waterbird conservation is available in a form that is useful for planning, implementation, and management purposes.

- Increase effectiveness of communication by partnering with outreach activities for other birds and for other environmental programs.
- Develop relationships with educators of all levels and participate in programs that increase awareness and improve education.
- Develop and widely distribute educational information on habitat conservation strategies.
- Work with users of waterbird habitats to promote practices and policies that reduce impacts on the birds.

<u>Coordination and Integration Strategies</u>

- Establish cooperative actions with organizations concerned with the conservation, research, and management of waterbirds and their habitats.
- Establish cooperative actions with other bird conservation initiatives, particularly through common goal setting, and multi-species approaches such as advocated by North American Bird Conservation Initiative (NABCI).
- Establish cooperative linkages with other bird conservation initiatives concerned with aquatic habitats.
- When initiatives for other aquatic bird groups are not underway, catalyze simultaneous planning and conservation of all water-dependent bird species.
- Seek to achieve integrated bird conservation action that incorporates the needs of waterbirds.
- Exchange information and expertise with international, national, regional state/provincial and local partners, and establish networks between conservationists, scientists, and habitat managers.
- Develop waterbird plans, where appropriate, at national, regional, JV, and state/provincial levels.
- Influence environmental policies and programs to positively affect waterbird conservation.
- Participate in international programs in ways that enhance the conservation of waterbirds.
- Increase human and financial resources available for waterbird conservation.

2.5 USFWS/CDFG Tricolored Blackbird Status Update and Management Guidelines (Beedy, E.C. and W.J. Hamilton 1997. Tricolored Blackbird Status Update and Management Guidelines. Jones and Stokes, Inc. 97-009. Sacramento, CA. Prepared for USFWS and CDFG. 55 pp.)

- Maintain viable, self-sustaining populations distributed throughout the current range of the species.
- Avoid losses of tricolored blackbird colonies and their reproductive effort throughout their range.
- Increase the breeding opportunities on suitable public lands and on private lands managed for this species.
- Enhance public awareness and support for protection of this unique species.

- Minimize losses of important foraging habitat for both nesting and wintering populations.

2.6 Pacific Flyway Management Plan: Western Management Unit Mourning Dove Goals and Objectives

(Pacific Flyway Council. 2003. Pacific Flyway Management Plan for Western White-winged Doves. U. S. Fish and Wildlife Service, Portland, Oregon. 27pp.)

- Maintain the Western Management Unit (WMU) population of mourning doves and its habitat at levels consistent with optimum distribution, density, and recreational uses of the resources.
- Determine the causes of mourning dove population declines in the WMU and establish procedures to reverse the trends.
- Increase the population levels of WMU mourning doves to a point where call-count indices average no less than 16 in the Coastal subunit.
- Increase and maintain adequate habitat to sustain the current seasonal distribution of WMU mourning doves throughout their range. The important habitat components are appropriate structures for nesting and roosting (trees), and food and water sources.
- Maximize the potential for sustained consumptive and non-consumptive uses of the mourning dove resource in the WMU.

2.7 Anadromous Fish Restoration Program

The Central Valley Project Improvement Act (CVPIA) was signed into law in 1992. The CVPIA directed the Secretary of the Interior to amend previous authorizations of California's Central Valley Project to: "include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic use and fish and wildlife enhancement as a project purpose equal to power generation." Section 3406(b)(1) of the CVPIA directs the Secretary of the Interior to develop and implement a program that makes all reasonable efforts to at least double natural production of anadromous fish in California's Central Valley streams on a long-term, sustainable basis.

The major resulting program is known as the Anadromous Fish Restoration Program (AFRP). The goal of the AFRP, is concurrent to section 3406(b)(1) of the CVPIA, to "develop within three years of enactment and implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991." Since 1995, the AFRP has helped implement over 195 projects to restore natural production of anadromous fish.

Six general objectives need to be met to achieve this program goal:

- Improve habitat for all life stages of anadromous fish through provision of flows of suitable quality, quantity, and timing, and improved physical habitat;

- Improve survival rates by reducing or eliminating entrainment of juveniles at diversions;
- Improve the opportunity for adult fish to reach their spawning habitats in a timely manner;
- Collect fish population, health, and habitat data to facilitate evaluation of restoration actions;
- Integrate habitat restoration efforts with harvest and hatchery management;
- Involve partners in the implementation and evaluation of restoration actions.

3.0 State of California

3.1 California Wildlife Action Plan, California Wildlife Conservation Challenges (California Department of Fish and Game. 2005c. California Wildlife Conservation Challenges California's Wildlife Action Plan. Prepared by U. C. Davis Wildlife Health Center for the California Department of Fish and Game. Sacramento, CA. 624 pp.)

Conservation actions were considered for each region, based on the stressors and circumstances of the regions. Statewide conservation actions are those actions that are important across most or all regions. The following are recommended statewide conservation actions:

A. The state should develop policies and incentives to facilitate better integration of wildlife conservation considerations into local and regional planning and land-use decision-making.
B. Permitting agencies, county planners, and land management agencies should work to ensure that infrastructure development projects are designed and sited to avoid harmful effects on sensitive species and habitats.
C. The state should develop policies and incentives to better integrate wildlife conservation into state and regional transportation planning. Wildlife considerations need to be incorporated early in the transportation planning process.
D. State and federal agencies should work with cities and counties to secure sensitive habitats and key habitat linkages.
E. State and local agencies should allocate sufficient water for ecosystem uses and wildlife needs when planning for and meeting regional water supply needs.
F. Federal, state, and local agencies should provide greater resources and coordinate efforts to control existing occurrences of invasive species and to prevent new introductions.
G. Federal, state, and local agencies and nongovernmental conservation organizations, working with private landowners and public land managers, should expand efforts to restore and conserve riparian communities.
H. Federal, state, and local agencies and nongovernmental organizations, working with private landowners, should expand efforts to implement agricultural and rangeland management practices that are compatible with wildlife and habitat conservation.
I. In their conservation planning and ecosystem restoration work, state and federal wildlife agencies and land managers should consider the most current projections of the effects of global warming.

J. The state and federal governments should give greater priority to wildlife and natural resources conservation education.
K. The state should strengthen its capacity to implement conservation actions and to assist local agencies and landowners with planning and implementation of wildlife and habitat restoration and conservation efforts.

The following are recommended conservation actions for the Central Valley and Bay-Delta Region:

A. The California Resources Agency, Fish and Game, the U.S. Fish and Wildlife Service, public land managing agencies, and local governments need to develop multicounty regional habitat conservation and restoration plans.
B. While numerous private landowners are leaders in conservation, Fish and Game, the U.S. Fish and Wildlife Service, the USDA Natural Resources Conservation Service, and local resource conservation districts need to improve conservation and restoration on private lands by assisting private landowners.
C. Public land managers need to continue improving wildlife habitat for a variety of species on public lands.
D. Public agencies and private organizations need to work with the San Francisco Bay Joint Venture to protect and restore tidal habitats and baylands in San Francisco Bay.
E. Public agencies and private organizations need to collaboratively protect and restore habitat connectivity along major rivers in the Central Valley.
F. Public agencies and private organizations need to collaboratively protect and restore upland linkages among protected areas in the San Joaquin Valley.
G. Public agencies and private organizations need to collaboratively protect and restore lowland linkages in San Francisco Bay.
H. Public agencies and private organizations need to collaboratively protect upland linkages and reduce the risk of habitat isolation in the eastern and northern San Francisco Bay area.
I. Water management agencies need to secure dependable and adequate amounts and quality of water for wildlife.
J. Water management agencies need to reestablish and maintain more natural river flows, flooding patterns, water temperatures, and salinity conditions to support wildlife species and habitats.
K. Water management agencies need to restore gravel supply in sediment-starved rivers downstream of reservoirs to maintain functional riverine habitats.
L. Public agencies and private organizations should protect, restore, and improve water-dependent habitats (including wetland, riparian, and estuarine) throughout the region. Design of these actions should factor in the likely effects of accelerated climate change.
M. Water management agencies, state and federal wildlife agencies, and other public agencies and private organizations need to collaboratively improve fish passage by removing or modifying barriers to upstream habitat.

N. To support healthy aquatic ecosystems, public agencies and private organizations, in collaboration with the California Bay-Delta Authority, need to improve and maintain water quality in the major river systems of this region.
O. Regional water quality boards, in collaboration with other public agencies and private organizations, need to improve and maintain water quality in streams and tidal waters of San Francisco Bay.
P. Fish and Game should expand funding and coordinate efforts to prevent the establishment of invasive species and to reduce the damage of established invasive species.
Q. State and federal agencies should expand law enforcement funding and staffing and coordinate efforts to enforce regulations to prevent the degradation of rivers and streams and to detect, prevent and take actions to protect water quality.

4.0 County

The Sacramento, Delevan, Colusa, and Sutter Refuges include parts of Colusa, Glenn, and Sutter counties. Each county is a multi-purpose government structure directed by an elected Board of Supervisors. There are also numerous special districts within each county, which are limited-purpose governmental agencies, such as fire districts, mosquito and vector control districts, irrigation districts and reclamation districts. Local land use policies are established in the general plans of each county, which are adopted by the respective Boards of Supervisors. The three counties' general plans designate the Refuges as follows:

- **Glenn County General Plan (1993)** – The Refuge is entirely within the "Recreation" Land use designation and the "RZ (Recreational Zone)" Zoning District. The General Plan is primarily directed to the support of agricultural use in the rural area and there is also a policy specifying early consultation for projects involving Wildlife Management Agencies.
- **Colusa County General Plan (1989)** - The land use policies of the County General Plan is primarily directed to the support of agricultural use in the rural area and there are also policies regarding the value of natural resources.
- **Sutter County General Plan (1996)** – The Refuge is entirely within the "Open Space" land use designation. The land use policies of the County General Plan are primarily directed to the support of agricultural use in the rural area and there are also policies regarding the value of natural resources.

The local land use polices of Glenn, Colusa, and Sutter counties that relate to management of the Refuges are summarized in Table 2 below.

Table 2. Summary of Local Land Use Policies that relate to Refuge Management.		
County	**Category**	**Land Use Policy**
Glenn County General Plan (1993)	5.1.1 Agricultural/ Soils	As the most extensive land use in the county, agriculture constitutes a significant component of the local economy. Agricultural land also provides valuable open space and important wildlife habitat. It is important that the County take steps to preserve its agricultural land from both economic and environmental perspectives. ...Converting prime agricultural land to non-agricultural uses is considered an irreversible loss of resources. ...With the primary goal being that of preserving the county's valuable agricultural resources, a variety of preservation tools can be used.... NR Goal-1: Preservation of agricultural land
Glenn County General Plan (1993)	5.1.2 Water Resources	The abundant supplies of surface and groundwater within Glenn County make the county "water rich". A statewide demand for water for both domestic and agricultural: water use and recent State and federal requirements to ensure that adequate supplies of water are available in rivers, streams and other natural areas to sustain wildlife result in strong competition for available water. NR Goal-2: Protection and management of local water resources.
Glenn County General Plan (1993)	5.1.3 Biological Resources	The conservation, development and utilization of natural resources, including fisheries and wildlife, are the purpose of the conservation element. NR Goal-3: Preservation and enhancement of the county's biological resources in a manner compatible with a sound local economy.
Glenn County General Plan (1993)	6.7 Coordination with Wildlife and Land Management Agencies	For all projects, with the exception of those associated with sites low in wildlife value, early consultation with wildlife agencies should occur.

Table 2. Summary of Local Land Use Policies that relate to Refuge Management.		
County	**Category**	**Land Use Policy**
Integrated Resources Management Program for Flood Control in the Colusa Basin (Colusa Basin Drainage District and U.S. Bureau of Reclamation 2000)		The unincorporated communities within Colusa County include Arbuckle, College City, Grimes, Maxwell, Princeton, and Stonyford. Incorporated cities in Colusa County include Colusa and Williams. The county also contains small settlement areas with permanent populations of less than 100 people. Land uses in Colusa County are typical of the rural counties of California. The eastern half of the county is dominated by large farms with much of the privately owned land following square-mile section lines. This portion of the county is relatively flat and use for the cultivation of rice, orchards, and row crops. The western half of the county contains the Coastal Range foothills, which are often used as rangeland.
Colusa County General Plan (1989)	Land Use Element	The Land Use Element encourages a balanced mix of land uses, which reflect the need of the local population. Additionally, agricultural land will be conserved and protected through a variety of strategies including taxation, zoning, and general planning.
Colusa County General Plan (1989)	Resource Conservation Element	The Resource Conservation Element encourages conservation of fish and wildlife habitat throughout the county. Preservation of the natural qualities of rivers and streams is also encouraged. Zoning, planning, and taxation policies should preserve watershed areas, as well as agricultural lands and hillside areas. Development in the Sacramento River floodway and ecologically sensitive areas is discouraged.
Colusa County General Plan (1989)	Open Space and Recreation Element	The Open Space and Recreation Element encourages the preservation of open space and opportunities for recreational and leisure time activities.

Table 2. Summary of Local Land Use Policies that relate to Refuge Management.		
County	**Category**	**Land Use Policy**
Colusa County Interim Farmland 1996 (California Department of Conservation 1998)		"Current land use within the eastern one-half of Colusa County is primarily "irrigated farmland" with small pockets of "non-irrigated farmland," "urban and built-up land", and "other land" (primarily wildlife preservation areas). The central area of the county consists primarily of "non-irrigated farmland" and the westernmost section of the county is primarily "other land" (i.e., Mendocino National Forest). Water bodies in the county include Funks Reservoir and East Park Reservoir, which are located in the northern and western centers respectively.
Sutter County General Plan (1996)	Section 1 Land Use	Goal 1.F: To minimize conflicts between agricultural and non-agricultural uses. Goal 1.G: To preserve and protect open space and natural resources and reduce pollution. Goal 1.H: To preserve and protect the visual and scenic resources of the area.
Sutter County General Plan (1996)	Section 4 Conservation /Open Space – Natural Resources	Goal 4.B: To protect wetland and riparian wetlands throughout Sutter County. Goal 4.C: To protect and enhance habitats that support fish and wildlife species. Goal 4.D: To preserve and protect vegetation resources of Sutter County. Goal 4.E: To conserve, protect, and enhance open space lands and natural resources in Sutter County.
Sutter County General Plan (1996)	Section 5 Conservation /Open Space – Recreation and Cultural Resources	Goal 5.A: To provide adequate park and open space areas for passive and active recreational, social, educational and cultural opportunities for the residents of Sutter County.
Sutter County General Plan (1996)	Section 6 Agricultural Resources	Goal 6.A: To preserve high quality agricultural land for agricultural purposes.

Appendix N. List of Planning Team Members and Persons Responsible for Preparing this Document

U.S. Fish and Wildlife Service

Core Planning Team

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Appendix O. Wilderness Review

Introduction

The purpose of a wilderness review is to identify and recommend for Congressional designation National Wildlife Refuge System (Refuge System) lands and waters that merit inclusion in the National Wilderness Preservation System (NWPS). Wilderness reviews are a required element of comprehensive conservation plans (CCPs) and conducted in accordance with the refuge planning process outlined in 602 FW 1 and 3, including public involvement and the National Environmental Policy Act (NEPA) compliance.

There are three phases to the wilderness review: (1) inventory, (2) study; and (3) recommendation. Lands and waters that meet the minimum criteria for wilderness are identified in the inventory phase. These areas are called wilderness study areas (WSAs). WSAs are evaluated through the CCP process to determine their suitability for wilderness designation. In the study phase, a range of management alternatives are evaluated to determine if a WSA is suitable for wilderness designation or management under an alternate set of goals and objectives that do not involve wilderness designation. The recommendation phase consists of forwarding or reporting recommendations for wilderness designation from the Director through the Secretary and the President to Congress in a wilderness study report.

If the inventory does not identify any areas that meet the WSA criteria, we document our findings in the administrative record for the CCP, fulfilling the planning requirement for a wilderness review. We inventoried U.S. Fish and Wildlife Service (Service) lands and waters within the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges (Refuges) and found no areas that meet the eligibility criteria for a WSA as defined by the Wilderness Act. This appendix summarizes the wilderness inventory for the Refuges.

Inventory Criteria

The wilderness inventory is a broad look at the planning area to identify WSAs. These are roadless areas that meet the minimum criteria for wilderness identified in Section 2(c) of the Wilderness Act.

> "*A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions, and which: (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an*

unimpaired condition; and (4) may also contain ecological, geological or other features of scientific, educational, scenic, or historical value."

A WSA must be a roadless area or island, meet the size criteria, appear natural, and provide outstanding opportunities for solitude or primitive recreation. The process for identification of roadless areas and islands in Refuges and application of the wilderness criteria are described in the following sections.

Identification of Roadless Areas and Roadless Islands
Identification of roadless areas and roadless islands required gathering and evaluating land status maps, land use and road inventory data, and aerial photographs for the Refuges. “Roadless” refers to the absence of improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use. Only lands currently owned by the Service in fee title were evaluated.

Evaluation of the Size Criteria
Roadless areas or roadless islands meet the size criteria if any one of the following standards apply.

- An area with over 5,000 contiguous acres. State and private lands are not included in making this acreage determination.
- A roadless island of any size. A roadless island is defined as an area surrounded by permanent waters or that is markedly distinguished from the surrounding lands by topographical or ecological features.
- An area of less than 5,000 contiguous Federal acres that is of sufficient size as to make practicable its preservation and use in an unimpaired condition, and of a size suitable for wilderness management.
- An area of less than 5,000 contiguous Federal acres that is contiguous with a designated wilderness, recommended wilderness, or area under wilderness review by another Federal wilderness managing agency such as the Forest Service, National Park Service, or Bureau of Land Management.

Evaluation of the Naturalness Criteria
In addition to being roadless, a WSA must meet the naturalness criteria. Section 2(c) defines wilderness as an area that “... generally appears to have been affected primarily by the forces of nature with the imprint of man’s work substantially unnoticeable.” The area must appear natural to the average visitor rather than “pristine.” The presence of historic landscape conditions is not required. An area may include some human impacts provided they are substantially unnoticeable in the unit as a whole. Significant human-caused hazards, such as the presence of unexploded ordnance from military activity, and the physical impacts of refuge management facilities and activities are also considered in evaluation of the naturalness criteria. An area may not be considered unnatural in appearance solely on the basis of the “sights and sounds” of human impacts and activities outside the boundary of the unit.

Evaluation of Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation

In addition to meeting the size and naturalness criteria, a WSA must provide outstanding opportunities for solitude or primitive recreation. The area does not have to possess outstanding opportunities for both solitude and primitive and unconfined recreation, and does not need to have outstanding opportunities on every acre. Further, an area does not have to be open to public use and access to qualify under this criteria; Congress has designated a number of wilderness areas in the Refuge System that are closed to public access to protect resource values.

Opportunities for solitude refer to the ability of a visitor to be alone and secluded from other visitors in the area. Primitive and unconfined recreation means non-motorized, dispersed outdoor recreation activities that are compatible and do not require developed facilities or mechanical transport. These primitive recreation activities may provide opportunities to experience challenge and risk, self reliance, and adventure.

These two "opportunity elements" are not well defined by the Wilderness Act but, in most cases, can be expected to occur together. However, an outstanding opportunity for solitude may be present in an area offering only limited primitive recreation potential. Conversely, an area may be so attractive for recreation use that experiencing solitude is not an option.

Evaluation of Supplemental Values

Supplemental values are defined by the Wilderness Act as "...ecological, geological, or other features of scientific, educational, scenic, or historic value." These values are not required for wilderness but their presence should be documented.

Inventory Findings

As documented below, none of the parcels in the Refuges meet the criteria for a WSA.

Roadless Areas and Roadless Islands

None of the Refuges are roadless areas. Each of the Refuges has multiple access roads that accommodate motorized access to the refuge units. Sacramento Refuge has a paved entrance road to the Refuge Headquarters, a six mile graveled auto tour route, and multiple graveled management roads and parking areas. Colusa Refuge has a three mile graveled auto tour route, and multiple graveled management roads and parking areas. Delevan and Sutter Refuges also have multiple graveled management roads and parking areas. The public has year-round access to the entrance roads and auto tour routes. During the hunting season, the public also has access to various graveled management roads on all four Refuges to get to designated hunter parking areas and check stations.

Size Criteria
A total of 23,973 acres of Service owned-land are included within the Refuges. The Refuges do not contain 5,000 contiguous roadless acres, nor do the Refuges have any units of sufficient size to make their preservation practicable as Wilderness.

Naturalness Criteria
The wetland and riparian habitats within the Refuges appear natural to the refuge visitor. However, there are approximately 270 separate management units on the Refuges (USFWS 1989-2007). Intensively managed wetlands comprise the majority of those units. In order to more effectively maintain, manage, and monitor these Refuges, a habitat management system was implemented in the early 1980's (Mensik and O'Halloran 1990). The system, which has evolved with several modifications and additions, along with some upgraded technology, has been used successfully at Sacramento Refuge Complex for over 20 years. For a description of the refuge environment, see Chapter 3 of the CCP (USFWS 2008).

The Refuges' lands have been substantially affected by humans, particularly through agriculture and urban development. As a result of the extensive modification of natural habitats and ongoing manipulation of natural processes, adopting a wilderness management approach for the Refuges would not facilitate the restoration of a pristine or pre-settlement condition, which is a goal of wilderness designation.

Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation
The Refuges are located immediately adjacent to the communities of Willows, Maxwell, Colusa, Sutter, and Yuba City. Although the Refuges do provide opportunities for escape from the urban environment, the sites and sounds of urbanization are always present just beyond the Refuge boundary.

Supplemental Values
The wetland and riparian habitats on the Refuges provide scenic and regionally significant ecological value.

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Mensik, J.G. and P. O'Halloran. 1990. Monitoring marsh management of the Sacramento National Wildlife Refuge Complex. *Transactions of the Western Section of the Wildlife Society* 26:24–28.

U. S. Fish and Wildlife Service. 1988-2007. Refuge Management Plans for Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, Sacramento National Wildlife Refuge files, Willows, CA.

USFWS. 2008. Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges Draft Comprehensive Conservation Plan. U.S. Fish and Wildlife Service, California/Nevada Office.

Appendix P. Tree Reduction Operations Plan – Tract 1, Sutter National Wildlife Refuge

Background

Established in 1945, the Sutter National Wildlife Refuge (Refuge) consists of 2,591 acres, the majority of which (85 percent) are located within the Sutter Bypass (Bypass), a flood channel designed to reroute high water from the Sacramento River. Sutter Refuge acreage is managed primarily as wetlands (73 percent) in order to support a diversity of migratory and resident wetland dependant wildlife species (Figure 1). The remaining acreage is comprised of riparian and upland habitat, roads, water delivery ditches and shop/hunter check station facilities and parking lots. Given the rich alluvial soil and relatively high water table, Refuge management within the Bypass produces a variety of vegetation, including tall emergent wetland plants such as cattail and hardstem bulrush. In addition, a number of tree species including willows, cottonwoods, and some oaks, have been "volunteering" throughout the Bypass portions of Sutter Refuge. This tree growth, both in number and eventually their size, has been of concern due to their potential for impeding flood flows that could impact the design capacity of the Bypass. As a result, and in cooperation with the California Department of Water Resources (DWR), the Refuge has been removing trees from within the center of the Bypass since 2001(see Figure 2 and attached pictures). Required follow-up maintenance (mowing, disking, herbicide application) has been accomplished annually to ensure that resprouting and regrowth is kept to a minimum.

Tract 1 "Northwest Grove"

Tract 1 is an upland area located within the Bypass on the north end of Sutter Refuge. A number of large oak and a few cottonwood trees have been present in the western portion of the unit (referred to as the "northwest grove") since the early 1960's. While it was once mostly a sparse oak savanna, over the years the density of woody plants in this location has increased substantially. Though the "northwest grove's" perimeter has not expanded into the Bypass significantly, it has filled-in (including some new species) to become a forest with a nearly complete canopy closure. The "northwest grove" is now comprised of an older, taller overstory of Valley Oaks and Fremont's cottonwoods; with a mid-story of box elders, Oregon Ash, willows (black and sandbar), younger Valley oak and Cottonwoods; and an under-story that includes Himalayan Blackberry, poison oak, wild rose, and young saplings of the above tree species. Ground vegetation includes low growing (i.e. < 2 feet tall) grasses, sedges, and herbaceous broadleaved species.

Management Strategy:

In an effort to address the potential for impedance of floodwater flows within the Sutter Bypass, the Refuge will reduce the volume of woody vegetation and Himalaya Berry within the "northwest grove". The focus will be on removing the majority of the understory plants and small trees. Some large trees will be left in place. For management purposes, and based upon existing topographic features, the area will be divided into five zones (Figure 3). For each zone, Refuge staff will evaluate the vegetative species composition and design an appropriate prescription for removal. As work is completed, Zones 1-4 will require annual maintenance treatments, such as livestock grazing, mowing, prescribed burning or herbicide applications, in order to suppress regrowth of trees, shrubs, and vines.

Zone 1:

Vegetation: Moderate density overstory, and light density mid-story and understory shrubs. A narrow slough with dense box elder trees exists along the west edge.

Treatment: Remove most (i.e., over 95 percent) of the willow, box elder, and Oregon ash trees. Remove 90-95 percent of oaks and cottonwoods less than 20 inches diameter at breast height (DBH). Limb-up remaining oaks and cottonwoods to a height (15 feet) in order to lessen impacts to high water flows. Remove all understory shrubs and vines.

Post-treatment conditions/maintenance: Grassland with a few scattered mature oak and cottonwood trees. Employ one or more of the following: livestock grazing, mowing, prescribed burning, or herbicide application; for control of undesirable plant species.

Zone 2:

Vegetation: Moderate density overstory, mid-story, and understory shrubs.

Treatment: Remove most (over 95 percent) of the willow, box elder, and Oregon ash trees. Remove 80-90 percent of the oak and cottonwood trees less than 20 inches DBH. Limb-up remaining oaks and cottonwoods to a height (15 feet) in order to lessen impacts to high water flows. Remove most of the understory shrubs and vines.

Post-treatment conditions/maintenance: Grassland with a few cottonwoods, several mature oaks and a few smaller oaks. Employ one or more of the following: livestock grazing, mowing, prescribed burning, or herbicide application; for control of undesirable plant species.

Zone 3:

Vegetation: A lower elevation slough area (capable of ponding water)
with a moderate overstory, a heavy midstory and understory of box elder, Oregon ash and shrubs.

Treatment: Remove most (over (90 percent) of the willow, box elder, and Oregon ash trees. Remove 70-80 percent of the oak and cottonwood trees less than 20 inches DBH. Limb-up remaining oaks and cottonwoods to a height (15 feet) in order to lessen impacts to high water flows. Remove most of the understory shrubs and vines

Post-treatment conditions/maintenance: Relatively open slough channel with a few cottonwoods, and several mature oaks on the adjacent high ground. Employ one or more of the following: livestock grazing, mowing, prescribed burning or herbicide application, for control of undesirable plant species.

Zone 4:

Vegetation: Mixed riparian forest that includes an overstory dominated by Valley Oak and relatively heavy understory of blackberry and poison oak, with some smaller trees.

Treatment: Remove most (over 90 percent) of the willow, box elder, and Oregon ash trees. Remove 70-80 percent of the oak and cottonwood trees less than 15 inches DBH. Limb-up remaining oaks and cottonwoods to a height (15 feet) in order to lessen impacts to high water flows. Remove most of the of the shrub/vine understory.

Post-treatment conditions/maintenance: Oak and cottonwood savanna with understory dominated by grasses and sedges. Employ one or more of the following: livestock grazing, mowing, prescribed burning or herbicide application; for control of undesirable plant species.

Zone 5:

Vegetation: Mixed riparian forest with heavy understory, comparable to the edge areas along the west side of Sutter Refuge down to Hughes Road. This is a northern extension of the forested west edge of the Bypass Channel, which helps to protect the levee from wave action.

Treatment: Remove hazardous limbs and trees near access road.

Post-treatment conditions/maintenance: Monitor conditions and treat as necessary.

Implementation:

Once planning is accomplished, cooperative efforts with DWR and others will begin. While a high Refuge priority, progress will likely be incremental due to availability of funding and personnel. Our Refuge goal is to have all zone 1-4 vegetation reduction prescriptions completed within the next 2-3 years.

As to what should be expected, we have included representative/illustrative "Before and After" photo examples of previous work (see Figure 4).

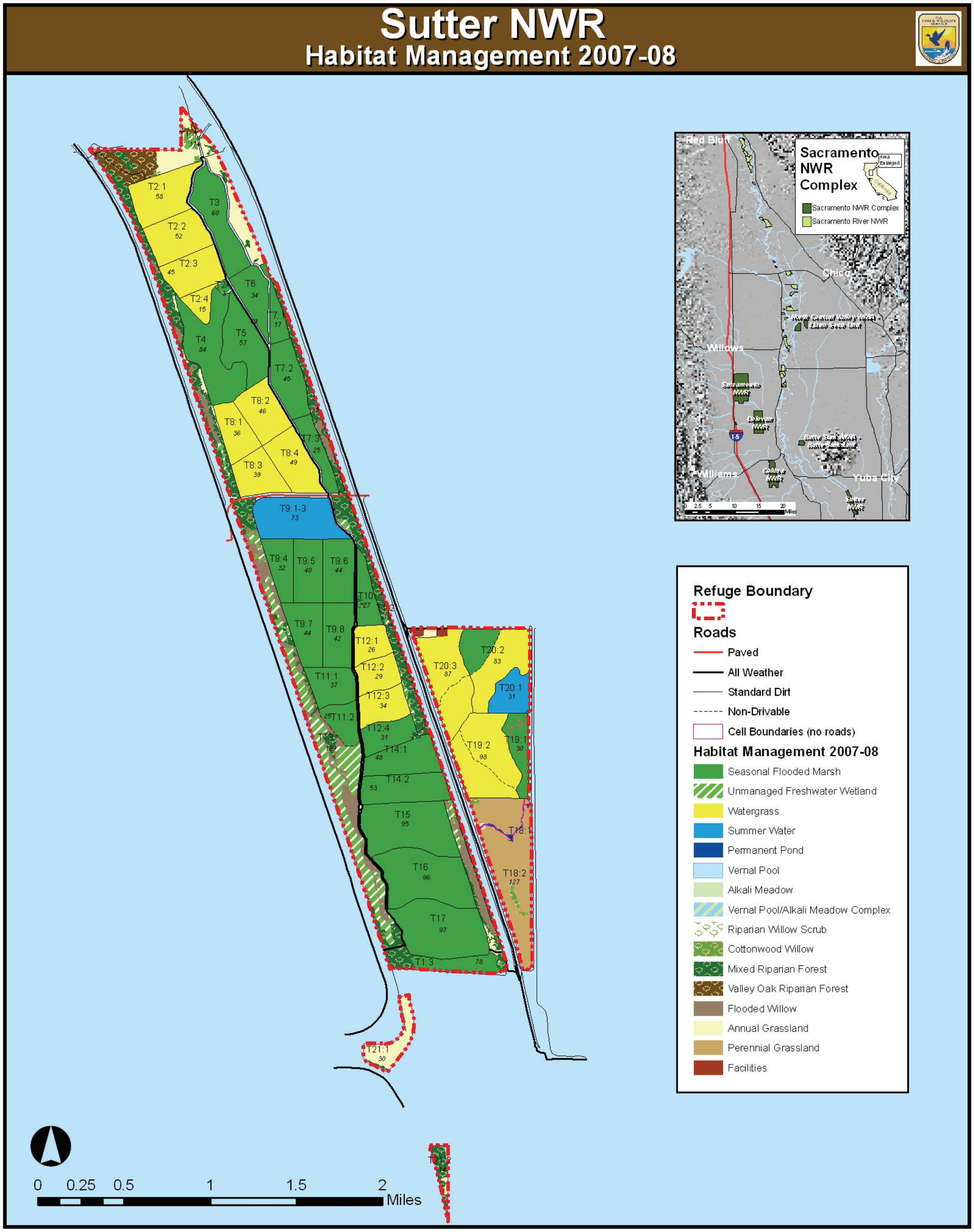

Figure 1. Habitat Map of Sutter National Wildlife Refuge

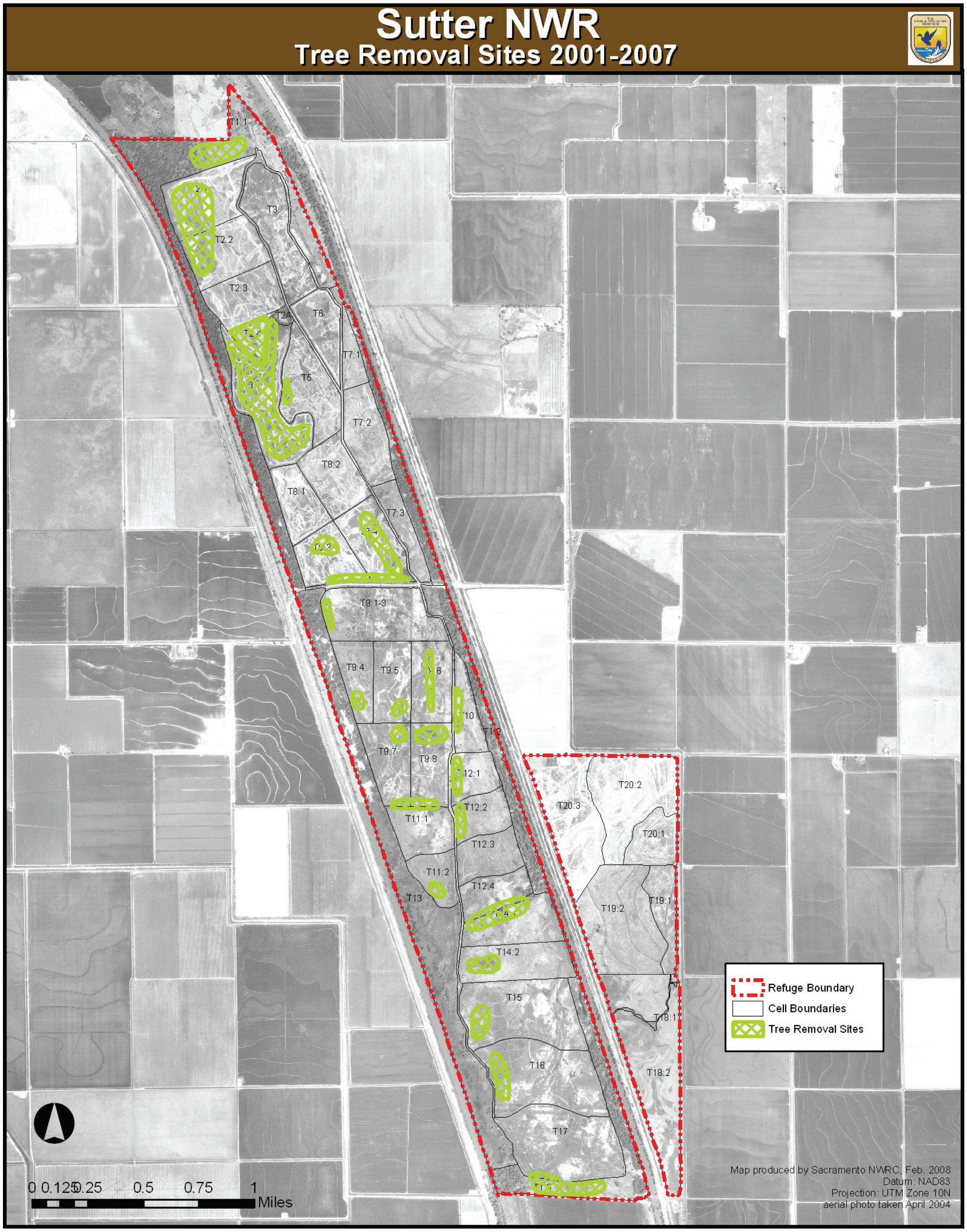

Figure 2. Tree Removal on Sutter National Wildlife Refuge from 2001-2007

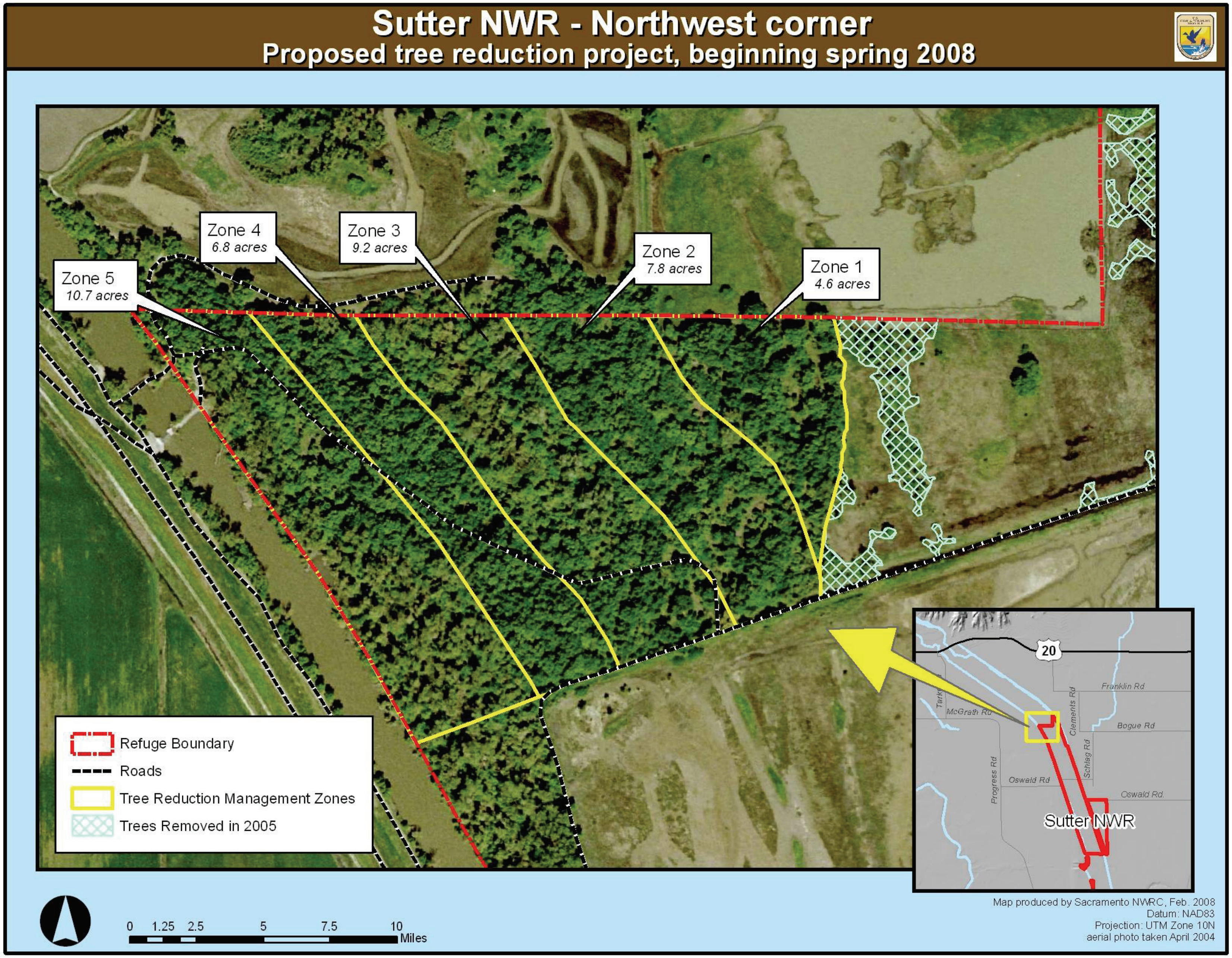

Figure 3. Proposed Tree Reduction Zones on Sutter NWR

Figure 4. Representative “before and after” pictures illustrating the overall concepts of the Tree Reduction Operations Plan objectives.

Tract 1, cell 1 west of lift pump before.

Tract 1, cell 1 west of lift pump after.