Appendix A. References

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Appendix B. Environmental Assessment

FIGURES

APPENDICES

Glossary of Terms and Acronyms

Bay	San Francisco Bay
CCG	Contra Costa goldfield
CCP	Comprehensive Conservation Plan
CDFG	California Department of Fish and Game
CLRA	California clapper rail
CTS	California tiger salamander
EA	Environmental Assessment
EEC	Environmental Education Center
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EO	Executive Order
GIS	Geographic Information System
I&M	Inventory and Monitoring
IMPLAN	Impact Analysis for Planning
NEPA	National Environmental Policy Act
NWR	National Wildlife Refuge
NWRS/Refuge System	National Wildlife Refuge System
PUP	Pesticide Use Proposal
Refuge	Don Edwards San Francisco Bay National Wildlife Refuge
RLGIS	Refuge Lands Geographic Information System
SBSPRP	South Bay Salt Pond Restoration Project
SCVWD	Santa Clara Valley Water District
SLAMM	Sea-Level Affecting Marsh Model
SMHM	salt marsh harvest mouse
USDA	U.S. Department of Agriculture
USFWS/Service	U.S. Fish and Wildlife Service
VPTS	Vernal pool tadpole shrimp
1997 Improvement Act	The National Wildlife Refuge System Improvement Act of 1997

Chapter 1. Purpose and Need for Action

Introduction

This environmental assessment (EA), in accordance with the requirements of the National Environmental Policy Act (NEPA), evaluates the environmental effects of three alternatives for managing the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) as presented in the draft Comprehensive Conservation Plan (CCP). The purpose of the CCP (also referred to as the *Plan*) is to provide a 15-year management plan for the Refuge and long-term guidance in relation to management decisions, as directed by the National Wildlife Refuge System Improvement Act of 1997 (1997 Improvement Act). Both direction and guidance are described in detail through a set of goals, objectives, and strategies in the CCP.

Plan Area

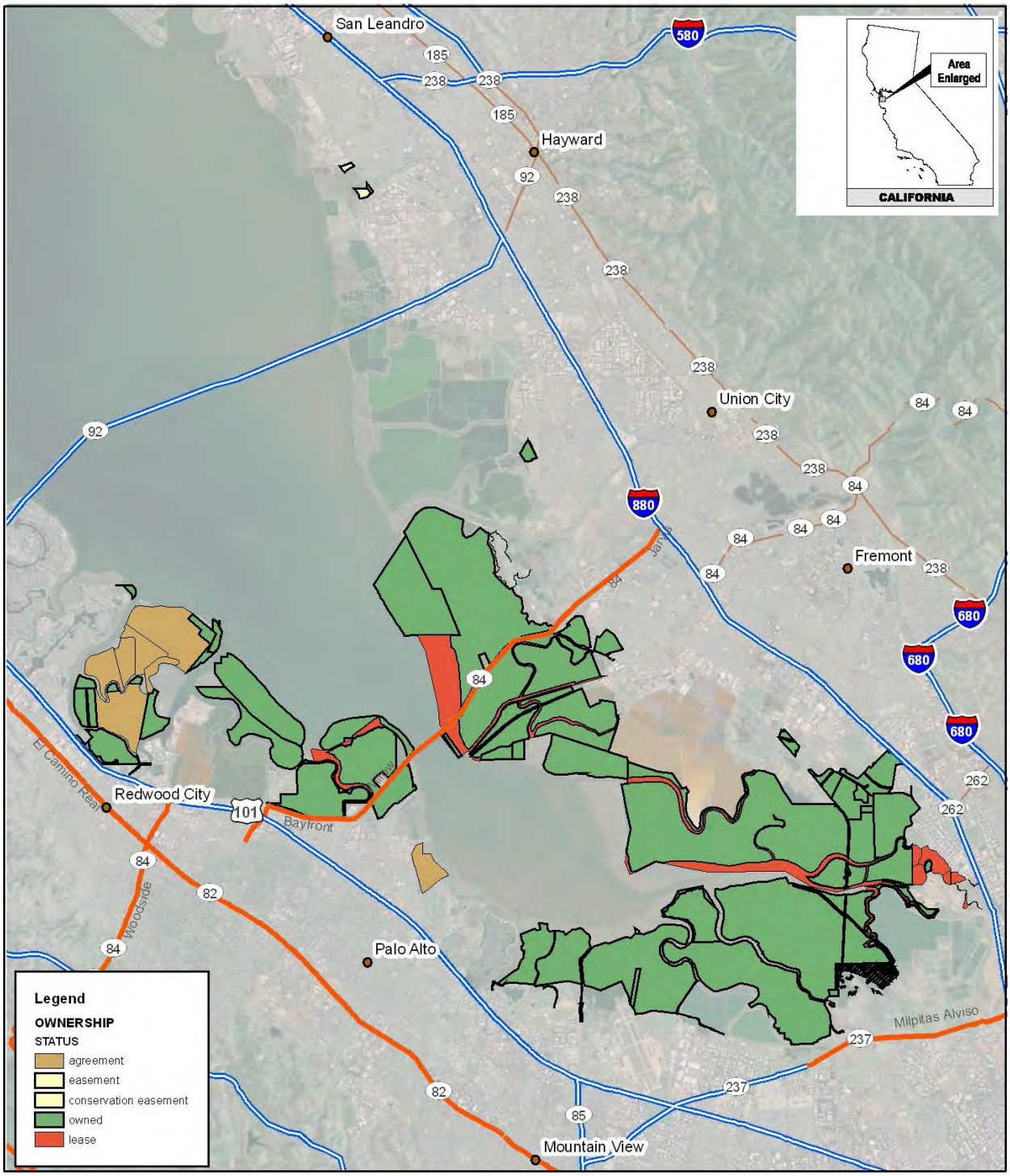
The Refuge surrounds the southern end of the San Francisco Bay Estuary. This subregion of the Estuary is also called South San Francisco Bay (Bay). The lands and waters included within the Refuge consist of portions of the urban communities of San Lorenzo, Hayward, Union City, Fremont, Newark, Milpitas, San Jose, Sunnyvale, Mountain View, East Palo Alto, Menlo Park, and Redwood City. The Refuge is located in a highly urbanized area with access from Interstate Highway 880, U.S. Route 101, California State Route 237, and California State Route 84. The Refuge is an important stopping point for migratory waterfowl, shorebirds, and songbirds. There are several threatened and endangered species present on the Refuge, including the Contra Costa goldfield (CCG), vernal pool tadpole shrimp (VPTS), California tiger salamander (CTS), California least tern, western snowy plover, California clapper rail (CLRA), and salt marsh harvest mouse (SMHM), that rely on the Refuge habitat for all or a portion of their lifecycles.

Proposed Action

The Service proposes to implement a CCP that best achieves the purposes for which the Refuge was established, helps fulfill the mission of the National Wildlife Refuge System (NWRS), is consistent with sound fish and wildlife management, and ensures that the biological integrity, diversity, and environmental health of the Refuge System are maintained.

The Service examined a range of management alternatives. A description of these alternatives is contained in Chapter 2. Alternative B represents the Service's proposed action for the Refuge; however, the final decision can be any of the alternatives and may reflect a modification of certain elements of any alternative based on consideration of public comment. Of the alternatives evaluated, Alternative B appears to best achieve the purpose, vision, and goals for the Refuge, while also appropriately addressing the major issues and relevant mandates identified for the Refuge during the development of the CCP.

Figure 1. Don Edwards San Francisco Bay National Wildlife Refuge (NWR)



Purpose and Need for the Proposed Action

A CCP is needed to provide guidance for conducting general Refuge operations, wildlife and habitat management, habitat enhancement and restoration, cultural resource management, and visitor services. The CCP is intended to ensure that management actions are consistent with the purposes for which the Refuge was established, the mandates of the Refuge System, and the

Refuge's goals and objectives. The purpose of the CCP is to describe the desired future conditions of the Refuge over the next 15 years and provide guidance for achieving those conditions. The CCP accomplishes the following:

- Sets a long-term vision for the Refuge;
- Establishes management goals, objectives, and strategies for the Refuge;
- Provides the Refuge with a 15-year management plan for the conservation of fish, wildlife, and plant resources and their related habitats;
- Defines compatible public uses;
- Develops a plan that, when fully implemented, will achieve Refuge purposes, help fulfill the mission of the System, and maintain and, where appropriate, restore ecological integrity;
- Communicates the Service's management priorities for the Refuge to the public; and
- Provides a basis for budget needs to support staffing, operations, maintenance, and capital improvements.

The development of this CCP is also required to fulfill legislative obligations of the Service. The National Wildlife Refuge System Administration Act of 1966, as amended by the 1997 Improvement Act, requires that every refuge or related complex of refuges have a CCP in place within 15 years of the Improvement Act's enactment. In order to comply with NEPA, an EA or Environmental Impact Statement (EIS) that evaluates the effects of different alternatives meeting the Refuge goals must be prepared to accompany the CCP. The Draft CCP and its appendices are herein incorporated by reference.

NEPA and this Document

NEPA requires Federal agencies to consider the environmental effects of all actions[1] they undertake. This EA evaluates the effects of various alternative management scenarios for the Refuge. Federal agencies must also consider the environmental effects of the Proposed Action and a reasonable range of alternatives, then disclose those effects to the public. If adverse environmental effects are identified, NEPA requires an agency to identify means to mitigate the adverse effects. An EA documents that an agency has considered and addressed all these issues. This EA has been prepared to assess the environmental effects of the action alternatives. The U.S. Fish and Wildlife Service (Service) will also use this EA to solicit public involvement in the Refuge planning process, as well as determine whether the CCP will have a significant effect on the quality of the human environment.

This EA discusses the purpose and need for the Refuge CCP; it also provides an analysis of the impacts that could be expected from each of the management proposals outlined in the Plan. This analysis will help the Service determine if it will need to prepare an EIS or a Finding of No Significant Impact (FONSI) regarding the preferred alternative for the Refuge.

The policies of the Service, the 1997 Improvement Act, and NEPA require the Service to actively seek public involvement in the preparation of environmental documents. NEPA also requires the Service to give serious consideration to all reasonable alternatives for managing refuges, including the no-action alternative representing continuation of current conditions and management

[1] Under NEPA and implementing regulations, *action* refers to a policy, plan, program, or project that is implemented, funded, permitted, or controlled by a Federal agency or agencies.

practices. Alternative management scenarios were developed as part of the planning process described in this EA.

This EA describes the existing resources on the Refuge and the projected environmental effects of the three management alternatives. Two of the three alternatives presented in this EA are *action alternatives* that would involve a change in the current management of the Refuge. The remaining alternative is the *no-action alternative*, under which current management of the Refuge would continue, and provides a basis of comparison to the action alternatives. A final CCP will be prepared regardless of which alternative is selected.

Decisions to be Made

Based on the analysis documented in this Draft EA, the Regional Director must determine the type and extent of management and visitor service opportunities on the Refuge as well as, whether the selected management alternative would have a significant effect on the quality of the environment. If the selected alternative has no significant impacts, then the Service would prepare a FONSI. If the proposed management alternative is found to have significant impacts, then the Service would prepare an EIS before making a decision.

The planning team has recommended Alternative B for implementation. The Service will make a final selection of an alternative to implement in the CCP, based on this document and the input received from the public during the comment process. The Plan will be monitored annually and revised when necessary.

Comprehensive Conservation Planning Process

The Service developed the CCP using a systematic decision-making approach that encouraged public involvement in management decisions throughout the planning process. A planning team was assembled (see Chapter 5) of personnel from the Service's San Francisco Bay National Wildlife Refuge Complex. The Service contacted a wide range of people to participate, including representatives of Federal agencies, Congress, State officials, State conservation agencies, conservation organizations, local interest groups, and other members of the public. These interested participants and local residents received announcements regarding the location, date, and time for the initial scoping meeting. At the scoping meeting, the staff explained the Refuge's purpose, history, and laws and regulations governing management, as well as the purpose and need for the CCP and the relevant management activities and issues.

The planning team consisted primarily of Refuge staff, Service technical experts, and other landowners of the Refuge (some Refuge lands are managed by the Service but owned by other public agencies). The team developed a list of issues and concerns that included comments generated from the scoping meeting, written comments, and verbal comments from discussions with various parties. The planning team reviewed the current Refuge management actions during the planning process and ultimately presented three alternatives for future Refuge management.

Key steps in the Service's comprehensive conservation planning are listed below:

1. Preplanning.
2. Identifying issues and developing a vision statement.
3. Gathering information.
4. Analyzing resource relationships.

5. Developing alternatives and assessing environmental effects.
6. Identifying a preferred alternative.
7. Publishing the draft plan and NEPA document.
8. Addressing public comments on the draft plan.
9. Preparing the final plan.
10. Securing approval from the Regional Director.
11. Implementing the plan.

Issues Identification

The Service followed NEPA scoping guidelines and identified issues, concerns, and opportunities through early planning discussions and the public scoping process, which began in the fall of 2009. The planning team identified a range of reasonable alternatives, evaluated the consequences of each alternative, and identified a preferred alternative for guiding the Refuge's future direction. This planning effort and the planning team's ongoing dialogue with various Federal, State, and county agencies; interest groups; and individuals provided important direction in synthesizing the proposed goals, objectives, and strategies found in the draft CCP. It will be necessary to further coordinate and cooperate with these entities to implement the Plan.

Public Involvement

Public involvement is an essential component of the comprehensive conservation planning and NEPA process. The Service announced the beginning of this planning effort for the Refuge through a *Federal Register* Notice of Intent on February 23, 2010. The Service sent individual letters announcing commencement of the planning process to several local organizations, the local city government, congressional members, State officials, State agencies, interested parties, and conservation organizations. In 2009, the Refuge hosted a series of public meetings on October 28, November 3, and November 5. Public comments were generated from the public meetings, and the *Federal Register* notice was published on February 23, 2010. A planning update, which introduced the Refuge and the planning process, was mailed to over 200 agency and organization representatives, members of the public, media, and elected representatives of each of the counties. An average of 10 people attended each of the meetings. A number of individuals provided comments at the meetings, via email, and by postal mail. The Refuge hosted another series of public meetings on April 13, 2011, and April 19, 2011, to present management alternatives. An average of 15 people attended each of these meetings.

Written public input received during the process is incorporated into the CCP and EA when feasible, and a summary of the comments is presented in the CCP. The original comments are maintained in planning team files at the San Francisco Bay National Wildlife Refuge Complex headquarters in Fremont, California, and are available for review.

U.S. Fish and Wildlife Service and National Wildlife Refuge System

The mission of the Service is working with others to conserve, protect, and enhance the Nation's fish and wildlife and their habitats for the continuing benefit of the American people. The Service is the primary Federal agency responsible for migratory birds, endangered plants and animals, certain marine mammals, and interjurisdictional fish. This responsibility to conserve the Nation's fish and wildlife resources is shared with other Federal agencies as well as with State and tribal governments.

As part of this responsibility, the Service manages the NWRS. The Refuge System is the only nationwide system of Federal lands managed and protected for wildlife and their habitats. The mission of the Refuge 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 Refuge is managed as part of the Refuge System in accordance with the National Wildlife Refuge System Administration Act of 1966 as amended and other relevant legislation, executive orders, regulations, and policies.

Purposes of the Don Edwards San Francisco Bay National Wildlife Refuge

Refuges are not only guided by the Service and NWRS missions, but also individual purposes that form the authority for the establishment of a Refuge. These purposes are often drawn from Federal acts or executive orders. Further, these purposes provided the foundation for which the Refuge vision statement and the CCP goals have been developed. Don Edwards San Francisco Bay NWR was established under the following authorities:

86 Stat. 399, dated June 30, 1972 – "... for the preservation and enhancement of highly significant wildlife habitat ... for the protection of migratory waterfowl and other wildlife, including species known to be threatened with extinction, and to provide an opportunity for wildlife-oriented recreation and nature study...."

An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes (16 U.S.C. 667b) – "... particular value in carrying out the national migratory bird management program."

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

Fish and Wildlife Act of 1956 (16 U.S.C. 742f) – "... 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).

Vision Statement

The Don Edwards San Francisco Bay National Wildlife Refuge was born out of the foresight and perseverance of conservation-minded individuals who recognized the unique landscape of the South San Francisco Bay. As part of the larger San Francisco Estuary, a site of hemispheric importance for shorebirds and waterfowl, the Refuge protects and restores almost 30,000 acres of some of the last remaining tidal marsh, mudflat, open bay, vernal pool, grassland, and upland habitats in the South San Francisco Bay. Within an area of intense urban development, we will strive to restore, acquire and protect additional lands to create a functioning ecosystem of diverse habitats that will support healthy populations of migratory birds, endangered wildlife, and other native plant and animal species. Through management and restoration of these habitats, we will also aid in the recovery of a number of listed and sensitive species that depend on Refuge lands for their continued existence, including the California clapper rail, salt marsh harvest mouse, vernal pool tadpole shrimp, and Contra Costa goldfields.

To promote the conservation legacy of this Refuge, we will provide wildlife-oriented recreation, environmental education, and interpretation to foster public stewardship, increase appreciation, and encourage community involvement in the conservation of the Estuary.

Goals of the Refuge

Refuge goals were developed on the basis of four themes: wildlife management, habitat management, compatible wildlife-oriented recreation, and environmental education and outreach.

Goal 1

Protect and contribute to the recovery of endangered, threatened, and special status species on the Refuge by conservation and management of the habitats on which these species depend.

Goal 2

Conserve, restore, enhance, create, and acquire habitats to support the diversity and abundance of migratory birds and other native flora and fauna that depend on Refuge lands.

Goal 3

Provide the local community and other visitors with compatible wildlife-oriented outdoor recreation opportunities to enjoy, understand, and appreciate the resources of the Refuge.

Goal 4

Through diverse environmental education, interpretation, and outreach opportunities, increase public awareness of the Refuge's purpose and the ecosystem of San Francisco Bay Estuary and promote environmental stewardship and conservation.

Goal 5

Instill community stewardship through volunteerism to support the Refuge's diverse purposes.

Chapter 2. Alternatives, Including the Preferred Alternative

This chapter describes three alternatives for managing the Refuge: Alternative A (No Action, current management), Alternative B, and Alternative C. These alternatives are described below and summarized in Table 1 at the end of this chapter. Some of the visitor service and environmental education alternatives (not all actions have been designated a location and therefore could not be depicted) are also depicted in Figure 2, Figure 3, and Figure 4 at the end of this chapter. All proposed alternatives considered in this EA were developed with the mission of the Refuge System and the purposes of the Refuge as guiding principles. Two of the three alternatives presented in this chapter are "action alternatives" that would result in a change to the current management of the Refuge. The Service's preferred alternative is Alternative B.

Current Management

The Refuge currently has no integrated plan to guide the management of all its resources and uses. Current management efforts on the Refuge focus on monitoring endangered species, monitoring non-native and invasive plants, habitat restoration, environmental education, and public uses.

For a complete description of the current management practices, please see Chapter 4, *Current Refuge Management and Programs*, of the CCP.

Alternatives Development Process

Three alternatives were developed to manage Don Edwards San Francisco Bay NWR.

- Alternative A: current management (no action).
- Alternative B: moderate increase in wildlife management, habitat management, visitor services, and the environmental education program.
- Alternative C: substantial increase in wildlife management, habitat management, visitor services, and the environmental education program.

The alternatives development process was an iterative process that began after the planning team developed the Refuge vision statement and revised the Refuge's goals. The first step in this process was to identify all the important issues related to Refuge management. The list of needs and issues was generated collaboratively by the core planning team, Service staff, and Refuge stakeholders. The public also helped to identify important management needs and issues through the scoping process.

Once the list of important management issues was generated, the planning team defined Alternative A (no action). It was important to describe this alternative accurately because the no-action alternative serves as the baseline to compare against all other alternatives.

Next, the planning team listed a wide range of management actions that would address the issues identified and achieve one or more of the Refuge goals. These actions were refined during several meetings and planning team reviews. The planning team then clustered these into action alternatives to increase biological and visitor service activities. Many actions are common to more than one alternative, but the actions within each alternative reflect a common management approach, as described in detail below.

Features Common to All Alternatives

There are a number of management components that are common to all the alternatives and would be part of the CCP regardless of the alternative selected for implementation. To reduce repetition in the alternatives descriptions, those features that are common among all of the alternatives are described in detail as follows.

Endangered Species Survey and Monitoring. All proposed alternatives involve some level of monitoring for endangered species, particularly the CLRA and the SMHM. Research studies relevant to management needs will be encouraged and supported.

Other Wildlife Management. Annual monitoring of shorebirds and waterfowl are conducted with partners throughout the San Francisco Bay Estuary. The Refuge oversees a variety of managed ponds at different water levels for a variety of bird species. Nesting habitat (e.g., islands) is created wherever possible. The Refuge responds to wildlife disease outbreaks that occur and contaminants monitoring is conducted opportunistically through partners. Research studies relevant to management needs occur when available through partnerships and grant funding.

Predator Management. All proposed alternatives involve some level of predator management. Certain native and non-native animal species are controlled by U.S. Department of Agriculture (USDA) Wildlife Services because they are a threat to the Refuge's trust species.

Mosquito Control. Mosquito control activities are coordinated and conducted with the Alameda, Santa Clara, and San Mateo County Mosquito Abatement Districts.

Vegetation Management. All the alternatives prescribe some level of monitoring, response, and prevention of the spread of non-native and invasive vegetation. The Refuge works with partners to actively monitor and control (through manual and chemical methods) invasive *Spartina* (cordgrass). Mapping of invasive pepperweed would be conducted under all alternatives. Some level of invasive weed control is conducted under all the alternatives through mechanical, cultural (e.g., grazing), thermal (i.e., burning), and chemical methods. The Refuge conducts native plant propagation at its nurseries and habitat restoration occurs through support from partners, volunteers, and school groups.

Tidal Marsh Restoration. Some tidal marsh restoration activities were planned prior to the CCP process (e.g., South Bay Salt Pond Restoration Project [SBSPRP] and the Bair Island Restoration Project). The restoration of additional diked wetland areas to tidal influence will continue.

Acquisition. The Refuge has continually acquired lands within the approved acquisition boundary that meet the Refuge purposes from willing sellers when refuge resources allow.

Public Uses. The Refuge provides opportunities for wildlife observation, photography, hunting, fishing, and interpretation. Some levels of all these activities are prescribed for each alternative. Waterfowl hunting is permitted on the Refuge per state regulations. A number of non-wildlife dependent recreational opportunities facilitate or occur in conjunction with wildlife observation, photography, hunting, fishing, and interpretation; these opportunities include hiking, dog-walking (at the headquarters), bicycling (on approved trails), boating, and a geocaching program.

Environmental Education. The Refuge conducts a wide range of environmental education programs that focus on primary themes of wetland conservation, habitat restoration, and watershed and water quality protection. A number of special environmental education events are also conducted to promote the Refuge's mission, including the South Bay Bird Festival, Spooky Slough, and Shark Day.

Cultural Resources. Cultural resource surveys are conducted opportunistically when projects occur. All cultural resource site locations are kept confidential. Cultural resources are managed in accordance with public law and agency policy. Any unknown cultural resources found during any ground disturbance or projects affecting historic structures on the Refuge would be assessed by Service cultural resources staff to determine potential impacts and compliance with applicable Federal laws and executive orders. For any major ground disturbing projects, the Refuge would consult with the State Historic Preservation Office (SHPO), federally recognized Tribes, and interested parties, when appropriate.

Facilities Maintenance. General maintenance of existing facilities, including mechanical control of vegetation; inspection, repair, rehabilitation, or replacement of infrastructure and equipment (e.g., fencing and signage); and oversight of safety of operations, is required on the Refuge to provide safe access for staff, researchers, law enforcement activities, educational field trips, and the public. Upland areas require mowing to reduce fire hazards, provide non-native weed control, and provide access for maintenance, monitoring, and restoration/enhancement projects. The Refuge's headquarters site, Environmental Education Center, water control structures, levees, and trails require frequent maintenance and repair.

Law Enforcement and Resource Protection. Law enforcement on the Refuge safeguards the public, staff, facilities, and natural and cultural resources from criminal action, accidents, vandalism, and negligence.

Alternatives Considered but Eliminated from Detailed Analysis

The alternatives development process under NEPA and the Improvement Act are designed to allow the planning team to consider the widest possible range of issues and develop feasible management solutions that respond to these issues. These management solutions are then incorporated into one or more alternatives evaluated in the EA process and considered for inclusion in the CCP.

Actions and alternatives that are not feasible or may cause substantial harm to the environment are usually not considered in an EA. Similarly, an action (and therefore, an alternative containing that action) should generally not receive further consideration if:

- It is illegal (unless it is the No Action Alternative, which must be considered to provide a baseline for evaluation of other alternatives, even though it may not be capable of legal implementation).
- It does not fulfill the mission of the National Wildlife Refuge System.
- It does not relate to or help achieve one of the goals of the Refuge.
- Its environmental impacts have already been evaluated in a previously approved NEPA document.

However, if such actions or alternatives address a controversial issue or an issue on which many public comments were received, they may be considered within detail in a NEPA document to

demonstrate clearly why they are not feasible or would cause substantial harm to the environment.

During the alternatives development process, the planning team considered a wide variety of potential actions on the Refuge. The following actions were ultimately rejected and excluded from the proposed alternatives because they did not achieve Refuge purposes or were incompatible with one or more goals.

Closing Hunting on Mowry Ponds. The Refuge staff considered closing the Mowry Ponds to potentially increase protection to wetlands. However, after consulting with hunters, the use at the ponds was considered low volume and thus impacts to vegetation and wildlife also low. This discussion resulted in no change to the Mowry Pond hunting area.

Entry Point at Mowry Ponds. The Refuge staff considered limiting access to the Mowry Ponds to a designated entry point in order to reduce trampling of vegetation by boat and foot traffic, as well as reduce wildlife disturbance. However, after consulting with hunters, the use at the ponds was considered low volume and thus impacts to vegetation and wildlife also low.

Opening Additional Ponds to Hunting. The Refuge staff considered opening Ponds A20, A21, and A2W to hunting. After analyses regarding wildlife considerations, it was decided that these ponds remain closed to provide waterfowl resting areas.

Close Faber-Laumeister Access. The Refuge staff considered closing the middle levee of the Faber-Laumeister subunit to public access. It was thought that closing access would reduce disturbance to the levee, which tidal marsh species in the area (e.g., CLRA) use for high tide refugia. After feedback from local community representatives and local officials, public access would remain open to the subunit. It was also decided that when funds become available, a raised boardwalk would be constructed on the levee to provide a barrier between the public and the sensitive transition zone to the tidal marsh.

Preferred Alternative

The planning policy that implements the Improvement Act requires the Service to select a preferred alternative, which is also the preferred alternative under NEPA. The complete written description of this preferred alternative is Chapter 5: *Refuge Management Direction* of the Draft CCP. Alternative B is the preferred alternative for the Refuge because it meets the following criteria:

- achieves the mission of the National Wildlife Refuge System;
- achieves the purposes of the Refuge;
- provides guidance for achieving the Refuge's 15-year vision and goals;
- maintains and restores the habitats and populations on the Refuge;
- addresses the important issues identified in the scoping process;
- addresses the legal mandates of the Service and the Refuge; and
- is consistent with the scientific principles of sound fish and wildlife management and endangered species recovery.

The preferred alternative described in the EA is preliminary. The action ultimately selected and described in the Final CCP will be determined, in part, by the comments received on the Draft EA. The preferred alternative presented in the Final CCP may suggest a modification of one of

the alternatives presented here. The three alternatives considered for managing the Refuge are summarized in Table 1 and are described as follows.

Description of Management Alternatives

Alternative A: No Action

Under this alternative, the Refuge would continue current management actions, including habitat management, wildlife management, wildlife-oriented opportunities, and environmental education. Habitat and wildlife management activities would emphasize habitat restoration projects, invasive weed management, wildlife surveys, and predator management. A wide variety of wildlife-oriented opportunities would continue to be offered. The environmental education program would continue to conduct a variety of topics. A few non-wildlife dependent recreational opportunities would continue to be permitted. Also, the volunteer program that supports the biology, visitor services, environmental education, and management needs of the Refuge would continue. Current staffing and funding would remain the same. The Refuge would continue to implement existing restoration and management plans (e.g., Bair Island Restoration and Management Plan and SBSPRP). The Refuge would also actively work with partners and willing sellers to acquire the remaining lands within the approved acquisition boundary.

Listed Species. Under Alternative A, annual CLRA surveys would continue to be conducted within a subset of the Refuge. Opportunistic surveys for the SMHM would also be conducted. Vernal pool surveys to determine presence of CTS, VPTS, and CCG would also continue. The Refuge would continue to work with partners to monitor and research the western snowy plover. Predator management of mammals would be conducted to protect and reduce threats to listed species. Sporadic restoration (through partners) of the ecotone/transition zone would increase high-tide refugia for listed species. Tidal restoration activities under this alternative would also benefit listed species.

Other Species. Under Alternative A, biological monitoring would continue, including waterfowl and shorebird surveys with partners on an annual basis by ground and aerial surveys. Tidal restoration activities under this alternative would benefit a variety of species. Mammalian predator management (e.g., red fox control) would also continue to benefit wildlife resources. The Refuge would carry on support of fish, migratory bird, and other wildlife monitoring and research through its partners. Intermittent weed management activities would also continue to the benefit of wildlife resources. Vernal pool vegetation and upland grassland surveys would continue to be conducted to provide input on management to benefit native species. Ponds would remain managed at different water levels to support shorebirds and wildlife. The Refuge staff would continue to respond to botulism and other outbreaks to recover wildlife resources.

Habitat Management. Under Alternative A, the Service would continue to manage the habitat on the Refuge as described in detail in Chapter 4 of the CCP. The primary habitat types managed are vernal pool grassland, ecotone/transition zone, managed ponds, and tidal and managed marsh. Managed ponds and marsh would continue to be restored as appropriate to improve tidal connectivity and restore marsh vegetation. Water levels in the remaining managed ponds would be operated to support a variety of shorebirds and waterfowl. Grazing and prescribed burning would continue to be used to reduce biomass of residual dry matter. Sporadic weed control and revegetation of the ecotone/transition zone would carry on as funds permit. *Spartina* control would continue to be conducted through partners, and intermittent control of pepperweed and

other priority weeds would be conducted as funds and staffing permit. Volunteers would maintain support of habitat restoration through manual weed removal, plant propagation at the Refuge and partner nurseries, planting native vegetation on the Refuge, and conducting non-native vegetation surveys.

There is a long history of mosquito management throughout the San Francisco Bay region given the large human population in the area. Per public health protection, mosquito control on the Refuge is an existing use conducted by the Alameda, Santa Clara, and San Mateo Mosquito Abatement Districts. Mosquito management activities involve mosquito population monitoring, disease surveillance, and habitat improvements (e.g., wetland enhancements, ditching). The Refuge would continue to work with these mosquito abatement districts to manage the threat of mosquito-borne disease on the Refuge through physical, biological, and chemical methods. Use of larvicide, pupacide, and adulticide is coordinated between the districts and the Refuge when mosquito populations and/or mosquito-borne diseases are detected on or within flight range of the Refuge.

Acquisition. The Refuge would continue to acquire lands within the approved acquisition boundary that meet the Refuge purposes from willing sellers when refuge resources allow.

Public Access. Under Alternative A, the Refuge would continue to provide hunting, fishing, wildlife observation, wildlife photography, and interpretation as detailed in Chapter 4 of the CCP. Under this alternative, waterfowl hunting would continue to be allowed in several ponds surrounding the South Bay. Approximately 7,500 acres of the 30,000 acres on the Refuge are open to waterfowl hunting. This acreage includes managed ponds, tidal areas, and the open Bay. All Refuge hunting areas are generally accessible by boat only. All hunting on the Refuge must comply with State and Federal Regulations. In order to conduct the hunt program (e.g., provide improvements to hunt blinds, hunt access, and outreach and education materials), an annual waterfowl hunt fee program would be developed.

Fishing would also continue to be permitted on the Refuge by boat, from the pier at the Refuge headquarters, the shoreline of the Faber-Laumeister subunit, and at Coyote Creek Lagoon. The public fishing pier is located at the end of Marshlands Road and is open year-round. However, birds, particularly the threatened western snowy plover, occasionally nest along Marshlands Road. From April 1 through August 31, when nesting birds are found, Marshlands Road is closed to public vehicle traffic. When the closure is in effect on weekends, public access to the fishing pier is via free shuttle service. As a designated "Public Fishing Pier," no fishing license is needed at this location. The Refuge would also conduct an annual fishing day event held at the fishing pier in the headquarters location.

Wildlife observation, photography, and interpretation would continue to be facilitated by more than 30 miles of trails, access sites, overlooks, a visitor center, more than 200 guided opportunities, self-guided interpretative opportunities, and some visitor contact services at the Environmental Education Center. The Refuge would also continue to offer special events under this alternative, such as an Earth Day Cleanup and an Endangered Species Poster Contest.

Environmental Education. Under this alternative, the Refuge would continue providing a comprehensive environmental education program. The Program serves over 10,000 students annually through a variety of programs, including Wetland Round-up, Restoration Education,

Summer Camp, Slow the Flow, Scout Program, and the Santa Clara Valley Urban Runoff Pollution Programs.

Other. Under Alternative A, other non-wildlife dependent recreational uses would continue, including a geocache program, dog-walking, jogging, hiking, bicycling, and boating in order to facilitate priority public uses (i.e., wildlife observation, photography, hunting, fishing, and interpretation). The uses are permitted in designated areas on the Refuge. Dog walking, a use that has occurred for several decades, will continue to be permitted on the Tidelands (including the Pumphouse Trail), Harrier Spur, and Quarry Trails of the Refuge, which are all located at the Fremont headquarters. Dogs are also permitted on Marshlands Road, which is owned by Caltrans. Staff participates in a variety of off-site outreach events annually. Additionally, the staff conducts outreach via its *Tideline* newsletter, Web site, television and video, Facebook, and audio tours.

Law enforcement would continue to be provided through the San Francisco Bay National Wildlife Refuge Complex. The Refuge also coordinates a comprehensive volunteer program to support biology, visitor services, and management needs.

Alternative B: moderate increase in wildlife management, habitat management, visitor services, and the environmental education program (preferred alternative).

Alternative B includes those actions in Alternative A; in addition, the Refuge would moderately expand biological, habitat management, visitor service, and environmental education activities. Additional biological activities include increased survey efforts on priority listed species as well as baseline surveys on native focal flora and fauna (biologists would prioritize what native species to survey). Habitat would be improved for the western snowy plover and California least tern. Other habitat management activities include implementation of a comprehensive weed management plan, additional improvement to tidal marsh areas, restoring the ecotone/transition zone, and addressing climate change impacts on Refuge resources. The Service's "Big 6" public uses—wildlife observation, photography, hunting, fishing, interpretation, and environmental education—would all be enhanced on the Refuge. Refuge staff would expand the volunteer program to recruit new volunteers and provide additional learning opportunities to existing volunteers. Additional staff and funding would be needed to implement this alternative.

Listed Species. Under Alternative B, SMHM surveys would be conducted annually within a subset of the Refuge. The monitoring plan for listed species would be revised to standardize protocols. Nest site enhancement, additional management actions, and monitoring would be conducted to increase western snowy plover productivity. The Refuge would also survey and monitor several listed plant species, including the Suisun thistle, salt marsh bird's-beak, soft bird's beak, and California sea-blite. Nesting habitat would be created for the California least tern. Further research on trail and noise disturbance effects to the CLRA would be conducted. Avian and mammalian predator management actions would be conducted to protect listed species. High marsh and ecotone would be enhanced or raised where possible to benefit tidal marsh listed species. CCG would be seeded into restored vernal pools, where warranted. Increased law enforcement, public education, and staff training would reduce wildlife disturbance and benefit listed species.

Other Species. Additional survey efforts, including completing baseline population density, presence/absence, and/or abundance surveys would be conducted on focal plant and animal

species. Additional surveys would be conducted on the California black rail, song sparrow subspecies, and salt marsh common yellowthroat. Survey and mapping of occupied burrowing owl nesting habitat and pairs would be conducted on the Refuge; Refuge staff would also participate in regional burrowing owl surveys. Coordinate with other burrowing owl survey partners (e.g., Santa Clara Valley Audubon Society, City of Mountain View Shoreline Park).Additional law enforcement, staff training, and public education would also benefit wildlife resource protection. Additional predator management focused on avian species (e.g., control of raptors that prey on threatened and endangered species) would also be conducted to benefit wildlife resources. Burrowing owl habitat would be sought for restoration as well.

Habitat Management. Under Alternative B, additional nesting habitat and habitat enhancements would be created for the western snowy plover and the California least tern. Additional tidal and managed marsh actions would be conducted at La Riviere Marsh, Mayhews Landing, and New Chicago Marsh where feasible. High marsh and ecotone would be heightened and expanded where possible to provide wildlife refugia. A comprehensive weed and re-vegetation management plan would be implemented to control priority weeds, and controlled areas would be replaced with a native plant pallet. Priority weeds would be controlled using a variety of mechanical, cultural, thermal, and chemical methods. Further detail on weed targets are described in the Weed Management Plan which is appended to the CCP.

In the Warm Spring subunit, invasive plant cover would be reduced to less than 30 percent using a variety of control measures. Also, biomass of residual dry matter would be reduced by 1,000–1,200 pounds per acre through grazing. In 2012, the Refuge will begin to manage the adjacent 444- acre former Pacific Commons Preserve (currently managed by ProLogis as required by mitigation), as part of the Warm Springs subunit. As a result of the increased acreage, the cattle grazing program would be managed among ten refuge pastures. Cows would be kept in several small herds and would be rotated seasonally throughout the pastures according to target grazing rates. Cows would remain in at least three small herds throughout the year and would not be moved off-site. The prescribed burn season at Warm Springs would be expanded to include summer. Cover of native upland plants would be enhanced by controlling weeds, managing the grazing program, and seeding.

The Refuge staff would also work with partners to increase shorebird and waterfowl nesting habitat where possible in the Alviso, Mowry, and Newark Ponds. The marsh-upland ecotone would be enhanced and restored to a native plant dominant community, particularly at Faber-Laumeister, La Riviere Marsh, the EEC, Pond A6, and Pond A8. The Refuge would also implement the Mosquito Management Plan which is appended to the CCP. Expansion of the restoration education program would also support restoration of the ecotone/transition zone.

Acquisition. The Refuge would take a more active approach, working with partners and willing sellers to acquire the remaining lands within the approved acquisition boundary that meet the Refuge purposes. Using the 1990 Final Environmental Assessment, Potential Additions to the San Francisco Bay National Wildlife Refuge, Alameda, San Mateo, and Santa Clara Counties, California as a reference, the Refuge staff would assess and prioritize remaining lands within the approved acquisition boundary for acquisition (from willing sellers). Lands would be prioritized based on endangered species and other trust species (e.g., migratory birds) needs, as well as lands that have feasible opportunities to address climate change impacts (e.g., uplands near tidal marsh) such as sea-level rise.

Public Uses. Under Alternative B, a visitor services plan would be developed with a unified message of three main themes developed for public programs and outreach. Refuge staff will also assess trail use, particularly on Refuge/Bay Trails, and develop additional management and monitoring guidelines. Step-down planning for trail uses would also be considered. Wildlife observation opportunities would be expanded through trail enhancements, additional viewing areas, and non-motorized boat launch/destination sites (in concert with the San Francisco Bay Area Water Trail). A raised boardwalk would be installed at Faber-Laumeister for wildlife observation, photography, and fishing. Additional wildlife viewing areas would be constructed where feasible. A remote camera would be installed near closed or sensitive areas to promote compatible wildlife observation. Water-based (e.g., canoe, kayak) launches would be explored and, if feasible, implemented at Alviso Slough, Newark Slough, Bair Island, and/or Dumbarton Bridge. Signage would be installed to reduce boating impacts. At least one universally-accessible photography blind would be constructed. A wildlife photography permit system would be developed to allow photographers additional access opportunities. A bus stop at headquarters would be explored and, if feasible, implemented to promote use of public transit.

Hunt acreage and protocols would remain unchanged from Alternative A. Coordination with hunters would be improved through additional outreach meetings, an interactive Web site, additional hunt material and information, and hunt data collection. A volunteer program would be enhanced for the upkeep of current hunt blinds.

Fishing would be expanded under this alternative. The fishing pier at Marshlands Road would be renovated, including improving the fish cleaning stations. A small fishing platform would be installed at the Coyote Creek Lagoon and Faber-Laumeister sites (as mentioned previously) while fishing access would be explored at Alviso Slough.

To facilitate visitation and interpretation, a LEED-certified visitor center complex would be constructed at headquarters. Visitor contact services would be improved at the EEC through additional staffing. Two new interpretive programs would be rotated into the existing interpretive offerings to increase the diversity of activities. In addition, ten special events and nine outreach events would be offered. Tours of the vernal pools would be increased to four annually during the flowering season. All interpretive materials such as interpretive panels and information sheets would be updated.

Environmental Education. The environmental education program would be updated and expanded in several ways, such as through the remodel of the Environmental Education Center (EEC), updating current educator training materials, Spanish translation of materials and curriculum, and adding additional programs at different sites. The EEC would be updated to LEED-certified silver or better per Service and federal government sustainability and greenhouse gas reduction policies. Interpretive materials and programs would be developed based on these LEED features and their benefits to refuge resources.

Educator training materials and other environmental education resources would be improved or expanded for all existing environmental education programs. Programs and materials would be offered in Spanish. Additional Science Night programs would be offered at more schools. The Restoration Education Program would be expanded to six high schools and four colleges as well as non-school based audiences. Enrichment activities would be expanded throughout the year for

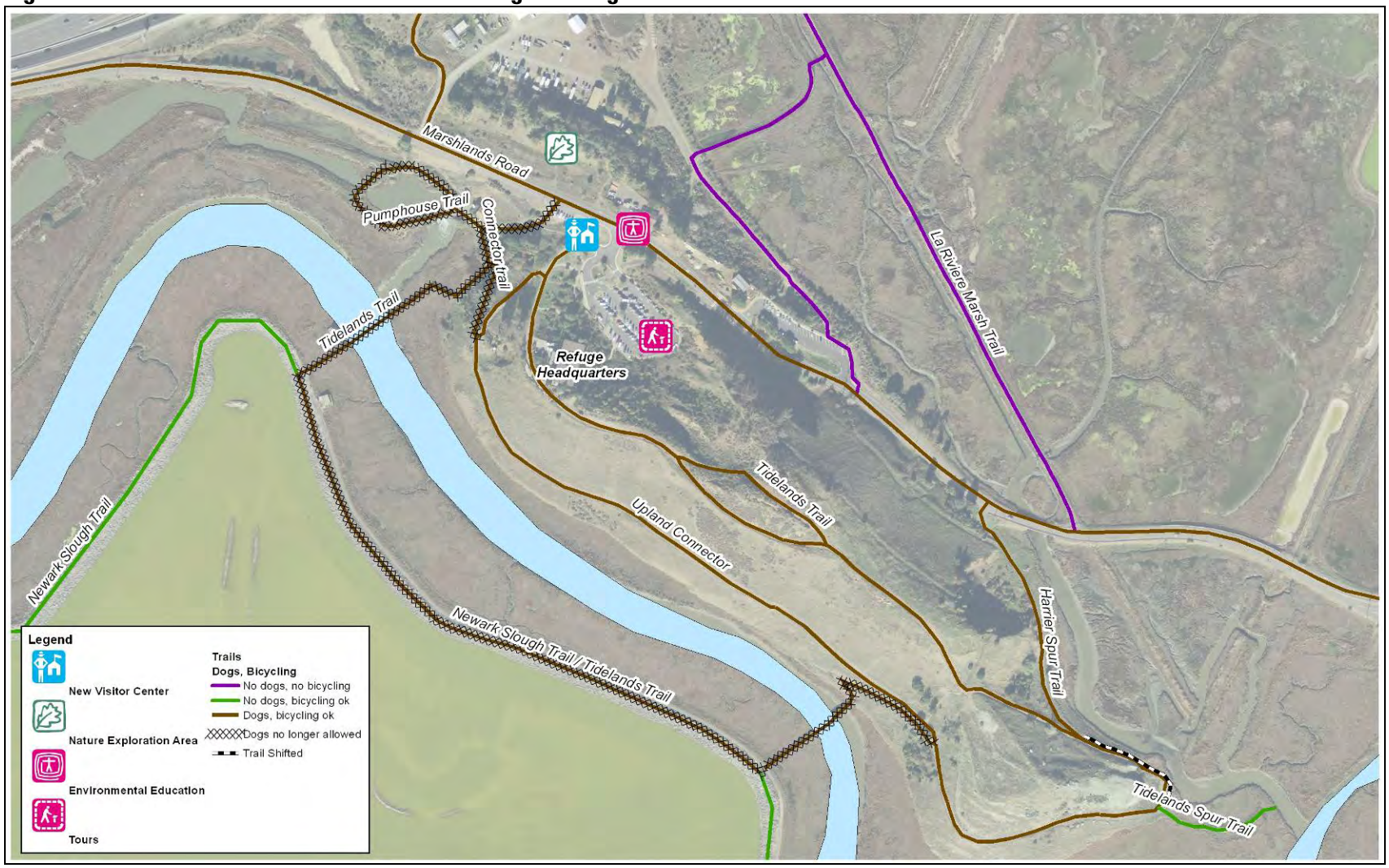
Habitat Heroes who support the Summer Camp Program. Like Alternative A, programs would continue to promote watershed study and water conservation in the San Jose/Santa Clara watershed, targeted at fifth grade through college levels. Four discovery packs would be redesigned to support environmental education programs.

Other. The Refuge would improve outreach to present careers in conservation at events and programs. A nature exploration area would also be developed at headquarters to promote the Service's Children in Nature Initiative. Three virtual geocache and earth cache sites would be developed to encourage compatible outdoor exploration.

The volunteer program would be expanded through increased volunteer and volunteer hour solicitation goals. Volunteer training would be improved and the Refuge would recruit volunteers from different segments of the Bay Area. Site specific stewardship projects would be developed at Warm Springs, Alviso's managed ponds, Moffett Bay Trail, Ravenswood, Bair Island, Faber-Laumeister, and others as determined.

We are concerned that by allowing the continued use of dog walking near tidal marsh, we are opening the door to future use on other Refuge trails and across the Refuge System. To this end, dog-walking would be modified to limit dogs to trails primarily in the upland areas only, in order to reduce disturbance to tidal marsh species, including the endangered CLRA. A total of 0.8 miles of trails open to dog walking would be closed, out of 2.1 miles (a reduction of 38 percent). Dog walking beyond the Tidelands Trail bridge crossings would be prohibited. Also, shifting the section of trail between the Tidelands Spur Trail and the Harrier Spur Trail slightly inland would be considered in order to expand a buffer between the trail and the adjacent tidal marsh which is at the same elevation (see Figure 2). This area is to remain open to dog walking in order to accommodate the loop feature of the trail. Law enforcement and staff/volunteer contact with visitors would be increased to ensure compliance. Additional signage would be placed to inform the public about these dog walking changes. A three to six month monitoring program would also be implemented to ensure compliance. If impacts to wildlife or their habitats are identified that cannot be effectively mitigated, dog walking may be prohibited entirely.

Figure 2. Alternative B - Reduced Access for Dog Walking



Alternative C: same as B; and substantial increase in wildlife management, habitat management, visitor services, and the environmental education program.

Under Alternative C, the Refuge would increase the frequency of baseline monitoring, investigate reintroduction of the listed species, survey for listed plant species, and encourage additional research to benefit listed species. Additional habitat management actions include additional tidal marsh improvements, more aggressive control of invasive weeds, revegetation of grassland areas, and more aggressive enhancement and restoration of the marsh-upland ecotone. All "Big 6" public uses would be further improved, such as opening additional hunt acreage, installing additional interpretive signage, constructing an auto tour route, and enhancing the environmental education program offsite, beyond the field trip experience. Additional staff and funding would be needed to implement this alternative.

Listed Species. Under Alternative C, the Refuge would conduct SMHM surveys in all Refuge marshes. The Refuge would also investigate and, if feasible, implement the reintroduction of the SMHM and the CLRA in appropriate Refuge habitat. Further studies would be encouraged through partners on how pepperweed density and plot size affect the SMHM. The Refuge would also contract or partner with others to investigate CLRA populations, fledging success, survival and dispersal rates, and interspecies aggression. The Refuge would also contract or partner to research habitat restoration and climate change effects on listed species.

Other Species. Under Alternative C, the frequency of baseline monitoring would increase. Every five years, population density, presence/absence, abundance, and/or cover on focal plant and animal species would be conducted. Baseline abundance assessments would be conducted on native and non-native predators. The addition of a boat launch would improve law enforcement access to protect wildlife resources. The Refuge would also work with others to investigate mudflat and shallow pond biofilm relationship to shorebird diets. In addition, the Refuge would partner to monitor priority contaminants in priority species and work with others to establish threshold levels of contaminants.

Habitat Management. Additional tidal marsh enhancement would be conducted at the Faber-Laumeister and Munster subunits. A more aggressive approach would be taken on weed control, such as reducing cover of invasive pepperweed by 50 percent. At the Warm Springs subunit, the Refuge would work with a nursery to collect seed from the site and amplify for hydroseeding on weedy areas of the subunit. A hydro-geomorphic survey would be conducted on Warm Springs to improve circulation through berm removal. Additional enhancements and restoration would be made along the marsh-upland ecotone in the Ravenswood and Alviso pond systems as feasible.

Public Uses. Under Alternative C, additional interpretive signage and overlooks would be installed on the Shoreline and Alviso Slough Trails. Interpretive programs such as vernal pool tours (three times per week during the vernal pool flowering season) would be increased. EEC visitor contact services and staffing would be increased on weekends and weekdays. The Refuge would develop a walking path or footbridge from the bus stop at headquarters. An auto tour route along Marshlands Road would be developed with safe pullouts to facilitate wildlife observation and photography. Four or more universally-accessible photography blinds would be constructed to facilitate wildlife photography. A youth photography day camp would also be offered. The feasibility of a bus stop would also be explored at the EEC. Kayaks/canoes and bicycles would be

purchased to facilitate wildlife observation programs and a boat dock would be constructed. At least one stop would be developed to meet the San Francisco Bay Water Trail goals.

An additional 340 acres of pond habitat at A6 would be open to waterfowl hunting. A universally-accessible hunt blind would also be constructed and additional hunting-related courses would be offered, particularly for youth. A fishing day would be offered at an additional site on the Refuge (other than the fishing pier).

Environmental Education. Under Alternative C, green/LEED building and other related workshops, classes, and tours would be offered on climate change impacts and how to reduce one's carbon footprint. The EEC would be used to conduct vocational education and college-level environmental education programs focused on reducing climate change impacts to wetlands (e.g., reducing carbon footprint, green/LEED building).

The Wetland Round-up and Restoration Education Programs would be significantly expanded. Both programs and related materials would be enhanced and additional materials developed to enrich the field-based experience. The Refuge staff would work more closely with schools to enhance learning beyond the Refuge through its Schoolyard Habitats, Green Teams, School Waste Diversion, and other programs. The programs and their materials would be translated into additional languages beyond Spanish. The Refuge would also train existing and new partners to host the Wetland Roundup Program to new audiences. The Restoration Education Program would be expanded to additional sites such as Bair Island. Also, this program would be expanded beyond Alternative B to include ten high schools, eight colleges, vocational education programs, master gardener programs, eight non-school based audiences, and local community programs (e.g., waste reduction, community gardens).

The Summer Camp Program would be expanded from 80 campers to 120. The Habitat Heroes Program, which supports the Summer Camp, would also be expanded to accommodate more young adults, and more enrichment opportunities would be provided. The Slow the Flow Program would be expanded to cover additional watersheds not served by the San Jose/Santa Clara Water Pollution Control Plan. Additional water quality programs would be expanded to colleges.

Other. The volunteer program would be the same as Alternative B. Dog walking would be prohibited on the entire Refuge. Other non-wildlife dependent recreational uses would be expanded, including offering six virtual geocache and six earth caches sites as well as a nature exploration area at the EEC.

Table 1. Summary of Alternatives

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
Biological			
Monitoring and Research	• Conduct annual surveys on migratory waterfowl and shorebirds.	• Same as Alternative A.	• Same as Alternative A.
	• Support monthly surveys of shorebird and waterfowl use of salt ponds and managed ponds; assess water quality within those ponds.	• Same as Alternative A.	• Same as Alternative A.
	• Support fish monitoring in sloughs and restored tidal marshes.	• Same as Alternative A.	• Same as Alternative A.
	• Support monitoring and research on nesting success of shorebirds, terns, and gulls.	• Same as Alternative A.	• Same as Alternative A.
		• Complete baseline population density, presence/absence, abundance, and/or cover on focal plant and animal species.	• Same as Alternative B.
		• Participate in regional database (e.g., CNDDB, E Bird, BIOS) to make data publicly available.	• Same as Alternative B.
		• Develop standardized quantitative and qualitative monitoring protocols.	• Same as Alternative B.
		• Conduct surveys of California black rail, song sparrow subspecies, and saltmarsh common yellowthroat.	• Same as Alternative B.
		• Assess the status of burrowing owls on the Warm Springs sub-unit. Maintain short grass/vegetation height prior to nesting season to facilitate site selection.	• Same as Alternative B.
		• Conduct survey and mapping of occupied burrowing owl nesting habitat and pairs on the Refuge; participate in regional burrowing owl surveys. Coordinate with other burrowing owl survey partners (e.g., Santa Clara Valley Audubon Society, City of Mountain View Shoreline Park).	• Same as Alternative B.
			• Monitor population density, presence/absence, abundance, and/or cover on focal plant and animal species

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
			every five years.
Listed Species	• Conduct annual CLRA surveys (call counts and high tide surveys) within a subset of Refuge units. • Support monitoring and research on nesting success of western snowy plovers. • Conduct opportunistic surveys for SMHM in select marshes.	• Same as Alternative A. • Same as Alternative A. • Conduct SMHM surveys annually within a subset of existing, restored, and managed marshes. • Revise and implement monitoring plan for listed and native species. • Increase western snowy plover productivity through nest site enhancement, management actions, and associated monitoring. • Create suitable nesting habitat for at least one colony of California least tern. • Investigate CLRA response to disturbance, including sensitivity to noise and trail use. • Survey/monitor for Suisun thistle, salt marsh bird's beak, soft bird's beak, and California sea-blite distribution and abundance.	• Same as Alternative A. • Same as Alternative A. • Conduct SMHM surveys annually in all marshes. • Same as Alternative B. • Same as Alternative B. • Same as Alternative B. • Same as Alternative B. • Same as Alternative B. • Investigate reintroduction of SMHM and CLRA into potential habitat that does not currently contain these species. • Support studies to ascertain at what density and plot size of pepperweed salt marsh harvest mice are excluded. • Contract or partner with others to investigate limits to CLRA populations, such as fledging success, survival and dispersal rates, and interspecies aggression. • Contract or identify partners to research habitat restoration and climate change

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
			effects on listed species.
Tidal and Managed Marsh Management	• Conduct restoration projects (e.g., Bair Island, SBSPRP). • Support research and monitoring to determine vegetation and sedimentation rates of newly restored areas.	• Same as Alternative A. • Same as Alternative A. • Heighten and expand high marsh and ecotone/transition zone wherever possible on the Refuge. • Improve ecological function (e.g., hydrology, habitat management) at La Riviere Marsh, Mayhews Landing, and New Chicago Marsh units.	• Same as Alternative A. • Same as Alternative A. • Same as Alternative B. • Same as Alternative B, and also improve ecological function at Faber-Laumeister and Munster subunits to enhance tidal marsh habitat.
Predator Management	• Conduct predator management through USDA Wildlife Services based on existing predator management plan.	• Implement an updated mammalian predator management plan, and implement avian predator management. • Assess efficacy of predator management program on increasing numbers of listed species and breeding birds. • Develop outreach message to visitors and neighbors.	• Same as Alternative B. • Same as Alternative B. • Same as Alternative B. • Assess baseline abundance of native and non-native predators.
Wildlife Disturbance	• Conduct law enforcement patrols.	• Increase law enforcement patrols. • Develop and conduct training and other tools for staff, partners, special use permit holders, volunteers, neighbors, and visitors to reduce trespass and disturbance. • Conduct public outreach program to promote responsible, water-based recreation.	• Same as Alternative B. • Same as Alternative B. • Same as Alternative B. • Develop a boat launch site for improved law enforcement access.
Weed and Vegetation Management	• Work with partners to conduct chemical control of invasive *Spartina*. • Conduct intermittent control of invasive pepperweed and other priority weeds through chemical and manual methods.	• Same as Alternative A. • Complete and implement a weed management and re-vegetation plan.	• Same as Alternative A. • Same as Alternative B.

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
		• Control weeds, for example, contain invasive perennial pepperweed at boundaries and reduce cover of the main infestations on the Refuge by 20 percent as derived from the 2010–2011 baseline inventory within threatened and endangered species habitat (high tide refugia, transition zone, and tidal areas).	• Further control of weeds; for example, reduce cover of invasive perennial pepperweed on the Refuge by 50 percent of 2010–2011 baseline inventory within threatened and endangered species habitat (high tide refugia, transition zone and tidal areas). • Coordinate with others to conduct region-wide weed control efforts. • Increase acreages for weed control.
Vernal Pool and Grassland Management	• Conduct vernal pool surveys. • Use grazing and prescribed burning (Sept. 1-Oct. 15) to reduce biomass of residual dry matter.	• Same as Alternative A. • Reduce invasive plant cover to less than 30 percent using mechanical, manual, and chemical control treatments. • Reduce biomass of residual dry matter to 1000–1200 lbs. per acre using grazing. • Expand prescribed burn season to include summer (Jun. 15-Oct. 15). • Increase cover of native upland plants by 10 percent by weed control, grazing, and seeding.	• Same as Alternative A. • Same as Alternative B. • Same as Alternative B. • Same as Alternative B. • Same as Alternative B. • Contract with a nursery to collect seed on site and amplify. Hydroseed weedy areas and cover with rice straw. • Conduct hydro-geomorphic survey and improve circulation through berm removal.
Managed Pond and Mudflat Management	• Restoration and enhancement through SBSPRP. • Create islands throughout managed ponds as possible during levee maintenance work. • Manage ponds at different water levels for a variety of bird species.	• Same as Alternative A. • Same as Alternative A. • Same as Alternative A. • Work with partners to explore increasing nesting and roosting habitat to benefit shorebirds and waterfowl in the Alviso, Ravenswood, Mowry, and Newark	• Same as Alternative A. • Same as Alternative A. • Same as Alternative A. • Same as Alternative B.

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
		Ponds.	• Investigate the importance of mudflat and shallow pond biofilm on shorebird diet and the potential for management for biofilm.
Ecotone/Transition Zone	• Sporadic weed removal by chemical and manual means. • Sporadic planting done in ecotone and transition zones by staff and volunteers. • Work with local city government to control nesting Canada geese in newly restored upland and ecotone habitats.	• Weed control conducted through weed management and re-vegetation plan. • Utilize staff and volunteers to plant in ecotone and transition zones according to re-vegetation plan priorities. • Same as Alternative A. • Enhance and restore marsh-upland ecotone, especially at Faber-Laumeister, La Riviere Marsh, EEC, Pond A6, and Pond A8 through established a dominance (>50%) of native plants. • Conduct restoration education program focusing on ecotone/transition zone (e.g., Warm Springs, Alviso, Fremont, and East Palo Alto). • Identify potential acquisition areas to provide burrowing owl habitat. • Implement a plan to restore the ecotone of Faber-Laumeister and implement monthly plant maintenance.	• Same as Alternative B. • Same as Alternative B. • Same as Alternative A. • Enhance and restore marsh-upland ecotone along all levees in the Ravenswood and Alviso pond systems through established dominance (>50%) of native plants. • Same as Alternative B. • Same as Alternative B. • Same as Alternative B.
Acquisition	• Acquire lands within the approved acquisition boundary that meet the Refuge purposes from willing sellers when refuge resources allow	• Refuge would actively approach willing sellers to acquire the remaining lands within the approved acquisition boundary. Refuge would assess and prioritize remaining lands within the approved acquisition boundary.	• Same as Alternative B.
Partnerships	• Continue existing partnerships to support the biology, visitor services, and management needs of the Refuge. • Work with Friends group to promote public awareness and outreach of the Refuge.	• Maintain, enhance, and develop at least 10 new projects or partners to preserve, restore, and enhance the Refuge. • Same as Alternative A.	• Maintain enhance, and develop at least 20 new projects or partners to preserve, restore, and enhance the Refuge. • Same as Alternative A.

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
Disease	• Respond to botulism outbreaks in wetland and pond habitats. • Work with partners (e.g., SBSPRP and Regional Water Quality Control Board) to monitor priority species for mercury contamination. • Work with local mosquito abatement districts to manage threat of mosquito-borne disease on the Refuge through physical, biological, and chemical methods.	• Same as Alternative A. • Same as Alternative A. • Implement a mosquito management plan. • Monitor and mitigate effects of disease outbreaks that affect wildlife, plants, and public health.	• Same as Alternative A. • Work with partners (e.g., SBSPRP and RWQCB) to monitor priority species for priority contaminants in addition to mercury (PCBs, etc.). • Same as Alternative B. • Same as Alternative B. • Work with partners to establish threshold levels of contaminants (e.g., Hg) in priority species.
Climate Change	• Partner with others to share and improve knowledge about climate change science. • Encourage and seek funding for climate change modeling. • Coordinate with local partnerships (e.g., Bay Area Ecosystems Climate Change Consortium).	• Same as Alternative A. • Same as Alternative A. • Investigate and prioritize for acquisition, lands within the approved acquisition boundary in light of climate change impacts. • Reduce carbon footprint of Refuge operations by 30 percent using renewable energy sources and reducing facility, vehicle, and workforce costs. • Coordinate with the Service's Landscape Conservation Cooperatives and Inventory and Monitoring (I&M) efforts to address near-term and long-term climate change impacts. Identify and coordinate with new local climate change partnerships. • Investigate and prioritize for acquisition, lands within the approved acquisition boundary that have feasible	• Same as Alternative A. • Same as Alternative A. • Same as Alternative B. • Same as Alternative B. • Same as Alternative B. • Same as Alternative B.

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
		opportunities to address sea-level rise impacts for marsh migration and other effects from climate change. • Identify and implement best practices to mitigate climate change impacts.	• Same as Alternative B.
Land Management Priorities	• Acquire remaining lands within the approved acquisition boundary of the Refuge as approached by willing sellers.	• Actively work with partners and willing sellers to acquire remaining lands within the approved acquisition boundary of the Refuge.	• Same as Alternative B.
Public Uses			
	• Visitor Services division offers a variety of programs related to Refuge Resources.	• Develop and implement a unified message with three main themes for the public. Incorporate the unified message in all programs and outreach. • Develop a visitor services plan.	• Same as Alternative B. • Same as Alternative B.
Wildlife Observation	• Provide more than 30 miles trail, multiple access sites, and overlooks to facilitate wildlife observation. • Offer guided walks.	• Enhance, maintain, and expand public access opportunities (e.g., improve Tidelands Trail by installing water bars to slow erosion). • Same as Alternative A. • Assess trail use, particularly on Refuge/Bay Trails, and develop additional management and monitoring guidelines. Consider step-down planning for trail uses. • Install a raised boardwalk extending the entire length of the interior levee of the Faber-Laumeister site. • Explore the feasibility of a bus stop at the Fremont headquarters entrance. • Investigate and if feasible construct additional wildlife viewing facilities. • Install a remote camera near closed	• Same as Alternative B. • Same as Alternative A. • Same as Alternative B. • Install interpretive signage and overlooks on the Shoreline and Alviso Slough Trails. • Same as Alternative B. • Same as Alternative B. • Explore the feasibility of a bus stop at the EEC. • Develop a walking path/bridge from the bus stop to headquarters. • Same as Alternative B • Same as Alternative B.

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
		and/or sensitive areas for the purpose of remote public viewing. • Research and if feasible promote water-based wildlife observation at Alviso Slough, Newark Slough, and Bair Island (canoe, kayak tours). • Identify potential canoe and kayak launch/destination sites on the Refuge (e.g., near Dumbarton Bridge/fishing pier).	• Same as Alternative B. • Buy kayaks or canoes for water-based, wildlife observation programs. • Construct a dock on the Refuge. • Develop at least one stop on the proposed Water Trail.
Photography	• Provide more than 30 miles of trail, multiple access sites, and overlooks to facilitate wildlife observation. • Offer guided photography walks.	• Same as Alternative A. • Same as Alternative A. • Construct and maintain at least one universally-accessible photography blind. • Implement a wildlife photography permit system.	• Same as Alternative A. • Same as Alternative A. • Construct and maintain four or more universally-accessible photography blinds. • Same as Alternative B. • Offer a week-long photography day camp for youths 13–16.
Hunting	• Permit seasonal waterfowl hunting on 7,500 acres of ponds, tidal areas, and open Bay. • Conduct a hunter orientation meeting. • Enact an annual waterfowl hunt fee that would provide continued funding to improve hunt blinds, hunt access, and	• Same as Alternative A. • Increase number of meetings to solicit hunter feedback. • Track hunt use over a five-year period once major tidal restoration breaches are completed to determine use. • Develop an interactive hunt Web site for hunt permits, interactive hunt maps, relevant links to other hunt information, and collection of hunt data. • Same as Alternative A.	• Open an additional 340 acres to hunting (Pond A6). • Same as Alternative B. • Same as Alternative B. • Same as Alternative B. • Same as Alternative A.

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
	outreach and education materials.	• Develop brochures and wayside exhibits for hunting.	• Same as Alternative B. • Construct an additional universally-accessible hunt blind. • Offer bird identification, hunter safety, and youth hunt education classes.
Fishing	• Permit year-round pier fishing at headquarters. • Permit shoreline fishing at Coyote Creek Lagoon and Faber-Laumeister. • Host annual fishing day at pier.	• Same as Alternative A, also update fishing pier including renovation of fish cleaning stations. • Improve fishing facilities at Coyote Creek Lagoon and Faber-Laumeister with a small fishing platform. • Same as Alternative A. • Develop brochures and wayside exhibits for fishing. • Assess and, if possible, provide shoreline fishing to Alviso Slough.	• Same as Alternative B • Same as Alternative B. • Conduct one additional fishing day at another fishing access site. • Same as Alternative B. • Same as Alternative B.
Interpretation and Outreach	• Maintain a Visitor Contact Station in Fremont. • Provide limited visitor contact services at the EEC. • Offer about 200 guided interpretive activities (walks and other programs) on a variety of topics at different sites on the Refuge. • Offer self-guided interpretive exhibits and materials at the visitor center and EEC, some in Spanish. • Offer Discovery Pack Program, a self-guided interpretive walk targeted at families. • Host seven special on-site events, such as Earth Day Cleanup, Endangered	• Construct a visitor center complex (e.g., auditorium, resource library, staff offices, and EE facilities) in Fremont to Silver LEED certification or better. • Update the Environmental Education Center building and grounds to Silver LEED certification or better. Update EEC to improve visitor contact services on weekends. • Increase the diversity of interpretation activities by offering two new interpretive programs annually. • Same as Alternative A. • Same as Alternative A. • Host a minimum of 10 Special Events on site each year.	• Same as Alternative B. • Improve EEC visitor contact services on weekends and weekdays. • Same as Alternative B. • Same as Alternative A. • Same as Alternative A. • Host a minimum of 12 Special Events on site each year.

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
	Species Poster Contest, South Bay Bird Fest, and National Wildlife Refuge Week. • Publish quarterly *Tideline* newsletter, *Sloughs News*, and other written outreach materials. • Manage Website and Facebook postings. • Offer podcast tours of the EEC and headquarters. • Participate in six outreach events each year such as fairs and festivals. • Planting and weeding activities with special groups. • Partnerships with youth-oriented programs. • Offer 1–2 tours on vernal pool management at Warm Springs during the flowering season.	• Same as Alternative A. • Same as Alternative A. • Develop two new audio tours. • Conduct a minimum of nine outreach events each year. • Same as Alternative A. • Same as Alternative A. • Increase interpretation at Warm Springs, including increasing to four tours during the vernal pool flowering season. • Update old or outdated interpretive materials such as information sheets and interpretive panels. • Develop outreach materials to promote wildlife disturbance reduction messages within the water-based recreation user group.	• Same as Alternative A. • Same as Alternative A. • Same as Alternative B. • Develop a Refuge Podcast. • Conduct a minimum of 15 outreach events each year. • Same as Alternative A. • Same as Alternative A. • Increase vernal pool tours to three times per week during the peak vernal pool flowering season. • Same as Alternative B. • Provide equipment for interpretive programs, including bicycling and kayaking. • Seek out partners to conduct interpretive programs. • Create an auto tour route along Marshlands Road by offering safe pullouts for vehicles to observe and photograph wildlife. • Same as Alternative B. • Preserve and interpret salt pond history such as hunting and infrastructure.
Environmental Education	• EEC Building built in 1979.	• Update the Environmental Education Center building and grounds to Silver	• Same as Alternative B.

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
		LEED certification or better. • Develop interpretive materials & programs to present green/LEED features as conservation measures that can be replicated. • Use green elements as teaching tools in environmental education and climate change curriculum.	• Offer green/ LEED building and reducing carbon footprint workshops, classes, and tours. • Same as Alternative B. • Use the EEC for vocational education programs and college level environmental education programs focusing on climate change impacts to wetlands (e.g., reducing carbon footprint, and green/ LEED building).
Wetland Round-up Program	• Offer 3–4 field trips per week at two sites.	• Improve educator training and pilot new environmental education resources for use by educators and partners. • Revise Salt Marsh Manual. • Translate Salt Marsh Manual into Spanish. • Offer programs in Spanish. • Develop new teacher and student resources. • Develop and enhance training materials for educator lead field trips, (including electronic materials, DVDs, and Web-based materials).	• Same as Alternative B. • Same as Alternative B. • Translate Salt Marsh Manual into Spanish and other languages (based on needs assessment). • Offer programs, continued education, and training in foreign language and translation. • Develop new teacher and student resources and new supporting activities to enrich field trips (such as Web-based pre- and post- visit activities and classroom based laboratory studies; provide equipment for these activities). • Develop and enhance training materials for educator lead field trips, (including electronic materials, DVDs, and Web-based materials), and work with schools to extend the field trip experience and enhance learning by providing training and support for Schoolyard Habitats,

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
			Green Teams, School Waste Diversion Programs, and other such activities.
		• Train partners to host Wetland Round-up Field Trip programs for other groups (e.g., Girl Scouts, Marine Science Institute).	• Train existing partners to host Wetland Round-up Field Trip programs for other groups; obtain new partnerships and grants for teacher institutes that would train partners and reach new audiences.
Science Night	• Science Night for George Mayne School annually at the Environmental Education Center.	• Continue to host Science Night for George Mayne School and expand to host and attend Science Night programs for other schools.	• Same as Alternative B.
Restoration Education Program	• Pilot field trip program in Alviso, Logan HS, and Habitat Heroes programs at Fremont; Youth Conservation Corps program in East Palo Alto.	• Develop & expand environmental education programs focused on habitat restoration for neighboring communities.	• Same as Alternative B.
		• Develop environmental education programs focused on habitat restoration in Warm Springs, Alviso, Fremont, and East Palo Alto.	• Same as B, but add additional sites such as Bair Island.
		• Research and implement restoration education at Mayhew's Landing and a Science Night with neighboring schools.	• Same as B, but also develop supporting activities and materials to extend the field experience (using programs such as Schoolyard Habitats and Green Teams).
		• Expand restoration education audience to include six high schools and four colleges.	• Expand restoration education audience to include ten high schools and eight colleges.
		• Translate restoration education materials into Spanish.	• Work with vocational education programs and master gardeners to promote native plant gardens in local communities.
		• Offer programs in Spanish.	• Offer programs and translate restoration education materials into Spanish and other languages (based on needs assessment).
			• Provide continued education and training in foreign language and translation.
		• Expand restoration education program to include four non-school based	• Expand restoration education audiences to include eight non-school based

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
		audiences.	audiences and extend restoration education to include community programs such as waste reduction and community gardens.
Summer Camp Programs	• Two camps each summer serving 80 campers (Marsh-In Camp for grades 1–6, Habitat Heroes for grades 7–12).	• Same as Alternative A. • Offer enrichment activities throughout the year for Habitat Heroes.	• Offer two weeks of Marsh-In Camp to accommodate 120 campers. • Accommodate more teens by offering a program for new Habitat Heroes and refresher program for returning Habitat Heroes. • Offer a greater enrichment trip for Habitat Heroes as well as the activities throughout the year.
Slow the Flow Integrated Field Trip Program	• Seven cities served (San Jose, Santa Clara, Cupertino, Milpitas, Los Gatos, Monte Sereno, and Campbell) with Slow the Flow Integrated Field Trip Program. • Offer programs for upper grade classes (fifth grade through college).	• Continue to offer programs that promote watershed study and water conservation in the area served by the San Jose Santa Clara Water Pollution Control Plant. • Continue to offer programs for upper classes (fifth grade through college). • Increase capacity for joint Water Pollution Control Plant/Environmental Education Center tour programs (more tours and improved curriculum).	• Expand to include other watersheds on the Refuge not served by the San Jose Santa Clara Water Pollution Control Plant. • Same as Alternative B. • Same as Alternative B. • Install digital water quality monitoring station in Artesian Slough for field trip use. • Develop more specialized curriculum and supporting materials for colleges.
Offsite Environmental Education	• Host a booth at Bay Area Environmental Education Resource Fair. • Participate in Audubon Wildlife Education Day.	• Same as Alternative A. • Same as Alternative A. • Develop and present careers in conservation program for outreach events and programs.	• Develop and lead workshops at BAEER fair. • Attend additional local offsite events that support the goals of the environmental education program. • Continue outreach and more career development and training (through internships, Student Temporary Employment Program positions, Youth Conservation Corps, and other

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
	• Conduct Slow the Flow Outreach or other environmental education events.	• Same as Alternative A.	programs). • Continue outreach and teach at Resource Area For Teaching Workshops.
Scout Programs	• Scout programs (badge program and service projects) offered by Santa Clara Valley Urban Runoff Pollution Prevention Program in Alviso and offered by volunteers in Fremont. • Support Scout programs with materials (Discovery Packs).	• Same as Alternative A. • Redesign four Discovery Packs with self-guided activities.	• Expand badge offerings. • Offer Scout camps. • Offer programs in conjunction with the national Scout offices. • Create eight Scout packs. • Offer Train-the-Trainer workshops to Scout Leaders for use of the packs.
Special Environmental Education Events (Provided by Slow the Flow/Santa Clara Valley Urban Runoff Pollution Program grants)	• Continue to offer two annual outreach events at the EEC (South Bay Bird Festival, and Spooky Slough/Shark Day).	• Same as Alternative A. • Collaborate with and incorporate additional partner organizations that would contribute to outreach activities and the Refuge mission.	• Same as Alternative A. • Increase event capacity (facilitate additional transportation and staff, volunteer, and visitor parking). • Increase FWS staff participation when possible (site preparation, on-site assistance).
Other Recreational Uses	• Dog walking would continue on designated trails at the headquarters. • Permit bicycling. • Offer one virtual geocache site. • Permit boating on the Bay and tributaries of the Refuge.	• Limit dog walking only to the upland portion of trails near the headquarters. • Same as Alternative A. • Offer three virtual geocache sites and three earth cache sites. • Same as Alternative A. • Develop a nature exploration area at headquarters to promote Children in Nature Initiative.	• Prohibit dog walking on the entire Refuge. • Same as Alternative A. • Offer six virtual geocache sites and six earth cache sites. • Construct a boat dock. • In addition to headquarters, develop a nature exploration area at EEC.
Volunteers	• Manage internship and volunteer programs to support biology, environmental education, visitor	• Expand volunteer program though increasing volunteers and volunteer hours.	• Same as Alternative B.

	Alternative A: No Action (Status Quo)	Alternative B: moderate increase in wildlife management, habitat management, visitor services, and environmental education programs	Alternative C: substantial increase in wildlife management, habitat management, visitor services and environmental education
	services, and management needs. • Recruit volunteers from businesses, community groups, and court-ordered community service to conduct long-term projects such as weed removal, cleanups, and plantings.	• Same as Alternative A.	• Same as Alternative A.
		• Expand volunteer docent program and materials (volunteer development, training, evaluation, and recruitment).	• Same as Alternative B.
		• Develop permanent stewardship projects for: Warm Springs, Alviso managed ponds, Moffett Bay Trail, Ravenswood, Bair Island, Faber-Laumeister, and others.	• Same as Alternative B.
		• Develop one volunteer program every five years that outreaches to different segments of the bay-area community.	• Same as Alternative B.
		• Separate visitor center roles from volunteer coordinator roles.	• Same as Alternative B.

Figure 3. Visitor Service and Environmental Education Activities for Alternative A

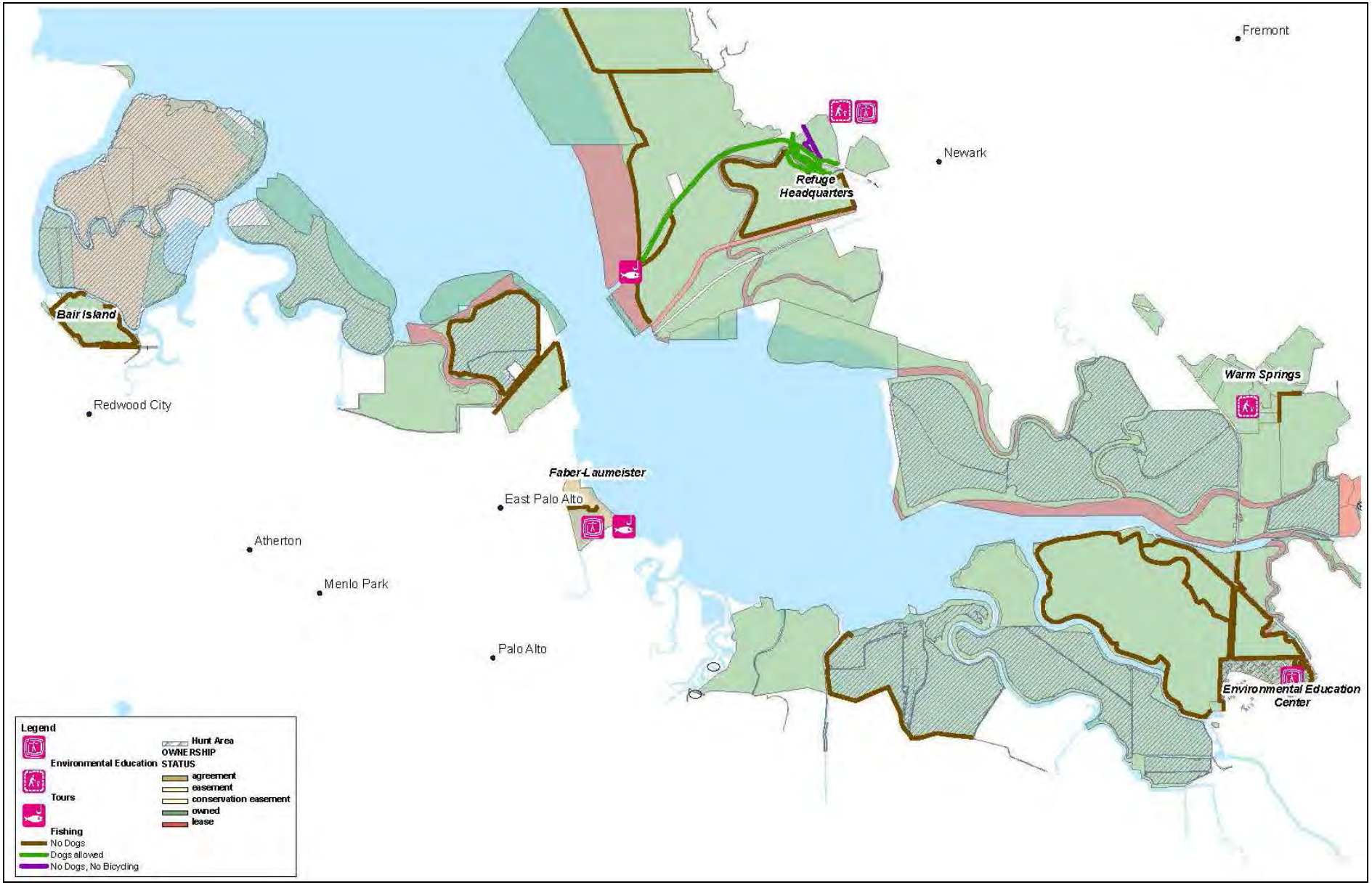


Figure 4. Visitor Service and Environmental Education Activities for Alternative B

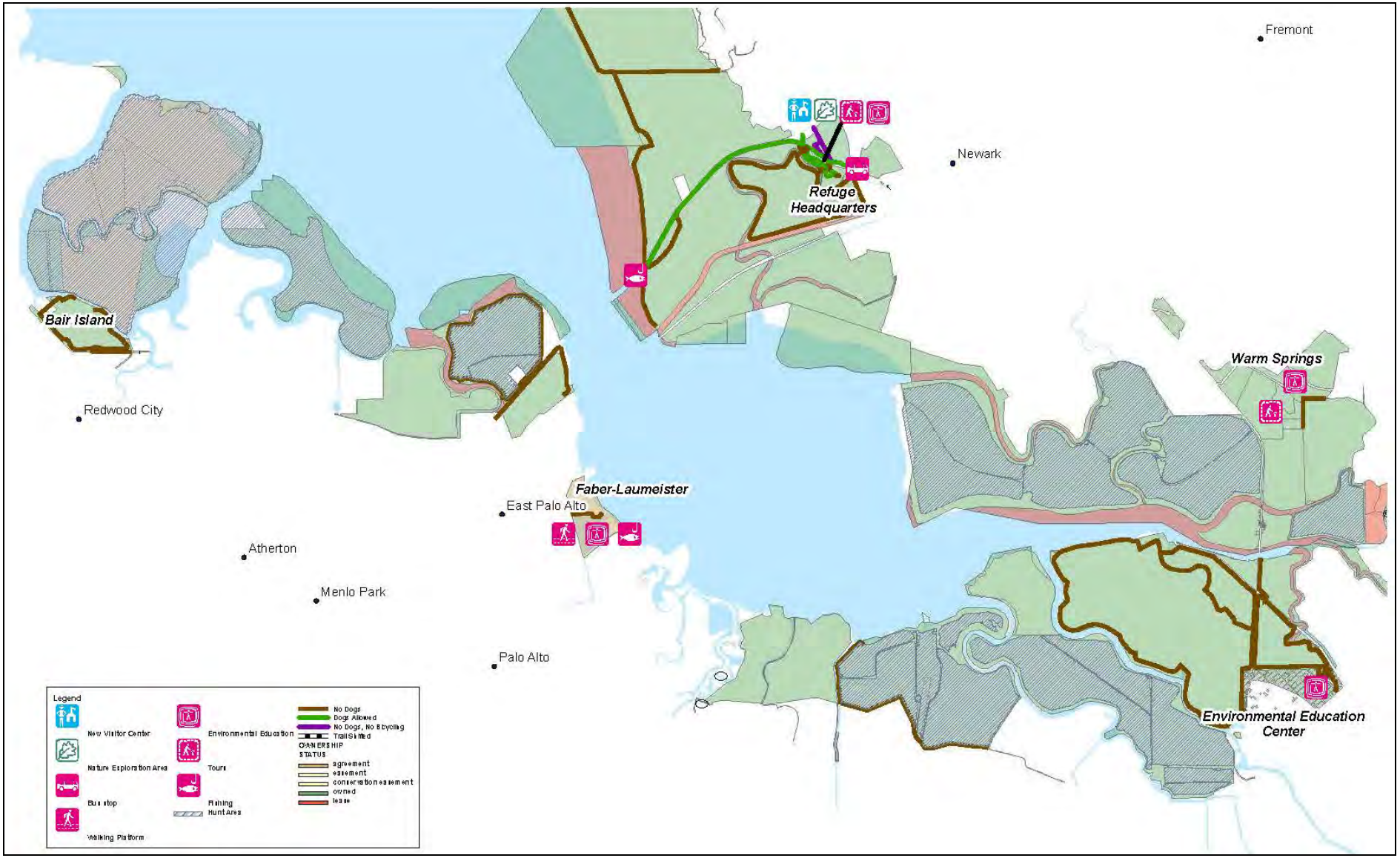
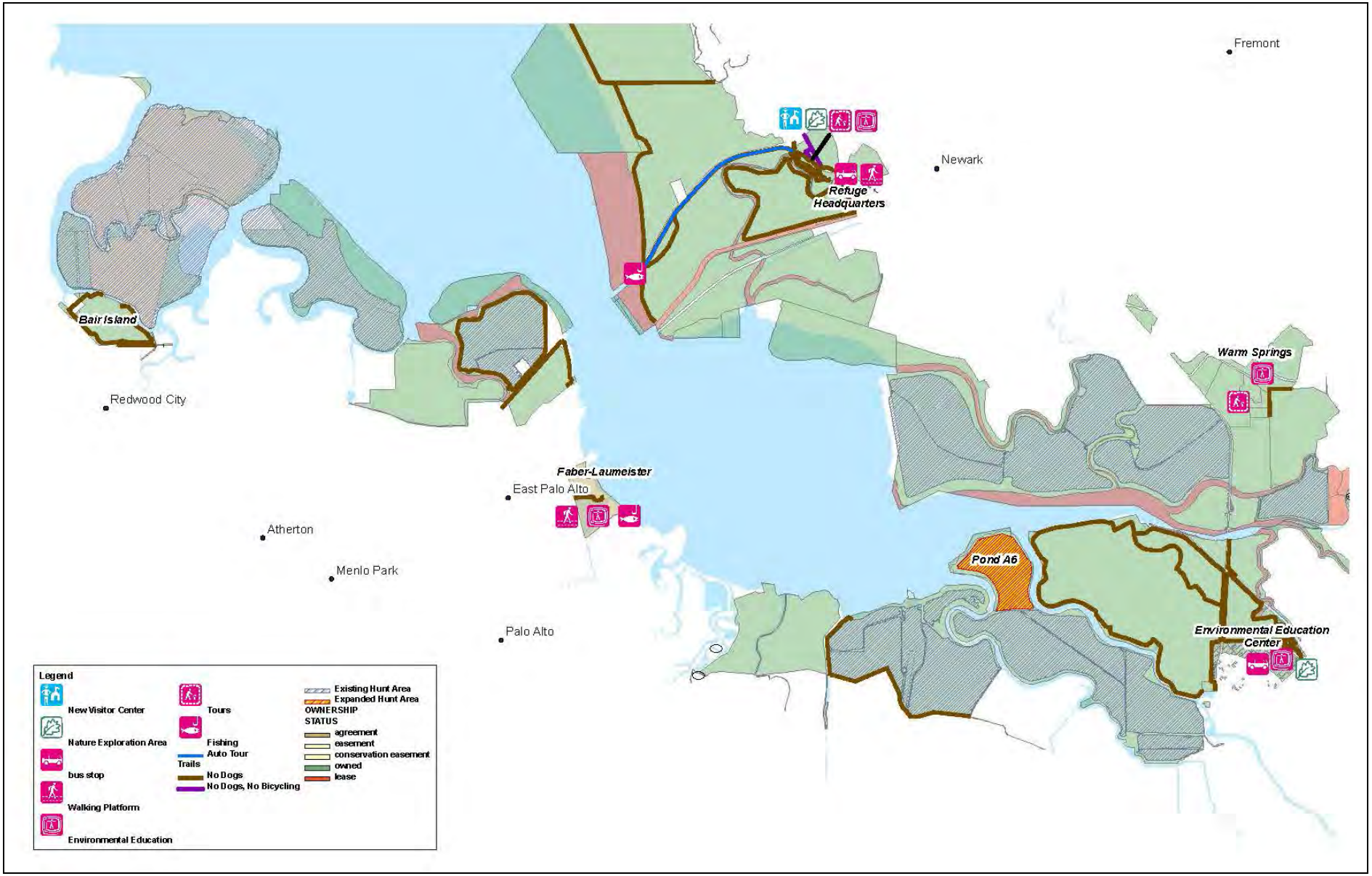


Figure 5. Visitor Service and Environmental Education Activities for Alternative C



Chapter 3. Affected Environment

This chapter is intended to describe the physical, biological, and cultural resources, as well as the social and economic environment that would most likely be affected by the alternatives. Chapter 3, *Affected Environment*, of the CCP provides a detailed description of each of these components.

Chapter 4. Environmental Consequences

Chapter 4 analyzes the environmental impacts expected to result from implementation of the alternatives. Potential impacts to these resources are characterized by evaluating direct, indirect, and cumulative impacts for each alternative where applicable. Direct impacts are generally caused by the proposed actions and occur at the same time and place as the action, such as flushing of wildlife from wildlife observation activities. Indirect impacts are defined as reasonably foreseeable effects caused by the proposed action, but occurring later in time or farther away from the source of impact than direct effects. An example of an indirect impact is habitat modification that results in a change in abundance, breeding success, or prey availability. Cumulative effects would occur when incremental direct or indirect impacts are added to the impacts of other past, present and reasonably foreseeable future actions, regardless of the agency or person who undertakes them. The analysis is organized by each aspect of the environments described in Chapter 3 of the CCP, including physical, biological, cultural, social, and economic resources. The purpose of the analysis is to provide the context and intensity of the impacts of the action such that a determination of significance can be made by the decision-makers.

The analysis of environmental consequences focuses on all units of the Refuge. A separate, detailed NEPA analysis has been completed for individual restoration projects, such as the Bair Island Restoration Project and the SBSPRP. The discussion and analysis in these documents is incorporated by reference, but the following analysis is focused on new actions proposed under the CCP.

NEPA requires the development of mitigation measures when Federal activities are likely to result in adverse impacts on the human environment. The EA and CCP identify measures that would avoid and minimize any environmental impacts that could occur during implementation of the CCP. Alternative A (no action) is a continuation of management practices that are currently in place and serves as a baseline against which Alternatives B and C are compared.

Physical Resources

Hydrology

Common to All Alternatives

Because much of the Refuge is located at or below sea level, much of the Refuge is affected by tide changes in the Estuary. Levees and water control features from prior development have altered the hydrological patterns (i.e., natural slough channels) in the area resulting in poor water circulation, such as trapping of stagnant water in some areas. Poor circulation has in turn resulted in poor quality tidal marsh vegetation. Under each of the alternatives, the restoration projects described in the Bair Island EIS/Environmental Impact Report (EIR) and the SBSPRP EIS/EIR would continue to be implemented. Implementing these restoration projects means that some dry areas would be flooded long-term while other formerly diked ponds would begin to accumulate sediment from resumed tidal influence. Breaches and dredging associated with the restoration projects will cause high velocity water flows thereby inundating sites and scouring existing channels. Sediment (e.g., silt, clay, sand, and gravel) carried into low elevation areas will settle and discourage stagnating water. Over time, sedimentation will reduce these flows, improve floodplain function, encourage plant communities to form and stabilize the area, and channels will reach equilibrium. These hydrologic effects are discussed in detail in the EIS/EIR associated

with the Bair Island restoration project and SBSPRP. The EIS/EIR for the SBSPRP provides both a programmatic analysis of hydrological impacts as well as a site specific analysis of the hydrologic impacts from implementing Phase 1 of the overall restoration project. As subsequent phases of the SBSPRP are developed, additional site specific analysis, including a NEPA document, will be completed. The NEPA documents for both the Bair Island project and the SBSPRP can be found at: www.southbayrestoration.org/index.html.

From a public health perspective, stagnant waters breed mosquito populations that may carry diseases that are a threat to human health. Restoration activities associated with the Bair Island and SBSPRP are also expected to improve or restore hydrological patterns and wetland function, reduce stagnant waters, improve floodplain function, and result in an increase in tidal marsh habitat. These hydrological improvements should reduce mosquito populations, providing a benefit to public health as well as to wildlife communities. Mosquito management activities (i.e., mosquito population monitoring, disease surveillance, and habitat improvements) are not expected to negatively impact hydrology. Physical improvements such as ditching conducted by the mosquito abatement districts are expected to improve hydrology in areas with stagnant water issues.

Routine operation and maintenance of the ponds is limited to maintaining the levees between the ponds and would not have any adverse impacts on the hydrology of ponds. Weed management activities, particularly manual removal of weeds by hand pulling, cutting, digging, chopping, uprooting (weed wrenching), sawing, weed-whacking, and mowing may expose soil and make it vulnerable to erosion. However, those sites will be replaced by native plants through hydroseeding or planting seedlings to prevent long-term soil loss.

The Service recognizes the need to protect levees and other structures for the purpose of public safety and protection of private property. As restoration projects are developed in the future, we will carefully evaluate hydrological impacts to neighboring public and private property before implementation.

Alternative A

Under Alternative A, the restoration projects associated with Bair Island and the SBSP would continue to move forward, and the effects on hydrology would be the same as described under Common to All Alternatives.

Alternative B

Under Alternative B, additional hydrological improvements would be assessed and conducted as funding permits at La Riviere Marsh, Mayhews Landing, New Chicago Marsh, and others as possible. These sites are diked or sedimented, weedy, and have poor hydrological connectivity. Impacts similar to those described under Common to All Alternatives would occur. Earth moving on these sites may result in short-term changes (e.g., erosion, sedimentation) to their hydrology but with long-term benefits to improving floodplain function. As in Alternative A, ongoing restorations and enhancements have the potential to cause high velocity water flows thereby inundating sites and scouring channels. These water flows will reduce over time with the buildup of sedimentation and vegetation, and equilibrium being reached in channels. Additional analysis for tidal impoundments and other hydrological issues would be assessed in site specific planning and NEPA document. Under Alternative B, construction of new nesting and roosting habitat for migratory birds will result in changes to the water flow in managed ponds, but is not likely to

adversely affect the overall hydrology of the ponds.

Under this alternative, increased weed control activities as implemented by the weed management plan may result in more soil erosion than existing weed management. However, these sites will be replaced with native vegetation to prevent long-term soil erosion.

Alternative C
In addition to those elements in Alternative B, hydrological patterns would be assessed and improved at Faber-Laumeister, Munster, and Warm Springs. These improvements would result in similar impacts as described in Alternative B. Increased weed management activities would result in the same effects as described in Alternative B.

Water Quality and Contaminants

Common to All Alternatives
Ongoing restoration actions described in the Bair Island and SBSP projects may cause short term water quality impacts, but will result in long-term benefits to water quality. As described in the NEPA documents for those projects, tidal restoration and removal of invasive and non-native vegetation may result in short-term soil erosion and increase the turbidity in waterways. Restoration activities such as breaches, the moving of fill, and dredging could result in temporary, short-term water quality impacts such as increased turbidity from soil erosion, sedimentation, and the introduction of contaminants carried by tidal waters entering refuge units. Mitigation measures adopted in the Records of Decision for the Bair Island and SBSP projects incorporated best management practices that include the use of barriers to prevent sediment from flowing off the Refuge, thus minimizing impacts to water quality.

In the long-term, restoration activities are expected to improve water quality by allowing tidal exchange of water. As a result of restoration, salinity and dissolved oxygen levels of water bodies on the Refuge would be regulated through regular tidal exchange. Restoration actions will also draw sediment from waterways and the Bay into the refuge units to create land and eventually tidal marsh communities. However, the ongoing tidal restoration activities may also introduce contaminants into or out of the Refuge. The Refuge is researching contaminants issues in current tidal restoration projects to inform future management actions. Of particular concern is the distribution of legacy mercury now trapped in South Bay sediments and conversion of inorganic mercury to forms more bioavailable to wildlife. This could result in impacts to breeding success and longevity of certain species of wildlife.

Weed control activities in the form of mechanical, cultural, thermal, and chemical removal methods may cause soil disturbance and will introduce chemicals into the environment. However, only approved herbicides appropriate for the Refuge's upland and tidal marsh environments will be used according to label directions. Herbicide application will be permitted in or near water bodies, but not during inclement weather to reduce impacts to water quality. All herbicides approved by the Service through the Pesticide Use Proposal (PUP) process would be applied at label rates and all label recommendations would be followed (e.g., measures to preclude herbicide application on windy days).

The Refuge would continue to periodically use Service-approved aquatic herbicides including: Round-up®, GlyproPlus, Aquamaster and Rodeo® (glyphosate), Garlon 4® (triclopyr), Habitat, Polaris (imazapyr), Milestone (aminopyralid) and Transline® (clopyralid) to control invasive

plants on the Refuge. Glyphosate, the active ingredient in Rodeo, Roundup pro, and Roundup pro is considered nonmobile in soils and sediments because it rapidly and strongly adheres to soil particles and degrades in the soil. Glyphosate is moderately persistent in the soil. Glyphosate is highly adsorbed on most soils especially those with high organic content. More information on glyphosate is included in the soils section, above.

Therefore, because glyphosate is so tightly bound to the soil and little is transferred by rain or irrigation water, it is not expected to affect water quality. One estimate showed less than 2 percent of the applied chemical was lost to runoff (USFS 1984). The herbicide could move when attached to soil particles in erosion run-off. In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms. Its half-life in pond water ranges from 12 days to 10 weeks (Cornell University 1994). Because glyphosate is tightly bound to the soil and with the implementation of the Service's PUP requirements, the Service anticipates there will be no adverse effects to water quality.

Triclopyr is not strongly adsorbed to soil particles, has the potential to be mobile, and is fairly rapidly degraded by soil microorganisms. Triclopyr was tested but not found in a host of groundwater sites throughout the country (Williams et al. 1988). The half-life of triclopyr exposed to sunlight is between 3 hours to 4.3 days. It degrades readily by photodegredation, but also by microbial metabolism and hydrolysis. Garlon 4 and Pathfinder II are not soluble in water, but Garlon 3A is highly soluble. It can be toxic to both fish and invertebrates (USFS 1996).

The half-life of clopyralid in water ranges from 8 to 40 days. It is highly water soluble and does not bind strongly to solids in water. Clopyralid degrades primarily through microbial metabolism. It can, however, contaminate ground and surface waters, but it is not toxic to fish, birds, or mammals (Tu et al. 2001).
The active ingredient in Milestone®, Aminopyralid is considered minimally to moderately mobile in soils, with a half-life of 103 days (WSDOT 2009). Given its high mobility, and moderate persistence in soil, aminopyralid is likely to leach to ground water, irrespective of soil type (U.S. EPA/OPP-EFED 2004 in SERA 2007). Additionally, this herbicide is considered non-toxic to slightly toxic to aquatic insects, such as dragonflies and water bugs (WSDOT 2009).

Imazapyr is the active ingredient found in herbicides such as Habitat® or Polaris®. It is highly soluble in water. The half-life of Imazapyr in water is 3-5 days with photodegredation being the primary form of degradation. Due to its rapid photodegradation by sunlight, water contamination by imazapyr is generally not of concern. (Leson and Associates 2005)

Mosquito management activities (i.e., mosquito population monitoring, disease surveillance, and habitat improvements) are not expected to negatively impact water quality. Population monitoring and disease surveillance does not involve access or application of materials into waterways. Physical improvements such as ditching conducted by the mosquito abatement districts may cause temporary soil disturbance, but are expected to improve hydrology and overall water quality in areas with stagnant water issues. Best management practices will be implemented to reduce water quality impacts, such as avoiding ditch work during inclement weather and constructing barriers to prevent impact to waterways. Also, only biological and chemical mosquito controls approved for use will be permitted in aquatic areas (see Table 2 for a list of mosquito control pesticides currently approved). All mosquito controls approved by the Service through the Pesticide Use Proposal (PUP) process would be applied at label rates and all

label recommendations would be followed (e.g., measures for aquatic environments).

Alternative A
Under Alternative A, the Bair Island and SBSP restoration projects would continue to move forward, and the effects on water quality and contaminants would be the same as described under Common to All Alternatives.

Alternatives B and C
Alternatives B and C would result in similar effects described in Alternative A. Additional hydrological improvements at La Riviere Marsh, Mayhews Landing, and New Chicago Marsh may result in increased water turbidity from soil erosion in the short-term. In the long term, water quality such as salinity and dissolved oxygen will be improved through regular tidal exchange and reduction of water impoundments at these sites. As restoration alternatives at La Riviere Marsh, Mayhews Landing, and New Chicago Marsh are developed, a site specific analysis will be completed, including a NEPA document. Best management practices will be implemented to reduce water quality impacts, such as avoiding restoration activities during inclement weather and constructing barriers to prevent impact to waterbodies.

Increased weed control efforts may result in greater temporary water quality impacts such as introduction of herbicides and soil erosion into waterways and the Bay. However, only herbicides approved for use in aquatic environments will be permitted.

Construction of nesting islands may also result in minor, short-term turbidity in managed ponds. Best management practices will be implemented to reduce water quality impacts, such as avoiding construction activities during inclement weather and constructing barriers to prevent impact to waterbodies. Contaminants monitoring in Alternative C will benefit water quality knowledge and management. Also under this alternative, by working with partners, the Refuge will improve its knowledge and management of contaminants such as mercury.

Soils and Topography

Common to All Alternatives
Ongoing tidal restoration activities implemented as part of the Bair Island and SBSP restoration projects will result in changes or disturbance to soil and topography of the Refuge. Restoration activities will increase sedimentation in some areas of the Refuge and reduce sedimentation in other areas, changing the topography of sites. The construction of nesting islands and other additional habitat will result in changes to pond topography to the benefit of shorebirds and waterfowl. Some areas may encounter increased sedimentation, while sediment loss may occur in other areas depending on tidal flows.

Impacts to soils during ongoing operation and maintenance of Refuge land would come primarily from weed control. Weed control activities in the form of mechanical, cultural, thermal, and chemical removal methods may result in varying levels of soil disturbance and will introduce herbicides into the environment. Invasive plant removal may also result in temporary soil erosion, but these areas will be re-planted with native plants which should reduce long-term erosion potential. As part of weed control efforts, immediate best management practices to mitigate for soil erosion include constructing fencing or using hay bales to prevent soil from escaping the area.

The Refuge would continue to periodically use Service-approved herbicides including: Round-up®, GlyproPlus, Aquamaster and Rodeo® (glyphosate), Garlon 4® (triclopyr), Habitat, Polaris (imazapyr), Milestone (aminopyralid) and Transline® (clopyralid) to control invasive plants on the Refuge. The interaction of herbicides with soils affects the chemical's availability to interact with water, fish and wildlife. The active ingredient for each pesticide and its availability in the soil is presented below. How herbicides interact with the soil affects its availability to potentially effect wildlife and fish, as discussed under the *Wildlife* and *Fish* sections below.

Glyphosate is considered nonmobile in soils and sediments because it rapidly and strongly adheres to soil particles and degrades in the soil. Glyphosate is moderately persistent in the soil. Glyphosate has no known effect on soil microorganisms. Glyphosate is highly adsorbed on most soils especially those with high organic content. The compound is so strongly attracted to the soil that little is expected to leach from the applied area. Microbes are primarily responsible for the breakdown of the product. The time it takes for half of the product to break down (half-life) ranges from 1 to 174 days (USFS 1984). The herbicide could move when attached to soil particles in erosion run-off. In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms (Cornell University 1994). With the implementation of the Service's PUP requirements, the Service anticipates there will be no adverse effects to soils or soil microorganisms.

The half-life of triclopyr in soil is from 30 to 90 days, depending on soil type and environmental conditions, with an average of about 46 days. The half-life of one of the breakdown products (trichloro-pyridinol) in 15 soil types (similar to those at the Refuge) ranged from 8 to 279 days with 12 of the tested soils having half-lives of less than 90 days. Longer half-lives occur in cold or arid conditions (Cornell University 1993). Clopyralid has a very high potential of mobility in soil. The half-life of clopyralid in soil is greater than 12 years and in water is 261 days. Under aerobic soil conditions, the half-life is 71 days. In the soil, clopyralid has a half-life of 8 to 66 days. Degradation is faster in warm, moist conditions and slower in cold, dry conditions. It degrades in the environment through the activity of soil microbes. Bioconcentration potential is low and biodegradation under aerobic lab conditions is below detectable levels. Transline is low in toxicity to mammals, birds, fish and bees (Dow AgroSciences 2003a, 2003b).

The active ingredient in Milestone®, Aminopyralid is considered minimally to moderately mobile in soils, with a half-life of 103 days (WSDOT, 2009). Due to this transport ability, the amount of herbicide expected to transport from the upland areas into the wetland/riparian areas is expected to be insignificant (Koopmann & Andersen 2009 in WSDOT 2009).

The herbicides Habitat® and Polaris® which contain Imazapyr, are considered highly mobile in soils with a half-life of 25-141 days depending on water inundation. Imazapyr is relatively mobile in soils because it adsorbs to soils and sediments only weakly. Adsorption increases with decreasing pH. Above a pH of 5, imazapyr is ionized and does not adsorb to soil. Volatilization of imazapyr from soil is insignificant. The mobility of Imazapyr in soils is of small concern however, as it does not bio accumulate and is considered practically non-toxic to mildly toxic to mammals, birds, fish, and aquatic invertebrates (Leson and Associates 2005).

Both restoration and weed control are expected to result in temporary impacts to soil while providing long-term stability to soil regimes on the Refuge with the replacement of native vegetation.

Mosquito management activities (i.e., mosquito population monitoring, disease surveillance, and habitat improvements) are not expected to negatively impact soil and topography. These activities are primarily done on foot by a few individuals. Use of trucks and ARGOs (all-terrain vehicle) would be restricted to levees and established berms. Only small all-terrain vehicles will be permitted around vernal pools, and because of their weight, are unlikely to impact topography or soil. Physical improvements such as ditching conducted by the mosquito abatement districts may cause temporary soil disturbance, but are not expected to result in major soil loss or change in topography.

Alternative A

No new projects would be developed under Alternative A, so the effects on topography and soils would be the same as described under Common to All Alternatives.

Alternative B

Under Alternative B, additional restoration sites would be assessed and enhanced at La Riviere Marsh, Mayhews Landing, and New Chicago Marsh sites, as needed. This restoration effort will result in localized soil erosion or sedimentation in the short-term, which would be offset by the formation of tidal marsh plant communities that will stabilize soil topography in the long-term. Native plant restoration of the Faber-Laumeister, La Riviere, EEC, Pond A6, and Pond A8 marsh-upland ecotone (levees) will result in short-term, localized soil disturbance through hand planting of native plants, but will stabilize soil in the long term. More intense weed control efforts, such as prescribed burns, may result in additional soil disturbance and erosion, but would be offset by avoiding areas at high risk of erosion and planting controlled areas with native plants. Under this alternative, high marsh and ecotone/transition zones will be heightened where possible using additional fill material, resulting in changes to soil topography. Localized soil disturbance will occur with the placement of fill material, but the formation of plant communities on these filled areas over the long-term is expected to stabilize soils.

Increased soil disturbance and erosion will occur in varying degrees from improvements to existing and placement of new visitor amenities (i.e., signage, bus stop, remote camera system, kayak/canoe boat launch, photography blind, boardwalk, fishing platform/pier, geocache sites, earth cache sites, and visitor center complex). Localized soil disturbance (e.g., compaction and erosion) will occur from the use of motorized heavy equipment and foot traffic to place this infrastructure. The placement of these features will be assessed individually; infrastructure will not be placed in sensitive habitat and sites that may be at high risk for soil erosion.

Climate change modeling in Alternative B would inform management activities to adapt to future changing conditions. For example, modeling results will inform refuge staff where changes to soil and topography conditions (e.g., conversion of tidal marsh and mudflats to open water) are expected as a result of sea-level rise. Modeling will help identify specific needs for where acquisition of mudflat, marsh, and uplands should take place.

Additional wildlife-oriented recreation, interpretation, environmental education, and volunteer opportunities under this alternative will result in additional foot traffic on the Refuge. Increased visitation may also result in soil disturbance. To reduce soil impacts, increased signage and staff training to contact visitors will be used to encourage visitors to stay on trails and avoid sensitive habitats.

Alternative C
Activities conducted in Alternative C would result in similar effects as Alternative B. In addition to these effects, there would be additional short-term soil disturbance from native plant enhancement and restoration of the marsh-upland ecotone along all levees in the Ravenswood and Alviso pond systems, which would be offset by the formation of native plant communities. More aggressive weed control efforts would result in greater potential for soil disturbance. Like Alternative B, these activities would be mitigated by avoiding areas at high risk of erosion and planting disturbed areas with native plants.

Air Quality

Common to All Alternatives
The Bay Area Air Quality Management District (BAAQMD) regulates air quality standards in the region. All ongoing restoration-related construction and general operation and maintenance would have temporary increases in dust (PM10) from earth moving activities and tailpipe emissions (e.g., nitrous oxides, sulfur oxides, carbon dioxide) from vehicle use. Prescribed burns for weed management will also result in temporary, localized increases in smoke and particulate matter. The Refuge will obtain any necessary permits from the BAAQMD prior to all prescribed burns. These activities temporarily affect air quality in the local area. On average, burns would be conducted no more than once every three years. Also, most visitors to the Refuge arrive by motorized vehicles which would result in particulate emissions as well. Mitigation measures related to ongoing restoration work are described in the EIS/EIRs for the Bair Island and SBSP restoration projects.

General operation, maintenance, management, and visitor activities would not substantially affect air quality. Operation and maintenance activities are generally limited to driving on existing roads and levee crowns as well as localized levee repair work. It is reasonable to assume that an increase in visitor use at the Refuge may reflect visitors choosing the Refuge as their destination rather than another location offering similar opportunities in the San Francisco Bay area (such as East Bay Regional Park System, in proximity to the Refuge). For this reason, the Service anticipates that there would be few to no new vehicle trips, but if there is an increase in tailpipe emissions resulting from increased visitor opportunities, it is likely to be negligible.

Alternative A
Alternative A would have the same effects on air quality and climate as described under Common to All Alternatives.

Alternatives B and C
Implementing tidal enhancement activities (at La Riviere Marsh, Mayhews Landing, and New Chicago Marsh) under Alternatives B and C will increase localized and temporary dust (PM10) and tailpipe emission from heavy equipment operation. Construction of additional public use infrastructure such as trails and fishing platforms will also increase localized dust particles from vehicle emissions. Again, these activities are expected to be infrequent, one-time projects with short-term increases to air emissions. Measures to mitigate for dust include avoiding activities during extreme dry seasons or wetting down soil during construction activities to reduce dust. As the details of these restoration projects are developed, specific mitigation measures will be developed.

In addition to construction, increased biological surveys and research are anticipated under Alternatives B and C, and would result in short-term, minor increased tailpipe emissions.

More aggressive weed control activities under Alternatives B and C may result in temporary and minor increases in localized particulate matter. Mechanical control (e.g., pulling, mowing, disking) will result in temporary, localized increases in fugitive dust and increases in tailpipe emissions when heavy equipment is used. Herbicide application is not likely to affect air quality. Application of chemicals to control non-native vegetation would not occur during inclement weather such as high winds to avoid the possibility of chemical drift. Also, herbicide would be applied in close contact to the plant, either via backpack sprayer or truck/ATV-mounted tanks. Expanding the prescribed burn season from the current September 1-October 15th to June 15th – October 15th in Alternatives B and C may result in temporary effects to air quality. Thermal weed control (i.e., prescribed burns) may be utilized more under Alternatives B and C and would likely increase particulate matter. However, burns would only occur approximately once every three years on average on areas no larger than 50 acres. Prior to burns, permits will be obtained from the BAAQMD to comply with air quality requirements and determine best management practices. These may include restrictions on igniting under certain wind speeds/directions, humidity, or other conditions that would cause local air quality to be degraded. The selection of, and adherence to a proper prescription, and careful coordination with the BAAQMD, Alameda County Fire Department, and the Service Regional Fire Management Officer will greatly limit the chance of an extreme intensity burn.

Alternatives B and C are designed to increase visitation (from 750,000 to at least 1,000,000 visitors annually) to the Refuge and thus will create overall long-term increases in tailpipe emissions to the area. However, these increases are not expected to significantly affect the overall air quality of the area. It is reasonable to assume that an increase in visitor use at the Refuge may reflect visitors choosing the Refuge as their destination rather than another location offering similar opportunities in the San Francisco Bay area (such as the East Bay Regional Park System, in proximity to the Refuge). For this reason, the Service anticipates that there would be few to no new vehicle trips, but if there is an increase in tailpipe emissions resulting from increased visitor opportunities it is likely to be negligible. Further, if a bus stop can be constructed at the headquarters (Alternative B) and EEC (Alternative C), individual vehicle trips to the Refuge could be reduced. Overall, increased management and visitor activities prescribed in Alternatives B and C are not expected to affect Refuge resources or regional ambient air quality.

Hazardous Materials and Safety Issues

Common to All Alternatives

Under all the alternatives, herbicides and pesticides are the only known hazardous materials that will be used on the Refuge. Pesticides and herbicides are selected based on human safety, environmental integrity, effectiveness, and cost. Pesticides and herbicides used on the Refuge must go through a rigorous review process and have completed necessary environmental documentation and procedures (e.g., pesticide use proposal). Because of this review process, selected pesticides and herbicides are not expected to result in any significant impacts to the Refuge or local environment. Herbicide will be stored in an approved spill-proof locker, according to label directions, California regulations, and Service policy. Crews applying the herbicide will be trained in storage and application to these same standards. Pesticide application for mosquito control will be conducted by trained personnel from local mosquito abatement districts. In the long-term, the use of herbicides is expected to decrease with the reduction of non-native

vegetation. Use of pesticides is expected to decrease with wetland enhancements. The current pesticides and herbicides approved for use on the Refuge are listed in Table 2.

Table 2. Current Pesticides and Herbicides Approved for Use on the Refuge (2012)

Pesticide or Herbicide Name	Purpose
VectoLex WDG, VectoLex CG, VectoLex WSP	Mosquito control
VectoBac G, VectoBac 12AS, Teknar HP-D, VectoBac WDG	Mosquito control
Bactimos pellets, Summit B.t.i. Briquets	Mosquito control
Altosid Pellets WSP, Altosid Briquets, Altosid XR Extended Residual Briquets, Altosid XR-G, Altosid Liquid Concentrate SR-20	Mosquito control
Altosid Liquid Larvicide Mosquito Growth Regulator	Mosquito control
Pyrenone 25-5	Mosquito control
Agnique MMF	Mosquito control
Mosquito Larvicide GB-1111(Clark)	Mosquito control
Aquamaster, Rodeo	Weed control
Milestone VM Plus	Weed control
Roundup Pro, Glypro Plus	Weed control
Garlon 4	Weed control
Habitat, Polaris AQ, Polaris	Weed control
Transline	Weed control

Ongoing tidal restoration projects may mobilize the contaminants (e.g., mercury) found in the soils on the Refuge. Removal of levees to increase tidal circulation may facilitate the movement of contaminants to different areas of the Refuge or possibly off the Refuge into navigable waters. Monitoring is included as a component of the restoration activities to understand the movement of contaminants and adapt to any necessary changes to eliminate or reduce their mobilization. The Refuge staff would work with partners to monitor priority species for priority contaminants known to be in the Bay, such as mercury and polychlorinated biphenyls.

Alternatives A and B

Alternatives A and B would have the same effects on as described under Common to All Alternatives.

Alternatives C

Under this alternative, the Refuge staff would increase efforts with partners to monitor priority species for priority contaminants known to be in the Bay, such as mercury and PCBs. Contaminant threshold levels will also be developed for priority species. Our Refuge management activities would benefit from knowledge gained through these studies.

Wilderness

Because there is no designated wilderness at the Refuge, none of the alternatives will impact wilderness.

Biological Resources

Vegetation and Habitat

Common to All Alternatives

Operation and maintenance activities conducted under each alternative would have a beneficial impact to native plants. Weed control activities in the form of mechanical, cultural, thermal, and chemical removal methods will allow native plant communities to thrive with less competition from invasive weeds. Mechanical, cultural, and thermal weed control may also result in indirect effects to native plants. Small, discrete patches of native plants may be temporarily disturbed or trampled by heavy equipment, foot traffic, and grazing by cows. Although it has only been six full years of monitoring since grazing has been reintroduced, the results of the grazing analysis support that grazing at Warm Springs has contributed to the achievement of the program's ten-year goals (WRA 2011). Grazing has substantially reduced residual dry matter (dead plant material), increased native species cover, and maintained CCG populations and low invasive species cover.

Grazing is expected to continue to result in beneficial effects to native vegetation. Primary benefits associated with the grazing program include a reduction in the accumulation of dead plant material. This residual dry matter, or RDM, is measured annually at the end of the growing season to assist in monitoring the grazing program. High RDM values, which consist primarily of non-native annual grasses, have been associated with reduced native plant diversity in vernal pools (Barry 1998). By preferentially consuming the taller, more palatable non-native grasses, cattle effectively increase light and nutrient availability for the native forbs during a key stage in their development. RDM measurements at Warm Springs have gone from approximately 5,000-6,000 pounds per acre in the absence of grazing to approximately 1,250-3,000 pounds per acre in 2009 and 2010 (the last two years of data).

Prior to the reintroduction of grazing, there was concern that grazing could negatively impact vernal pool vegetation, particularly the endangered CCG. However, cattle are known to selectively forage on grasses (Kie & Boroski 1996; Stoddart et al. 1975) and help maintain a more open canopy (Weiss 1999) which benefits native vernal pool plants. Refuge staff has similarly observed that cows have shown a substantial preference for grazing on grasses and wild mustard over native vernal pool plants (I. Loredo, pers. comm., 2011). Also, experimental grazing exclosures within vernal pools have consistently shown that grazing reduces cover of non-native annual grasses and increases cover of native vernal pool forbs (see USFWS Annual Reports 2006-2011). Ungrazed plots are dominated by non-native annual grasses, while grazed plots have, on average, 2.5 times higher cover of native vernal pool plants (WRA 2011). As for upland plants, Refuge data show that grazed pasture have consistently higher cover of native plants than ungrazed pastures (WRA 2011). Grazing will be closely monitored and managed so that individual pastures are grazed at target stocking rates. Stocking rates have been determined through pasture-specific productivity measurements and target RDM values and can be adjusted based on annual climatic conditions. The Refuge has flexibility in increasing or decreasing stocking rates by working with the cooperative grazer to decide how many cows to sell each year. Water troughs are available in each pasture in the upland habitat to ensure that cows do not use the vernal pools as a water source and to therefore minimize effects to CCG and other vernal pool plants.

Prescribed burning will result in charring of vegetation, predominantly invasive vegetation, but may include some native vegetation. Burn areas are expected to be small, less than 50 acres in

size. However, the soil would be enriched by the burn, promoting rapid recovery of the areas. It is not expected that chemical control of weeds will impact native plants.

The application of herbicides will be properly calibrated to needs. Only trained applicators would apply herbicides, following label rates and other instructions per the Refuge's approved PUPs. Timing of application would take into account wind speed and moisture in the air to reduce the potential of transfer of herbicide to non-target plants. Use of herbicides would result in reduced non-native vegetation and allow for expansion of native plant communities. For any weed control activities, endangered plants will be flagged and avoided. Planting of native plants will also facilitate native plant communities. Refuge staff would use different planting pallets and compare results to determine how best to encourage the growth of native plant communities. Overall, weed control is expected to result in a net benefit to native vegetation. Other operation and maintenance activities would have minor local effects to vegetation. Repairing water control structures would take place in areas that are already disturbed and colonized by non-native vegetation. Monitoring, survey, and research activities (e.g., Warm Springs vernal pool surveys) would result in some trampling of vegetation, but these impacts would be limited and temporary.

Habitat restoration fulfills the Service's congressional mandate to preserve, restore, and enhance habitat for threatened and endangered species, songbirds, waterfowl, other migratory birds, interjurisdictional fish, marine mammals, resident wildlife, and plants. The ongoing plant and habitat restoration activities will result in the loss of seasonal freshwater wetland and upland habitat, but will result in an increase in tidal marsh habitat and enhancement of existing tidal marsh habitat.

Impacts to vegetation could occur during access (on-foot, ARGOs) within tidal marsh to conduct mosquito management. The use of mechanized vehicles that traverse wetland areas (ARGOs and ATVs) have a much greater impact on vegetation than foot access, including the trampling of plants. However, these vehicles have low ground pressure (minimal pound per square inch) and not expected to completely crush any plants. To reduce impacts to vegetation, mechanized vehicles will only be allowed on levees and existing roads unless approved by the Refuge manager. Techniques for approved ARGO operations will be used to limit impact, including: slow speeds; slow, several point turns; and using existing levees or upland to travel through sites when possible. Mosquito management activities could also spread or introduce non-native vegetation (through footwear, clothing, vehicle tires). To reduce the spread of non-native, invasive plants all construction equipment, vehicles and personnel gear must be cleaned of any possible seeds, soil or plant material before arriving on site.

The application of other pesticides, including adulticides, are not likely to adversely affect vegetation directly because the pesticides used for mosquito control are not known to harm plants. Pyrethrins are not expected to affect plants because the sodium channel mechanism of action for pyrethrins does not indicate that pyrethrins would be toxic to plants (USEPA 2006). As a precaution, pesticides will be applied according to pesticide label instructions and per habitat type.

Impacts to Refuge vegetation by current wildlife-oriented recreation opportunities (e.g., wildlife observation, photography, fishing, and hunting) is expected to be insignificant. Hunting is permitted on foot and by boat, but because the hunter population is relatively small, impacts to vegetation from this type of use is expected to be minimal. There is an average of 2,000 hunt visits annually on 7,500 acres of Refuge open to hunting that provides ample hunt acreage per hunt visit.

Access to hunt areas primarily takes place via existing levees, further minimizing disturbance to wetland areas. Also, use of hunt blinds deters hunters from disturbing vegetated areas. Fishing is expected to have minimal impact to vegetation. Fishing is allowed only in designated areas, such as the shoreline at Faber-Laumeister and the fishing pier at headquarters. Vegetation in these areas may be trampled, but is a small, localized impact compared to the size of the Refuge. Designated trails provide access to shoreline fishing areas; both the trails and fishing are generally packed dirt with little vegetation.

Like fishing, wildlife observation and photography are permitted on designated trails and overlook areas. However, discrete areas of vegetation may be trampled by visitors wandering away from designated areas. Trampling is expected to be temporary and small-scale. Interpretation and environmental education programs may have a negligible impact to vegetation. These programs are conducted in small groups and generally occur on trails and other designated areas for visitors. Small, discrete vegetated areas may be temporarily trampled during programs, but they are not expected to be significant impacts. In addition, these programs will be guided or supervised to ensure that visitors remain in designated areas and avoid sensitive habitat.

Alternative A

Alternatives A would have the same effects on vegetation and habitat as described under Common to All Alternatives.

Alternative B

In addition to the activities proposed in Alternative A, Alternative B would result in additional enhancements to existing tidal marsh to improve habitats and vegetation at subunits, including La Riviere Marsh, Mayhews Landing, and the New Chicago Marsh sites. Portions of these areas currently have low quality marsh plants due to poor water circulation. Specific enhancements have not yet been identified, but potential methods could include lowering of levees and creating breaches. These actions are not expected to replace one habitat type with another, but instead enhance tidal circulation in the tidal marsh habitat to improve vegetation for tidal marsh species. Under this alternative, high marsh and ecotone/transition zones will be heightened and expanded where possible, ensuring high tide refugia for tidal marsh wildlife. As site specific designs are developed at these other marsh areas, further NEPA documentation will be completed.

Under this alternative, a weed management plan will be implemented to control invasive weeds. Unlike current weed management activities that occur without planning and as resources allow, the plan will focus control efforts on priority weeds that out-compete native vegetation. The impacts of the control efforts are similar to those previously described in Common to All Alternatives. Ecotone/transition zones will benefit under this alternative, as most priority weeds are located in this habitat type and because they are prone to introduction of weeds from the general public, particularly at Faber-Laumeister, La Riviere Marsh, EEC, Pond A6, and Pond A8. A re-vegetation plan will also facilitate the formation of native plant communities.

Under this alternative, grazing at Warm Springs would occur among the entire 700 acres that will soon be managed solely by the Refuge. The addition of 444 acres of the former Pacific Commons Preserve (currently managed by ProLogis as part of a mitigation project) and a previously ungrazed pasture on Warm Springs to the grazing program will provide enough pastures among which to rotate cattle. Grazing is expected to continue to result in beneficial effects to native vegetation, as detailed above in the "Common to All Alternatives" section. In a large-scale vernal

pool grazing study, the continuously grazed pools had the highest relative cover of native species across all 3 years of the experiment, higher than both the ungrazed and seasonally grazed treatments (Marty 2005); similarly, Robins and Vollmar (2001), in a comprehensive review of grazing in vernal pool habitats, concluded that CCG populations thrived in regularly grazed or mowed sites and that ungrazed sites generally had smaller populations. Increased vegetation management activities at Warm Springs may cause increased disturbance through the use of mechanical, manual, and chemical control methods. However, control methods will continue to be managed properly in order to minimize impacts to native vegetation, and are expected to have an overall positive impact on native species. These activities, along with seeding, are expected to reduce non-native vegetation competition and allow native vernal pool/grassland vegetation species to thrive.

Also under this alternative, prioritization of remaining lands within the approved acquisition boundary and a more active role in acquiring these lands (from willing sellers) will be beneficial to habitat types that are most vulnerable to loss (e.g., tidal habitat) as a result of sea-level rise from climate change.

Coordination with the Service's LCC and I&M efforts to address near-term and long-term climate change impacts under this alternative will have added benefit to vegetation. Through understanding climate change impacts to the Refuge habitats, staff will identify adaptive changes or acquisition needs that may be required to support changing habitat. The process will help staff identify which habitats are most at risk of climate change effects and prioritize management actions to protect them.

The placement of public infrastructure, such as a visitor center complex, fishing platforms, signage, and interpretive panels will result in the loss of some vegetation. Loss of vegetation would be minimized to the small size of the construction footprint (less than one acre in total). Also, the infrastructure will not be placed in sensitive areas.

Additional visitor opportunities will have both negative and positive impacts on vegetation. Increased activities will result in additional visitors and more pressure on the habitat. More visitors may result in increased trampling of vegetation. However, staff contact, law enforcement, and signage will be increased to encourage visitors to stay in designated areas and out of sensitive habitats. Also, boardwalks and platforms will be installed to protect vegetation from trampling. Increased visitation of the Refuge may increase stewardship and support for native habitats.

The additional environmental education and volunteer opportunities prescribed under Alternative B will also benefit Refuge habitat and vegetation. The Restoration Education program and volunteers will benefit habitats through native plant propagation, weeding of non-native vegetation, and planting of native plants. Sensitive wildlife areas will be avoided. The benefit may extend beyond the Refuge itself; when visitors become informed of the advantages of native vegetation, they may begin to plant natives on their own property.

Hunting activities are not expected to be increased and therefore are not expected to impact vegetation. Constructing fishing platforms and associated infrastructure will result in the loss of habitat and vegetation at Coyote Creek and Faber-Laumeister. It is anticipated that less than a 0.25 acre of habitat will be lost to the development of these fishing areas. Upland ruderal vegetation will be selected to reduce impacts on sensitive wildlife. Fishing participation is

expected to increase as a result of fishing pier renovation and additional fishing locations. This may result in additional trampling of vegetation, but this impact is expected to be temporary and minimal in nature. Furthermore, designated platforms can reduce trampling of vegetation by confining the fishermen to the fishing platforms rather than allowing them to walk along the banks with native vegetation.

Alternative C

In addition to the activities proposed in Alternative B, Alternative C would result in additional enhancements to existing tidal marsh to improve habitats and vegetation at the Faber-Laumeister and Munster sites. Specific enhancements have not been identified yet, but potential methods could include lowering of levees and creating breaches. These actions are not expected to replace one habitat type with another, but instead enhance tidal circulation in the tidal marsh habitat to improve vegetation for tidal marsh species.

Under this alternative, weed control efforts will be increased that will allow native vegetation to thrive. The impacts of the control efforts are the same as those previously described in Common to All Alternatives. Ecotone/transition zones will benefit from action under this alternative, particularly along Ravenswood and Alviso Ponds.

The placement of additional public infrastructure, such as a boat launch, additional signage, EEC bus stop, walking path/bridge, water trail stop, auto tour route, geocache, earth cache, hunt blinds, and nature exploration area at the EEC will result in the loss of some vegetation. Loss of vegetation would be minimized to the small size of the construction footprint (not more than one acre in total). Also, the infrastructure will not be placed in sensitive areas. The opening of an additional 340 acres of ponds to waterfowl hunting may cause trampling of vegetation by foot and by boat. In addition, other increased visitor amenities may increase visitation numbers, which may also result in increased trampling of vegetation. However, these impacts are expected to be temporary in nature. Visitors will also be directed by signage and staff to designated public areas. Signage will indicated sensitive, closed areas. The Restoration Education program will be expanded to include an additional site on Bair Island.

Hunting activities will be expanded by 340 acres and may result in increased trampling of vegetation. The construction of a universally-accessible hunt blind will also result in a small loss of habitat and vegetation. This blind will be placed where there is the least amount of impact to sensitive habitat. Constructing fishing platforms and associated infrastructure will result in the loss of habitat and vegetation at Coyote Creek and Faber-Laumeister. It is anticipated that less than a 0.25 acre of habitat will be lost to the development of these fishing areas. Upland ruderal vegetation will be selected to reduce impacts on sensitive wildlife. Fishing participation is expected to increase as a result of fishing pier renovation and additional fishing locations. This may result in additional trampling of vegetation, but this impact is expected to be temporary and minimal in nature.

Wildlife

Common to All Alternatives

Any restoration projects would result in short-term impacts and long-term benefits for wildlife species as described in the EIS/EIRs for the Bair Island and SBSP projects. As described in the previous environmental documents, all construction activities would occur during daylight hours only (unless pre-approved by the Refuge Manager), allowing wildlife resting periods at night.

Wildlife could be temporarily flushed by construction activities (e.g., heavy equipment operation, foot traffic) associated with restoration and enhancement projects. These projects would also result in loss of diked upland habitat when they are exposed to tidal action. Upland species such as mammals, raptors, and songbirds will be permanently displaced as it evolves into a tidal marsh that will support CLRA, SMHM, and other marsh species. Conservation measures will be employed, such as avoiding sensitive breeding seasons; surveying areas before activities take place; and trapping, relocating, and fencing before activities begin. In the long-term, however, these areas are expected to accrete and create higher quality tidal marsh habitat. These activities would result in short-term disturbance to wildlife, but are not expected to result in population-level effects and would be outweighed by the creation of additional native habitat for wildlife or outreach through its environmental education and interpretation programs. As future restoration projects are identified, additional site specific NEPA documents will be completed.

Weed control and wildlife surveys could also disturb wildlife. Foot traffic and motor vehicle operations for these activities could temporarily flush wildlife. These operations would only occur during daylight hours and are expected to occur in small, discrete areas. Native plant restoration will directly cause disturbance in wildlife habitat and may temporarily flush wildlife. Manual and chemical removal of invasive weeds may adversely affect individuals, but not negatively affect wildlife populations because weeds are generally not considered habitat for native wildlife species. The Refuge would continue to periodically use Service-approved herbicides including: Round-up®, GlyproPlus, Aquamaster and Rodeo® (glyphosate), Garlon 4® (triclopyr), Habitat, Polaris (imazapyr), Milestone (aminopyralid) and Transline® (clopyralid) to control invasive plants on the Refuge. Triclopyr is low in toxicity when eaten by animals (NPIC 2002). Testing was documented on mammals such as rats and guinea pigs. Triclopyr is slightly to practically non-toxic to birds; depending on the species; and practically non-toxic to bees (NPIC 2002).

The Environmental Protection Agency (EPA) classification for Aminopyralid is toxicity category IV; the lowest toxicity category a chemical can receive (Dow AgroSciences 2006). Aminopyralid is considered practically non-toxic to mammals, bird species, bees, and fish. Additionally, this herbicide is considered non-toxic to slightly toxic to aquatic insects, such as dragonflies and water bugs Bioconcentration potential for Milestone® Herbicide is low. While indirect exposures to wildlife may occur, Aminopyralid is considered practically non-toxic and impacts to wildlife will be minimal should it come into contact with this herbicide (WSDOT 2009).

Based on U.S. EPA ecotoxicity criteria, Imazapyr is generally considered practically non-toxic to mammals, many birds, and bees. Toxicity rates among fish and aquatic invertebrates are considered low and within safe parameters according to standards established by the EPA. There is a lack of information on the toxic effects these herbicides have on reptiles, amphibians, raptors, and shorebirds (Leson and Associates 2005).

It is expected that the grazing program will continue to improve habitat for VPTS and CTS by increasing maximum pool depths and inundation times. In a published study using a controlled large-scale experimental design, it was demonstrated that year round grazing in vernal pools increased pool inundation times and aquatic invertebrate diversity when compared to seasonal grazing or complete rest from grazing (Marty 2005). Due to their high productivity, non-native annual grasses produce heightened levels of plant biomass along vernal pool edges as compared to native vernal pool species. As it accumulates, this organic matter decreases the net amount of water available for native species by increasing evapotranspiration rates, resulting in an overall

reduction in pool inundation period (Bremer et al. 2001, Frank 2003). By consuming the organic matter before it accumulates, cattle minimize these negative impacts of non-native annual grasses (Barry 1998, Robins and Vollmar 2001). At Warm Springs, pool inundation time has been the most reliable indicator of which pools will support VPTS and CTS because these species need a minimum amount of time (several weeks to several months) to complete their aquatic life stage.

The potential negative effects of grazing on VPTS and CTS are generally the result of over-grazing and include excessive trampling in vernal pools, increased nitrogen addition to pools, and the potential for cattle to cause pools to dry early by drinking from them. These effects have been hypothesized or observed in overgrazed study sites but most researchers and land managers currently agree that some level of grazing is important for maintaining ecosystem health within vernal pools (Robins and Vollmar 2001). Grazing generally is compatible with the continued use of rangelands by the CTS as long as best management practices are followed, intensive burrowing rodent control programs are not implemented in these areas, and grazing is not excessive (USFWS 2009, Shaffer et al. 1993). At Warm Springs, the grazing program has been carefully managed to avoid over-grazing. The installation of 16 water troughs, placed in upland areas throughout Warm Springs, has been successful in preventing cattle from using pools as water sources (I. Loredo, pers. comm., 2011). Also, there is no evidence that grazing has negatively affected populations of VPTS or CTS at Warm Springs. In fact, since annual aquatic dip-net surveys began in 1999, the two best years for VPTS were in 2010 and 2011 and for CTS were in 2008 and 2010 (USFWS 2011, USFWS 2010), long after the initiation of grazing.

By reducing the thick layer of annual grass thatch, grazing may favor rodent species that require areas of open ground to forage and escape from predators (USGS 2001). There also appears to be a strong association between grazed communities, burrowing rodents, and the presence of tiger salamanders (DiDonato 2006). Since grazing was reestablished in 2004, the abundance of ground squirrel burrows has notably increased (I. Loredo, pers. comm., 2011). Ground squirrel burrows are known habitat for CTS during the non-breeding season (Loredo et al. 1996) and also provide habitat for the California burrowing owl. The presence of California ground squirrels may be the single most important determinant of whether burrowing owls use a given site (Barclay 2001). Although annual surveys for burrowing owls have not been regularly conducted at Warm Springs, burrowing owls have continuously been observed breeding at Warm Springs and annual monitoring of the adjacent Pacific Commons Area (prior to Refuge acquisition) demonstrated an expansion of the burrowing owl population (WRA 2007 and 2006). Indeed, properly managed livestock grazing has been shown to benefit burrowing owls (Kantrud and Kologiski 1982, MacCracken et al. 1985) and may favor other bird species as well, including ground-foraging birds such as killdeer and American Robin (Bock et al. 1993).

Longer vernal pool inundation periods that result from grazing would also expand available habitat for shorebirds, wintering waterfowl, and neotropical migratory birds. Warm Springs supports breeding shorebirds and waterfowl, such as the American avocet, black necked stilt, killdeer, mallard, and Canada goose, that often begin nesting on vernal pool shorelines or islands while pools are still inundated (I. Loredo, pers. comm., 2011).

Grazing can have both negative and positive effects on birds. In riparian areas and prairies, some species of nesting waterfowl and songbirds may be negatively impacted by grazing (Krueper 1993, Kirsch 1969). However, certain guilds of migratory shorebirds require short and/or sparse foraging habitat (Baker and Baker 1973; Helmers 1992). Colwell and Dodd (1995) found greater

shorebird species diversity and abundance in grazed pastures in coastal California. Grazing at Warm Springs (already analyzed in a 2003 Environmental Assessment) produces a mosaic of plant heights and therefore continues to provide available habitat for grass-nesting species (I. Loredo, pers. comm., 2011). Grazing improves plant species composition and structure so that short-term or species-specific impacts to wildlife and habitat are expected to be mitigated by long-term benefits to Refuge vegetation, native plants, and overall wildlife habitat quality.

Prescribed burns would flush wildlife and may result in temporary loss of habitat for some species, but prescribed burn areas are small in size and burning occurs infrequently on the Refuge, thus limited the impacts to wildlife. Prescribed burns would also result in reduced air quality and visibility for wildlife. The use of herbicides for controlling invasive vegetation is not expected to affect wildlife species. Herbicides will be applied by hand directly to plants to avoid non-target species. Sensitive breeding seasons and locations will be avoided. The use of herbicides and pesticides is highly regulated through the Service's PUP process. This approach notes environmental hazards, efficacy, costs, and vulnerability of the pest. All herbicides approved by the Service through the PUP process would be applied at label rates and all label recommendations would be followed. Mitigation measures that may be employed include conducting surveys prior to removal activities to determine presence of nests or young. In the long-term, plant community restoration activities will benefit species by providing additional habitat.

The mammalian and avian predator management plans could result in loss of red fox, feral cat, rat, skunk, raccoon, common raven, American crow, California gull, red-tailed hawks, and northern harrier individuals. Other species may be taken as new data on predation becomes available. However, predator management will not result in a population-level effect on any of these species. Predator management activities may also indirectly disturb other wildlife. Installation of predator barriers may impede access for non-target species from entering or exiting their feeding, roosting, and breeding areas. Trapping activities may also flush or disturb non-target wildlife from their habitat. Nonetheless, predator management activities are expected to result in positive, long-term increases in migratory bird breeding success, recruitment, and total population size.

Mosquito Management

Impact to mammals that use the Refuge may occur during the monitoring, surveillance and control of mosquitoes, as well as the application of pesticides. The SMHM occurs throughout tidal marsh of the Refuge. Adverse impacts to salt marsh mammals may occur as a result of marsh access via foot or mechanized vehicles for mosquito management activities and addressed in the following endangered species section. Vehicle effects on habitat include compacted soil and destroyed vegetation (Bias and Morrison 1993). In addition, repeated vehicle travel over the same areas can create paths through the pickleweed that increases access for predators. Vehicle travel can also disrupt daily activity (e.g. movements) of small mammals and has the potential to cause mortality of individuals. In addition, boat, ARGO and foot travel can flush harbor seals which are particularly sensitive during the pupping season. Important seal haul out location exist in Corkscrew Slough (Bair Island), Calaveras Point and Mowry Slough. To mitigate these impacts, there will be restrictions during breeding periods to accessing tidal marsh and slough with known sensitive species. Boat access to Corkscrew Slough, Calaveras Point and Mowry Slough will be limited to the center channel during the harbor seal pupping season, March 15-June 15 to prevent flushing of pups from their mothers. Mechanized vehicles will only be allowed on levees and

existing roads unless approved by the Refuge Manager.

The use of larvicides and pupacides for the purpose of mosquito management are not likely to directly affect native mammal populations of the Refuge (USEPA 1998). Adverse effects on mammals from B.t.i., methoprene, and monomolecular films are not expected (Appendix K of the CCP) when applied according to the label instructions. Extensive acute toxicity studies indicated that B.t.i. is virtually innocuous to mammals (Siegel and Shadduck 1992). These studies exposed a variety of mammalian species to B.t.i. at moderate to high doses and no pathological symptoms, disease, or mortality were observed. Methoprene is not considered toxic to mammals (Appendix K of the CCP). Impacts to the mammalian community as a result of reduced invertebrate populations are not expected because many small mammal species that inhabit wetlands of the Refuge are herbivorous (invertebrates are not a primary component of their diet). Insectivorous species such as shrews (e.g., *Sorex ornatus*) occur in wetlands of the Refuge, and reduced arthropod populations may impact food availability for these species. Impacts to fish-eating harbor seals could occur if population-level effects to fish occur through the use of adulticides directly in waters and slough channels (see the following section on *Fish*).

Oral exposure of pyrethrins could occur through consumption of plants or plant parts that have been sprayed (ground-based application). A terrestrial exposure model showed no acute or chronic risks to mammal or bird species (USEPA 2006). To reduce overall impacts of mosquito pesticides to non-target wildlife, mosquito pesticides will be applied according to pesticide label instructions and per habitat type. Application of larvicides and pupacides will be discouraged during high tide events in order to avoid impacts to tidal marsh species. The MADs will also be required to minimize the use of pesticides and continually investigate formulations and compounds that are least damaging to fish and wildlife (including invertebrate) populations.

Conversely, significant mosquito production and absence of mosquito control may negatively affect mammal populations. Although mosquitoes themselves are a part of estuarine ecosystems, they are known vectors of disease, including diseases that cause harm to humans and wildlife (e.g., WNV). Mammals known to be infected by WNV include horses, bats, chipmunks, skunks, rabbits, and squirrels.

Impacts to birds that use the Refuge may occur during access for mosquito monitoring, surveillance and control, as well as the application of pesticides. There are three federally listed bird species that inhabit the Refuge: the CLRA, the western snowy plover, and the California least tern. These species are covered in the subsequent section on effects to *Threatened and Endangered Species*. There are many other bird species listed as Species of Special Concern by the California Department of Fish and Game that occur on the Refuge.

Birds may be temporarily flushed as a result of ground access via foot or mechanized vehicle as well as aerial pesticide application, although birds will most likely return to roosting sites once operations have ceased in the area. It is anticipated that disturbance to most birds is likely to be low as a result of regular communication between the Refuge and the MADs on known nesting sites and other sensitive habitat locations, and limitations on marsh access in areas with nesting birds. However, repeated travel over the same areas creates paths through the marsh that increases access for predators. In order to reduce impacts, aerial mosquito control application will be encouraged over ground-based application methods.
Also, aerial mosquito control applications will avoid low level flight over water to access or exit the

Refuge as possible, thus minimizing bird disturbance.

B.t.i. has practically no acute or chronic toxicity to birds (USEPA 1998, Appendix K of the CCP). There is the potential for B.t.i. to kill midge larvae (family Chironomidae). Chironomid (non-biting midge) larvae can be abundant in wetlands and form a significant portion of the food base for other wildlife, including birds (Batzer et al. 1993; Cooper and Anderson 1996; Cox et al. 1998). As with B.t.i., there is concern regarding potential negative impacts to chironomid larvae from methoprene. Some studies have suggested methoprene impacts to other organisms that may form part of the food base for birds. McKenney and Celestial (1996) noted significant reductions in number of young produced in mysid shrimp at 2 ppb. Sub-lethal effects on the cladoceran, *Daphnia magna*, in the form of reduced fecundity, increased time to first brood, and reduced molt frequency have also been observed at lower concentrations of methoprene (Olmstead and LeBlanc 2001). Methoprene showed no toxicity to slight toxic to birds at high concentrations and repeated exposure (Appendix K of the CCP, USEPA 2001). Monomolecular film is not known to cause direct chronic or acute avian toxicological effects to birds (Appendix K of the CCP). But monomolecular films are potentially lethal to any aquatic insect that lives on the water surface or requires periodic contact with the air-water interface to obtain oxygen (Appendix K of the CCP).

Pyrethrins are not considered toxic to birds (Milam et al. 2000, USEPA 2006) when applied at labeled rates. However, non-target effects to birds from pesticide application may occur as a result of reduced food base (e.g., Chironomid invertebrates). There is uncertainty with regard to pyrethrins, which have been shown to have no impact on large-bodied arthropods, but have been shown to reduce invertebrate populations, especially among small-bodied arthropods (Boyce et al. 2007).

Conversely, significant mosquito production and absence of mosquito control may negatively affect bird populations. Although mosquitoes themselves are a part of estuarine ecosystems, they are known vectors of disease, including diseases that cause harm to humans and wildlife (e.g., WNV). Mosquito-borne diseases such as WNV have shown to be lethal to wildlife. As of 2011, 326 bird species have been listed in the Center for Disease Control WNV avian mortality database (http://www.cdc.gov/ncidod/dvbid/westnile/birdspecies.htm, accessed May 2, 2011). The list includes wildlife that inhabit tidal marsh such as waterfowl, grebes, heron, egrets, cormorants, songbirds (wrens, yellowthroats, song sparrows), and rails (clapper rail, Virginia rail, common moorhen, American coot).

Mosquito control pesticide may affects reptiles and amphibians through reductions in insects that serve as food source (Hoffman et al. 2008), and through direct individual effects from pesticide application or from trampling of individuals or habitat (e.g., access via ARGOs and ATVs). Methoprene, monomolecular films, and adulticides would not be permitted in vernal pool habitat. Only B.t.i. and B.s., which have no direct adverse effects to vertebrates will be permitted at Warm Springs. Refuge surveys over the last several years indicate that there is continued, long-term presence of VPTS and CTS in these pools. Truck use by mosquito abatement district staff would be restricted to established levees, roads, and berms and would not be permitted around vernal pools. Only all-terrain vehicles will be permitted around vernal pools and no vehicles will be permitted to enter vernal pools. With regard to adulticides, direct chronic effects have been found for the San Francisco garter snake from application of labeled rates of permethrin (synthetic pyrethroid, Hoffman et al. 2008). While this species does not occur on the Refuge, these findings suggest other reptiles may incur direct chronic effects.

Monitoring and surveillance activities are not expected to adversely affect non-target invertebrate populations. Biological and chemical treatment of mosquito populations on the Refuge has the potential to adversely affect non-target invertebrates and these are described below.

How reductions in certain invertebrate populations as a result of repeated pesticide applications would impact specific invertebrate-plant interactions (e.g., pollination) within tidal marsh and vernal pools of the Refuge are not known. However, because most pollinators do not have an aquatic lifecycle stage, it is likely that pollinators would not be affected by larvicide and pupacide application. Pollinators may be affected by adulticides which are broadcast in liquid form at ultra-low volume, but use of adulticides would only be used under extreme conditions and in limited areas.

The effect on local populations of invertebrate species over time with periodic and continued use of B.t.i. is inconclusive, but potential for negative effects is a possibility (Appendix K of the CCP). Host range and effect on non-target organisms indicates that B.t.i. is relatively specific to the Nematocera suborder of Diptera, in particular filter-feed mosquitoes (Culicidae) and blackflies (Simuliidae) (Glare and O'Callaghan 1998). B.t.i. is pathogenic to some species of midges (Chironomidae) and Tipulidae, although to a lesser extent than mosquitoes and biting flies and is not reported to affect a large number of other invertebrate species (Glare and O'Callaghan 1998). B.t.i. concentration is may be important with regard to effects on nontarget organisms. Of particular concern is the potential for B.t.i. to kill midge larvae (family Chironomidae). Chironomid (non-biting midge) larvae are often the most abundant aquatic insect in wetland environments and form a significant portion of the food base for other wildlife (Batzer et al. 1993; Cooper and Anderson 1996; Cox et al. 1998). Reduced invertebrate populations as a result of food web effects (e.g., reduction of nematoceran, Diptera) have been shown in studies of B.t.i. (Hershey et al. 1998). However, current surveys indicate abundance of aquatic invertebrates in vernal pools receiving mosquito control with B.t.i. and B.s. (I. Loredo, pers. comm.). See the following section on endangered species for more information on VPTS.

Because methoprene is a juvenile hormone (JH) mimic and all insects produce JH, there is concern about potential adverse effects on non-target aquatic insects when this pesticide is used for mosquito control (Appendix K of the CCP). As with B.t.i., there is concern regarding potential negative effects on chironomid larvae due to their importance in food webs. As with any pesticide, toxicity is a factor of dose plus exposure. At mosquito control application rates, methoprene is present in the water at very small concentrations (4-10 parts per billion, initially). With regard to exposure, chironomid larvae occur primarily in the benthos, either within the sediments and/or within cases constructed of silk and detritus. Thus, there may be differences with regard to exposure to methoprene between chironomid and mosquito larvae, the latter occurring primarily in the water column. The published literature on the effects of methoprene to chironomids is not as extensive as that for B.t.i. However, there is evidence for potential toxicity to chironomid and other aquatic invertebrates from methoprene treatments. In summary, there is evidence for significant adverse non-target effects from methoprene even when applied at mosquito control rates.

Monomolecular films (Agnique, GB-1111) are potentially lethal to any aquatic insect that lives on the water surface and requires periodic contact with the air-water interface to obtain oxygen (USFWS 2004). The film interferes with larval orientation at the air-water interface and/or

increases wetting tracheal structures, thus suffocating the organism. As the film spreads over the water surface, the treatment tends to concentrate the larvae, which may increase mortality from crowding stress (Dale and Hulsman 1990).

All adulticides are very highly toxic to aquatic invertebrates in low concentrations (e.g., 1 ppb) (Milam et al. 2000). Because of this toxicity, pyrethrins can only be applied when there is high risk of mosquito-borne disease. Pyrethrins are known to cause acute toxicological effects to benthic invertebrates at rates used for mosquito abatement (USEPA 2006). Because pyrethrins are broad-spectrum insecticides, they are potentially lethal to most insects, including both terrestrial and benthic forms. There are also risks to aquatic invertebrates from direct deposition and runoff of the pesticides. To reduce impacts to aquatic invertebrates, adulticides will only be permitted in upland areas and interior water bodies. They will be applied only during low tides and away from open water and navigable slough channels to avoid potential runoff of the pesticides.

Public access opportunities in all proposed alternatives could result in some disturbance and mortality to wildlife. Wildlife observation (through biking, boating, and walking), photography, environmental education, interpretation, and non-wildlife dependent recreation could result in temporary disturbance to wildlife while hunting and fishing will result in direct mortality of individual waterfowl and fish. However, these activities will be limited in several ways, including habitat, time of day, and take limits. Signage will continue to be used to deter the public from entering closed areas to protect sensitive habitats.

Hunting

Hunting would occur in all the alternatives, resulting in disturbing, injuring, and killing waterfowl. Waterfowl hunting on the ponds, open bay, and navigable sloughs will result in the direct loss of waterfowl, migratory species protected under the Migratory Bird Treaty Act. Exact hunt statistics are unknown because there are no hunter check-in stations. While the existing hunter harvest reporting is mandatory under the Hunting Special Use Permit, voluntary reporting of hunt harvest is not always followed by the hunters. It is estimated that there are over 2,000 hunter visits annually that use the 7,500 acres of hunt area within the Refuge. Hunting on the Refuge requires the purchase of a Duck Stamp, is regulated by the State, and is not expected to result in population level effects to waterfowl species. Law enforcement monitoring is also used to control over-harvest.

Direct effects of hunting include mortality, wounding, and disturbance (DeLong 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; Madsen 1985; Bartelt 1987; 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 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 (Wolder 1993; Madsen 1995).

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 (Paulus 1984; Madsen 1995). In Denmark, hunting disturbance effects were experimentally tested by establishing two sanctuaries (Madsen 1995). Over a five-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 and ensure their continued use of the Refuge.

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 to 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 results in lower pintail densities on hunt areas during non-hunt days than non-hunt areas (Wolder 1993). The Refuge also only allows hunting three days per week during the hunt season. However, intermittent hunting may not always greatly reduce hunting impacts.

The California Department of Fish and Game (CDFG) is California's lead agency for management of fish, wildlife, and native plants— collectively called "wildlife." CDFG has trustee responsibility for the conservation and management of wildlife for the benefit and enjoyment of the public.

Resident game species are protected on refuges by both Federal and State laws and regulations to ensure that harvest rates do not negatively affect populations. The potential impacts of hunting on migratory bird and resident upland game birds are discussed and evaluated in the California Environmental Quality Act process (California Department of Fish and Game 2001, 2004a). This process results in periodically updated and publicly reviewed documents. Based on the findings of these documents, the State ensures that game animal hunting in California does not adversely impact its wildlife populations at an unacceptable level (California Department of Fish and Game 2004b).

Wildlife populations on the Refuge are able to sustain hunting and support other wildlife-dependent priority uses. To manage the populations to support hunting, the Refuge adopts harvest regulations set by the State within Federal framework guidelines. The regulatory procedures that govern harvest are described in the following section.

By its very nature, hunting has very few positive effects on the target species while the activity is occurring. However, in the Service's experience, 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's mission. Furthermore, despite the potential impacts of hunting, a goal of the Refuge 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

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.

Harvest Management – Regulatory Procedures
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 the following documents.

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 EA and FONSI. 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 EIS 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 (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 cannot 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.

Waterfowl – Flyway Analysis
The 2010 annual waterfowl harvest estimate for the Pacific Flyway is 3 million ducks, an increase from 2.8 million in 2009. This estimate represents almost 20 percent of the estimated total harvest for the U.S. of 14.9 million ducks harvested (Raftovich et al. 2011).

Waterfowl harvested in California are made up of wintering waterfowl (coming from breeding grounds to the north) and the resident breeding population. For comparison, the Mid-Winter Survey Index for 2010 estimated 4.6 million total ducks for the Flyway (Collins and Trost 2010). Breeding waterfowl estimates in 2009 for California were 511,000 ducks, down from 554,000 in 2008 (USFWS 2009). These numbers serve to demonstrate the relative importance of these areas (especially California) in the Pacific Flyway for wintering waterfowl, rather than for waterfowl production as a breeding site.

Waterfowl – Regional Analysis
Most recently available annual harvest estimates for California indicate that approximately 1.7 million ducks have been harvested by 55,500 waterfowl hunters in 2010, up from 1.4 million ducks harvested by 51,300 waterfowl hunters in 2009 (Raftovich et al. 2011). However, this may not be reflective of the exact hunter participation as estimates are based on voluntary survey participation.

Breeding waterfowl estimates in 2009 for California were 511,000 ducks, down from 554,000 in 2008 (USFWS 2009). Mallards generally comprise more than half of each year's breeding population estimate. As mentioned previously, the 2010 Midwinter Waterfowl Survey index for California totals 3.2 million ducks, further illustrating the relative importance of California's overall wintering waterfowl capacity within the Pacific Flyway (Collins and Trost 2010).

Waterfowl – Local Analysis
Waterfowl harvest numbers are unknown on the Refuge because there are no hunter check-in stations and reporting harvest numbers from the open bay is voluntary. The Refuge permits 7,500 acres of ponds, open bay, and navigable sloughs for waterfowl hunting. Refuge staff estimates that there are roughly 2,000 hunter visits annually on the Refuge given the difficulty of accessing hunt areas and the challenging tide conditions of two low tides per day. Any potential take from these hunter visits are still far below the Midwinter Waterfowl Surveys' estimated 98,989 ducks for the San Francisco Bay for 2010 (Collins and Trost 2010).

The hunting of waterfowl in the United States is based upon a thorough regulatory process that involves numerous sources of waterfowl population and harvest monitoring data. California hunter's estimated harvest of approximately 1.7 million ducks is approximately 11 percent of the total U.S. harvest of 14.9 million and more than 50 percent of the Pacific Flyway's 3.0 million harvest estimate (Raftovich et al. 2011). Refuge staff estimates that hunting on the Refuge likely

represents a negligible amount of all the waterfowl harvests conducted in California. Based on this analysis, the Service has concluded that hunting associated with each of the alternatives will not have a significant impact on local, regional, or Pacific Flyway waterfowl populations.

Alternative A

Alternative A would have the same effects on wildlife as described under Common to All Alternatives. Although we would continue to coordinate annually with the local MADs, we would not implement a Mosquito Management Plan under this alternative. The use of pyrethrin pesticides (adulticides) on the Refuge has only been permitted under limited conditions and application of adulticides has been fairly infrequent. Under Alternative A, the use of adulticides would continue to be limited and if necessary would only be allowed in upland areas and interior waterbodies. They would be applied only during low tides and away from open water and navigable slough channels to avoid potential runoff.

Under this alternative, recreation activities such as hiking and dog walking may potentially disturb wildlife in the tidal marsh and upland areas adjacent to trails causing wildlife to temporarily or permanently flush from these areas. In addition, while dogs are required to be on leash, sometimes owners may not comply with that regulation. In these instances, unrestrained dogs may go off the trail, thus threatening other visitors directly or flushing wildlife.

Dog disturbance to tidal marshes and other wildlife habitat can result in range of wildlife responses. Lenth and Knight (2008) found that the presence of dogs correlated with altered patterns of habitat utilization for mule deer, small mammals, prairie dogs, and bobcats. Small mammals, including squirrels (*Sciurus* spp.) and rabbits (*Sylvilagus* spp.), also exhibited reduced levels of activity within 50 meters of trails in areas that allowed dogs when compared with areas without dogs (Lenth and Knight 2008). Though leash rules have been found in certain urban parks to have no effect in protecting local biodiversity (Forrest and St. Clair 2006), the enforced use of leashes could restrict dog activity to a narrower trail corridor and minimize dogs' influence on wildlife (Lenth and Knight 2008).

Alternatively, because dog walking and public access has been occurring on designated trails for several decades, wildlife in the vicinity could be habituated to such activities. Some literature suggests that if animals perceive an activity as spatially predictable and nonthreatening, they may habituate to that activity (Whittaker and Knight 1998). For example, humans approaching from a parking area (an area with consistent human use) elicited less of a response from mountain sheep than did humans approaching from over a ridge, where human use was sporadic (MacArthur et al. 1982). Cooper et al. (2008) found that the alert distance of the eastern gray squirrel did not differ between the approach by a human alone and the approach by a human with a dog. Miller et al. (2001) found this same result for songbirds; however Miller found that presence of a dog resulted in greater influence on mule deer than just approach by a human.

Certain types of disturbances have occurred within or adjacent to some marsh areas for a long time and certain CLRA appear to have habituated or become tolerant of these disturbances, while others appear to habituate over time or are unable to habituate to these disturbances at all. On numerous occasions at the Corte Madera Ecological Preserve, CLRA have been observed seeking refuge from unrestrained dogs entering tidal marshes from adjacent levees with public access (J. Garcia, pers. comm. 1994).

These disturbances have occurred despite the presence of signs notifying users that they are entering sensitive wildlife species areas and that pets must be under restraint while in the preserve area. Similarly, along the Redwood Shores Peninsula in San Mateo County, fences and signs installed to prevent access into areas with endangered species habitat have been repeatedly vandalized and people continue to enter the prohibited areas beyond the fences and signs (Popper and Bennett 2005).

Alternative B

In addition to the effects described under Common to All Alternatives, Alternative B includes a variety of other activities that may affect wildlife. Baseline surveys on focal plant and wildlife species as well as the implementation of an avian predator management plan will be beneficial to wildlife. Burrowing owl survey with partners and on the Warm Springs sub-unit would improve our knowledge of this species of concern. Management of grassland at the Warm Spring sub-unit would also benefit burrowing owl productivity. A variety of avian species have been observed preying upon the federally threatened western snowy plover and the federally endangered California least tern. Existing predator management (focused on problem mammals) does not control problem avian species. Under this alternative, removal and deterrence of avian predators will be accomplished by various methods, including hazing, relocation, or lethal control. While selected individuals will be removed, predator management will not result in a population-level effect on any of these species. Increased predator management to control problem avian species is expected to result in increases in migratory bird breeding success, recruitment, and total population size.

Under Alternative B we would also implement a Mosquito Management Plan, as appended to the CCP. The Mosquito Management Plan provides the Service and MADs with a decision support system for mosquito control activities that is consistent with Refuge purposes, the mission and goals of the Refuge System, Department of Interior, and Service policy, and minimizes public health and wildlife health risk from Refuge-produced or harbored mosquitoes. The Mosquito Management Plan generally formalizes our ongoing mosquito control activities. However, under the Mosquito Management Plan, before we would allow the application of adulticides the MADs would need to show that mosquitoes on the Refuge pose a high risk for mosquito-borne disease. Should those criteria be met, including review and approval of proposed adulticide, then application would take place as described under Alternative A.

Increased law enforcement and staff contact with the public will reduce public disturbance to wildlife. Additional ecological improvements and enhancements under this alternative to La Riviere Marsh, Mayhew's Landing, and Munster subunits would also significantly improve the quality of habitat for tidal marsh species. Parts of these subunits currently have poor tidal circulation, which results in poor quality vegetation and low abundance of wildlife species. Species may be temporarily disturbed by restoration activities that may involve earth-moving equipment, foot traffic, heavy equipment, and vehicles.

The implementation of a weed management plan will have overall benefits to wildlife. The impacts of weed control are described under Common to All Alternatives. Wildlife will be temporarily disturbed or displaced by the increase in weed control activities, but will benefit in the long-term with increased native vegetation. However, these impacts are expected to be outweighed by the creation of additional, quality breeding habitat. Under this alternative, the grazing program would be expanded to include a previously ungrazed area and an additional 444 acres would be

added when the refuge takes over management of the Pacific Commons lands. Impacts to wildlife are not expected to differ from those described under the Common to All Alternatives section. The prescribed burn season would be extended from the current September 1 – October 15 to June 15 –October 15. There may be some additional impacts to nesting birds by including the summer months. However, burns will be conducted infrequently (no more than once every 3 years on average) on weedy areas of 50 acres or less. This will minimize potential impacts and allow wildlife to utilize unburned habitat nearby. Burrowing owl surveys would be conducted prior to any prescribed burns during their nesting season (up to August 31). If owls are observed, impacts would be minimized by using firebreaks or relocating the burn unit to exclude their burrows.

Also, prioritization of remaining lands within the approved acquisition boundary and a more active role in acquiring these lands (from willing sellers) will be beneficial to wildlife, particularly those most vulnerable to habitat loss (e.g., tidal habitat) as a result of sea-level rise from climate change.

Coordination with the Service's LCC and I&M efforts to address near-term and long-term climate change impacts under this alternative will have added benefit to wildlife. Through understanding climate change impacts to the Refuge habitats, staff will identify adaptive changes or acquisition needs that may be required to continue to support wildlife. The process will help staff identify which wildlife are most at risk for climate change effects and prioritize management actions to protect them.

The addition of a visitor center complex, fishing platforms/boardwalks, bus stop at headquarters, boat launch, photography blind, geocache program, earth cache program, and other associated infrastructure will increase number of visitors to the Refuge. The footprint of these features is not expected to impact wildlife habitat because they will be constructed in sparsely vegetated areas or other low quality wildlife habitat. To mitigate disturbance, public access areas will be designated where the least disturbance to wildlife would occur. Increased visitor use in the form of wildlife observation, fishing, photography, recreation, and environmental education will result in more traffic in habitat areas and may cause wildlife to temporarily flush from the area. However, messaging to visitors will also promote stewardship of habitat and wildlife. Additional signage and fencing will be installed as needed to deter the public from entering sensitive wildlife habitats. Increased law enforcement presence and staff training to inform the public will also reduce wildlife disturbance. These activities are not expected to result in a population-level effect on wildlife. Increased outreach through signage and interpretive panels/material will be used to deter disturbance to wildlife.

Under Alternative B, the closure of Tidelands Trail beyond the bridge crossings at Newark Slough to dog walking could reduce disturbance to migratory birds and other wildlife in tidal marsh areas. Expanding the buffer area (e.g., slightly shifting the trail inland) along the trail between the Harrier Spur and Tidelands Spur trails may also reduce disturbance to the adjacent tidal marsh area that is at the same elevation. This separation would create a larger buffer area between dogs on this short, but sensitive section of the trail (see Figure 2), while still accommodating a loop access.

The expanded interpretation and environmental education programs will accommodate additional visitors to the Refuge which could increase wildlife disturbance. Wildlife may be temporarily flushed from roosting areas, but these programs will be located away from sensitive breeding

habitats. Overall, programs will be beneficial to wildlife because of their stewardship message. Expanded environmental education opportunities such as the Wetland Round-up and the Restoration Education Program will outreach to a wider audience through Spanish-translated programs as well as improve habitat with nursery propagation and planting opportunities that will be beneficial to wildlife. Increased habitat restoration activities by volunteers are also expected to improve wildlife habitat.

Alternative C

Alternative C would include those activities and effects in Alternative B. In addition, there would be increased benefits and disturbances from activities prescribed in this alternative. Baseline surveys on focal plant and animal species every five years will provide better data on the status of Refuge species.

Additional ecological enhancements at Faber-Laumeister and Munster sub-units would benefit wildlife by providing higher quality habitat. The boat launch site would improve law enforcement access and thus wildlife protection. Research on mudflat and shallow pond biofilm will benefit knowledge on shorebirds. Enhancement and restoration to marsh-upland ecotone along the Ravenswood and Alviso Pond levees will provide additional wildlife habitat, especially during high tide events for tidal marsh species. Contaminants monitoring with partners will increase Refuge knowledge and management of wildlife resources. Climate change assessments and monitoring will also benefit long-term needs (such as identifying additional habitat) for wildlife.

Increased visitor uses under this alternative may potentially increase wildlife disturbance. A bus stop at the EEC, a walking bridge from the bus stop at headquarters, and equipment (e.g., kayaks, bicycles) loan system will increase interface between the public and wildlife. The equipment loan system could especially result in increased wildlife disturbance. Equipment users would be unsupervised and could flush wildlife. To mitigate for these potential effects, users would be instructed on responsible wildlife watching. Additional interpretation events will also increase public interface with wildlife, but potential for disturbance and impacts to habitat are expected to be low because these are guided activities. Wildlife could be flushed from roosting areas temporarily, but the Refuge would be closed after sunset allowing wildlife resting periods from the public. The auto tour route is not expected to significantly affect wildlife. Visitors will stay in their vehicles on the tour route or will have established pull-out areas with signage indicating sensitive areas.

The opening of an additional 340 acres to hunting could increase hunting pressure on wildlife. However, this is only an increase of five percent of area open to hunting and would not be sufficient to cause a significant increase in the number of waterfowl taken.

The addition of another fishing day (catch and release only) may cause temporary disturbance to wildlife. This event will be directed by staff that would oversee the activity and limit potential impacts to wildlife. Improvements to the environmental education programs are not expected to increase disturbance to wildlife. Additional students will be accommodated in the programs, but these programs will continue to take place in areas with the least sensitive wildlife habitat. Also, these programs will be supervised by staff, trained teachers, or trained volunteers which will decrease wildlife impacts. Additional expansion of the geocache and earth cache programs is not expected to impact wildlife. These sites will be located in areas away from sensitive wildlife habitats.

Under this alternative, eliminating all dog walking on the Refuge would remove all potential disturbance of wildlife from dog walking activities.

Fish and Marine Invertebrates

Common to All Alternatives

Ongoing tidal restoration activities could result in entrapment of fish and marine invertebrates during low tide conditions. Mitigation elements that are employed include avoiding construction activities during migration periods and using water control structures such as culverts to prevent entrapment. Tidal restoration activities will result in open water habitat appropriate for fish and invertebrate until sedimentation begins to take place. In the long-term, sub-tidal habitat is expected to increase and result in a benefit to fish and marine invertebrate populations.

Weed management and wildlife management activities are not expected to affect fish and marine species because they occur away from waterways. Further, only herbicides and pesticides approved for use in aquatic environments would be permitted. The Refuge would continue to periodically use Service-approved herbicides including: Round-up®, GlyproPlus, Aquamaster and Rodeo® (glyphosate), Garlon 4® (triclopyr), Habitat, Polaris (imazapyr), Milestone (aminopyralid) and Transline® (clopyralid) to control invasive plants on the Refuge. Triclopyr is low in toxicity when eaten by animals (NPIC 2002). Triclopyr is slightly to practically non-toxic to highly toxic to fish, depending on the fish species and the triclopyr formulation; practically non-toxic to moderately toxic to waterfleas, depending on the formulation; and practically non-toxic to highly toxic to several water insects, depending on the species (NPIC 2002).

Aminopyralid, the active ingredient in the herbicide Milestone®, is considered practically non-toxic to most invertebrates, practically non-toxic to the estuarine/marine mysids and slightly toxic to the estuarine/marine mollusks and both freshwater and saltwater fish (U.S. EPA/OPP-EFED 2004 in SERA, 2007). Additionally, this herbicide is considered non-toxic to slightly toxic to aquatic insects, such as dragonflies and water bugs (WSDOT 2009). Based largely or completely on information for aminopyralid, bioconcentration potential for Milestone® Herbicide is low (Dow AgroSciences 2006).

Imazapyr which can be found in the herbicides Habitat® and Polaris®, has a half-life in water of 2-4 days due to rapid photodegradation by sunlight. Because of this rapid photodegeneration, water contamination by imazapyr is generally not of concern. Additionally, due to Imazapyr's short half-life and low toxicity it is generally not considered a threat to most species of fish and aquatic invertebrates and has low potential for bioconcentration in aquatic organisms (Leson and Associates 2005).

Mosquito control pesticides are also applied at rates much lower than label rates and thus are not expected to affect fish species. Mosquito monitoring and surveillance activities are not expected to adversely affect fish because these activities do not occur within open sub-tidal waters of the Refuge (e.g., sloughs, channels, open bay) and are not expected to adversely affect water quality (e.g., turbidity, dissolved oxygen). Negative effects on fish populations are not expected from proposed larvicides and pupacides (USEPA 1998, Appendix K of the CCP). B.t. is practically non-toxic to fish (Appendix K of the CCP). However, the application of adulticides has the potential to adversely affect fish populations (Gunasekara 2005). Pyrethroids are considered highly toxic to

fish and invertebrates (Appendix K of the CCP). In order to mitigate for any potential impacts to fish and marine invertebrates, any pesticide application would only occur during low tides to avoid impacts to species that may move into the tidal marsh plain during high tides.

Fish mortality occurs from fishing activities that are permitted in the open bay and other approved fishing locations of the Refuge. However, fishing is enforced by the CDFG regulations and is not expected to result in a population-level effect on fish species.

Alternative A

Alternative A would have the same effects on fish and marine invertebrates as described under Common to All Alternatives. The use of adulticides for mosquito control can have adverse effects on fish. However, the frequency of conditions that would require use of adulticides on the Refuge has been rare over the past few decades. This pattern suggests that future use of adulticides in discrete areas of the Refuge is unlikely, but if occurred, the frequency and scope of application is not likely to cause significant adverse effects to fish and invertebrate populations. To reduce impacts to fish, adulticides will only be permitted in upland areas and interior water bodies. They will be applied away from open water and navigable slough channels to reduce impacts to fish. Application would only occur during low tides to avoid potential impacts to fish that may move into the tidal marsh plain during higher high or extreme tides.

Alternatives B and C

Under Alternatives B and C, future proposed tidal and managed marsh enhancements or restorations could result in impacts described for tidal restoration activities in Common to All Alternatives. Under both of these alternatives we would also implement a Mosquito Management Plan (Appendix K). Under the Mosquito Management Plan, the condition for use of adulticide would require a number of criteria including the presence of a mosquito-borne disease on the Refuge or within flight range of vector mosquito species present on the Refuge, as stated in the mosquito management plan. Should adulticides be necessary, the same restrictions on application described in Alternative A would apply. Species may be temporarily affected by restoration activities that may involve breaches and dredging, resulting in increased turbidity and sedimentation. However, these restoration and enhancement activities are expected to improve habitat in the long-term. Increased weed management activities are not expected to impact fish and invertebrates as they will take place away from navigable sloughs, channels, and the open bay. Additional fishing will be available at Coyote Creek Lagoon, Faber-Laumeister, and potentially Alviso Slough. Direct impacts include a probable higher fish loss than Alternative A. However, fishing will continue to adhere to state regulations and is not expected to adversely affect fish populations.

Endangered Species

Common to All Alternatives

All alternatives would result in short-term disturbance from operation and maintenance activities, but long-term benefits to listed species due to surveying and monitoring. Use of herbicides, prescribed burns, mechanical removal, cultural methods (e.g., salinization), and hand-pulling of non-native plants under all the alternatives have the potential to impact wildlife. Grazing results in trampling of vernal pools and their vegetation, but helps to increase vernal pool depths, increase aquatic diversity, and remove non-native grasses (Marty 2005). Removing non-native grasses will lengthen vernal pool inundation times, which will support the aquatic life stage of the VPTS and the CTS. Non-native, annual grasses produce heightened levels of plant biomass along

vernal pool edges, which decreases the net amount of water available for native species by increasing evapotranspiration rates and resulting in an overall reduction in pool inundation period (Bremer et al. 2001, Frank 2003). Robins and Vollmar (2001), in a comprehensive review of grazing in vernal pool habitats, concluded that CCG populations thrived in regularly grazed or mowed sites and that ungrazed sites generally had smaller populations. Grazing exclosures at Warm Springs have also clearly demonstrated that within a single pool, CCG cover is higher in the grazed plot versus the ungrazed, fenced in plot (USFWS 2011). Water troughs are available in each pasture in the upland habitat to ensure that cows do not use the vernal pools as a water source and to therefore minimize effects to CCG and other vernal pool plants.

Prescribed burns would occur when VPTS are in the dry cyst stage. Most CTS are estivating in burrows at this time. Burns will be limited to areas 50 acres or smaller and will average no more than once every three years. Prescribed burns would also result in reduced air quality and visibility for wildlife. Short-term impacts of plant removal are likely to include disturbance of roosting (non-breeding) clapper rails or mice within close proximity to the field crews conducting the removal. Such disturbance may force wildlife to relocate to other parts of the Refuge temporarily. The effects of herbicide application to endangered species area the same as those discussed previously in the *Wildlife* and *Fish* sections. Herbicide use would primarily take place outside of endangered species habitat. There may be targeted manual or chemical control of small patches of invasive plants that take place in the edges of endangered species habitat, in order to prevent further spread of plants into the interior of endangered species habitat. In order to reduce impacts to endangered species, these activities will be conducted by a qualified biologist and activities will not occur in the known presence of endangered species (e.g., identification of California clapper rail calls).

All the alternatives include native plant restoration. Increasing native plant cover as well as improving the high marsh and ecotone/transition zones will provide additional habitat and refugia for listed tidal marsh species in high tide events.

The mammalian predator management will result in loss of red fox, feral cat, rat, skunk, and raccoon individuals. Other species may be taken as new data on predation becomes available. However, predator management will not result in a population-level effect on any of these species. Predator management activities may also indirectly disturb other wildlife. Installation of predator barriers may impede access for non-target species entering or exiting their feeding, roosting, and breeding areas. Trapping activities may also flush or disturb non-target wildlife. However, these activities are expected to be temporary and/or minimal in nature. Moreover, predator management activities are expected to result in increases in SMHM, CLRA, western snowy plover, and California least tern breeding success, recruitment, and total population size.

Individual wildlife may be affected ongoing restoration projects, but restoration activities in all the alternatives are expected to benefit the long-term population of tidal marsh species, including listed species such as the CLRA and the SMHM. There could be a temporary loss of tidal marsh habitat from inundated areas where breaching occurs. Restoration activities could disturb and flush CLRAs and salt marsh harvest mice from the area. In the long-term, additional tidal marsh habitat would off-set the temporary loss of habitat. Mitigation measures adopted as part of the ongoing restoration projects to reduce impact to individuals includes surveying for presence or absence of individuals; providing a buffer near nest locations; avoiding activities during the nesting season; trapping and transplanting mice to other sites; installing barrier fence to prevent

re-entry; and slow flooding to allow mammals to seek refugia in higher elevation vegetation.

Mosquito Management
Because mosquito control (B.t.i., B.s.) is applied directly to vernal pools, VPTS may be directly affected. However, these biological controls are not expected to affect aquatic invertebrates such as VPTS (Appendix K of the CCP). Other pesticides, such as methoprene, monomolecular films, and adulticides will not be allowed for use in the vernal pools. Refuge surveys over the last several years indicate that there is continued, long-term presence of VPTS in these pools. In order to reduce impacts to listed species in vernal pool areas, MAD staff would be required to receive training in order to access vernal pool areas.

CTS could be adversely affected by mosquito monitoring, surveillance, or control due to crushing from access on foot or by mechanized vehicles. However, soil properties at Warm Springs are such that burrow crushing has not been observed; either by cattle, foot traffic, or ATV use (Loredo, 2012 personal communication). In any case, truck use would be restricted to established levees, roads, and berms and would not be permitted around vernal pools. Only all-terrain vehicles will be permitted around vernal pools and no vehicles will be permitted to enter vernal pools. Use of larvicides may have an indirect adverse effect on the CTS by reducing the availability of invertebrate prey. However, B.t.i. and B.s. are very target specific biological controls and the vernal pools at Warm Springs support an abundance and diversity of aquatic invertebrates that are not susceptible to these pesticides, most commonly ostracods, copepods, cladocera, coleoptera, and hemiptera. CTSs could also be adversely affected as described under the wildlife section. In order to reduce impacts to listed species in vernal pool areas, MAD staff would be required to receive training in order to access vernal pool areas.

Impacts to the steelhead and the North American green sturgeon are the same as those listed previously in the fish section. It is not anticipated that larvicides and pupacides will impact these fish species. In order to mitigate for any potential impacts to green sturgeon, any pesticide application would only occur during low tides to avoid impacts to species that may move into the tidal marsh plain during high tides.

Mosquito monitoring, surveillance, or control could adversely affect CLRA. Walking and especially ATV or ARGO driving in the marsh has the potential to disturb CLRAs as well as crush nests, eggs, or chicks. Also, repeated travel over the same areas creates paths though the marsh that increases access for predators. In order to reduce impacts to CLRA from disturbance, access along tidal channels and sloughs will be restricted in order to reduce impacts to vegetation used as habitat by wildlife (e.g., nesting and escape habitat). Access (via foot or mechanized vehicle) to tidal marsh and muted tidal marsh for the purpose of mosquito management will not be allowed access February 1 to July 15 in areas that are inhabited by California clapper rails and along slough and channel edges (100-meter buffer).

Like other birds, as described previously in the wildlife section, mosquito control pesticides are not likely to have direct affects to CLRAs. Instead, CLRAs may be impacted indirectly by reduced invertebrate prey base as a result of adulticiding. However, this is a rarely used pesticide. It is not known what affect the frequent use of larvicides and pupacides in tidal marsh habitat would have on the invertebrate prey base of CLRAs.

The California least tern forages in sloughs and large channels within the areas affected by this

plan. However, they are more often found foraging in the Bay or in managed ponds, and are not likely to be adversely affected by mosquito monitoring, surveillance, or control if best management practices are followed (e.g., avoiding nesting areas). If population-level impacts to forage fish occur, then California least terns could be negatively impacted (See wildlife section).

Western snowy plovers may occasionally forage in areas affected by this mosquito management. However, they do not nest in areas affected by this plan, and are more likely to forage on mudflats or along tidal channels at low tide. Therefore they are not likely to be adversely affected by mosquito monitoring, surveillance, or control if the best management practices are followed. As a precaution, access (via foot or mechanized vehicle) to seasonal pond habitats for the purpose of mosquito management would not be allowed between March 1 and September 15 in areas used by nesting western snowy plovers. If population-level impacts to invertebrate prey occur, then western snowy plovers could be negatively impacted (See wildlife section).

Adverse impacts to SMHM and other wetland mammals may occur as a result of marsh access via foot or mechanized vehicles for mosquito management activities. According to observations, vehicle effects on habitat include compacted soil, destroyed vegetation, and documented the destruction of at least one SMHM nest (Bias and Morrison 1993). In addition, repeated vehicle travel over the same areas creates paths through the pickleweed that increases access for predators. Lastly, they reported that vehicle travel can disrupt daily activity (e.g. movements) and has the potential to cause mortality of individual SMHM. In order to mitigate for any potential impacts from vehicles, mechanized vehicles will only be allowed on levees and existing roads unless approved by the Refuge Manager. Habitat enhancement and restoration activities for mosquito management may flush SMHM from their habitat. In order to mitigate for any potential impacts from habitat enhancement and restoration, marsh vegetation is to be hand mowed and removed down to the bare ground before dredging occurs to prevent harm to the SMHM. Areas of marsh vegetation that are submerged in water do not need to be mowed before dredging occurs. Before excavation occurs, crews must walk ahead of the equipment and haze SMHM out of vegetation. When clearing vegetation from an area, mowing will begin from the center of the area to be cleared and work toward the edges to avoid trapping SMHM in remaining patches of vegetation.

Impacts to the federally endangered CCGs are the same as those listed in the vegetation section. CCGs generally begin to bloom in April, and can be trampled and crushed by mechanized vehicles. During the germination and blooming period for CCG (which coincides with pond drying in the spring), ATVs will not be allowed around CCG pools and pools would be treated on foot. Foot access by trained personnel would not have a significant impact on goldfields. A map of CCG pools will be provided to mosquito abatement district staff and they would receive training to minimize impacts to areas with CCG blooms. In general, by the time CCG is germinating, pools are drying down significantly. Peak bloom generally occurs when the pond is completely dry. Most pollinators do not have an aquatic lifecycle stage, making it unlikely that pollinators would be affected by larvicide application.

In order to reduce effects for mosquito management activities on endangered species, MADs would be required to attend Refuge-approved training on measures to avoid impacts to wetland wildlife and in identification of sensitive species. Also, aerial pesticide (larvicide or pupacide) application would be required in lieu of ground-based application methods in areas with endangered species.

All alternatives may have short-term minor disturbance on wildlife from visitor services opportunities. Generally however, listed species habitat is off limits to visitors. Also public education (through staff training and contact), law enforcement, and signage would help to alleviate visitor disturbance.

Alternative A

Alternative A would have the same effects on endangered species as described under Common to All Alternatives. As described in the section on fish, the frequency of conditions that would require use of adulticides on the Refuge has been rare (last application was in 2006 at Outer Bair Island), suggesting that future use of adulticides in discrete areas of the Refuge is unlikely, but if occurred, the frequency and scope of application is not likely to cause significant adverse effects to fish and invertebrate populations. To reduce impacts to steelhead and green sturgeon, adulticides will only be permitted in upland areas and interior water bodies. They will be applied away from open water and navigable slough channels to reduce impacts to fish. Application would only occur during low tides to avoid potential impacts to fish that may move into the tidal marsh plain during higher high or extreme tides.

Under Alternative A, recreation activities such as hiking and dog walking in designated areas of the Refuge have the potential to disturb endangered species such as the CLRA and SMHM. However, the degree of disturbance from these activities is unknown, though this activity has been going on for several decades. Although there are no recent CLRA or SMHM surveys in the area, staff believe there is presence of CLRA and SMHM is this area. It is suspected that CLRA and SMHM in the area may have become habituated to dog walking activities due to the length of time this activity has occurred. Some literature suggests that if animals perceive an activity as spatially predictable and nonthreatening, they may habituate to that activity (Whittaker and Knight 1998). For example, humans approaching from a parking area (an area with consistent human use) elicited less of a response from mountain sheep than did humans approaching from over a ridge, where human use was sporadic (MacArthur et al. 1982). Cooper et al. 2008 found that the alert distance of the eastern gray squirrel did not differ between the approach by a human alone and the approach by a human with a dog. Miller et al. 2001 found this same result for songbirds; however Miller found that presence of a dog resulted in greater influence on mule deer than just approach by a human.

While certain types of disturbances have occurred within or adjacent to some marsh areas for a long time and certain CLRA appear to have habituated or become tolerant of disturbances, others appear to habituate over time or are unable to habituate to disturbances at all. For example, certain CLRA in the Palo Alto Baylands Nature Preserve appear to be somewhat tolerant of the relatively common pedestrian traffic on the public boardwalk that dissects the marsh. CLRA nests have been documented within 10 feet of 16 trails in the Elsie Romer and Cogswell marshes in Alameda County and within 65 feet of a busy street near White Slough (Solano County). Alternatively, on numerous occasions at the Corte Madera Ecological Preserve, rails have been observed seeking refuge from unrestrained dogs entering tidal marshes from adjacent levees with public access (J. Garcia, pers. comm. 1994). While some of these studies have limited applicability to controlled dog walking, they do suggest a range of either a tolerance for disturbance or a potential for disturbance.

These disturbances have occurred despite the presence of signs notifying users that they are entering sensitive wildlife species areas and that pets must be under restraint while in the preserve area. Similarly, along the Redwood Shores Peninsula in San Mateo County, fences and signs installed to prevent access into areas with endangered species habitat have been repeatedly vandalized and people continue to enter the prohibited areas beyond the fences and signs (Popper and Bennett 2005).

CLRA reaction to disturbance may vary with season, however both breeding and nonbreeding seasons are critical times. Disturbance during the nonbreeding season may primarily affect survival of adult and subadult rails. Adult clapper rail mortality is greatest during the winter (Albertson 1995; Eddleman 1989), and primarily due to predation (Albertson 1995).

Human-related disturbance of CLRA in the winter, particularly during high tide and storm events, may increase the birds' vulnerability to predators. The presence of people and their pets in the high marsh plain or near upland areas during winter high tides may prevent rails from leaving the lower marsh plain (Evens and Page 1983). CLRA that remain in the marsh plain during inundation are vulnerable to predation due to minimal vegetative cover available (Evens and Page 1986). A population viability analysis under development for CLRA identifies changes in adult survivorship as causing the greatest change in the population growth rate (M. Johnson, pers. comm.). Another model also indicates that adult survivorship of CLRA is the primary demographic variable for maintaining a stable population or causing the population to either increase or decline (Foin et al. 1997). These models indicate that survival of adult birds has the strongest effect on the perpetuation or extinction of the overall population.

Alternatives B and C

Under both alternatives, there will be increased temporary disturbance to listed species from survey activities, but no mortality is expected. Under Alternative B, Refuge staff will conduct additional surveys using standardized monitoring protocols for listed species. These changes in methodology will improve understanding of listed species and their recovery needs. Also under Alternative B, additional surveys will be conducted to determine presence of listed plants, including Suisun thistle, salt marsh bird's beak, soft bird's beak, and California sea-blite; there is no historical or current information on the presence of these species on the Refuge even though the Refuge provides potential habitat. Under Alternative C, additional research and Refuge-wide monitoring will further inform SMHM recovery needs. Under both of these alternatives we would also implement a mosquito management plan (Appendix K). The condition for use of adulticide would require a number of criteria including the presence of a mosquito-borne disease on the Refuge or within flight range of vector mosquito species present on the Refuge, as stated in the mosquito management plan. Should application of adulticides be necessary we would implement the same precautions as described in Alternative A.

Additional habitat enhancements and restorations under both alternatives will result in short-term disturbance (e.g., flushing), but result in long-term benefits such as higher quality habitat for listed species. Listed species will especially benefit from ecological enhancements at La Riviere Marsh, New Chicago Marsh, and Faber-Laumeister where present. Wildlife may be temporarily flushed from habitat due to moving of dirt or breaching levees. Mitigation measures may include live-trapping and removing salt marsh harvest mice as well as fencing construction areas to prevent mice from re-entering the work area. Enhancing vernal pool/upland grassland habitat under both alternatives will benefit the VPTS and the CTS. The activities will cumulatively

support the goals of the Refuge and the region in restoring and conserving wildlife resources.

Under Alternative B, the creation of nesting and roosting islands as feasible in the Alviso, Mowry, and Newark ponds will have a long-term benefit to the recovery of the western snowy plover and California least tern in ponds. However, these species may incur short-term disturbance from the construction of these islands. Birds may be temporarily flushed due to the operation of heavy equipment and foot traffic, making them vulnerable to predation. Construction activity will only take place during the non-breeding season and during the daytime, allowing birds a resting period at night. Further investigations on mudflat and shallow pond biofilm in Alternative C will inform management of ponds to improve shorebird diet, including snowy plovers and least terns.

Under both alternatives, implementation of the updated mammalian and an avian predator management plan will also help in the recovery of listed species by protecting population levels from predation. A variety of avian species have been observed preying upon the federally threatened western snowy plover and the federally endangered California least tern. Existing predator management (focused on problem mammals) does not control problem avian species. Under this alternative, removal and deterrence of avian predators will be accomplished by various methods, including hazing, relocation, or lethal control. While selected individuals will be removed, predator management will not result in a population-level effect on any of these species. Increased predator management to control problem avian species is expected to result in increases in SMHM, CLRA, western snowy plover, and California least tern breeding success, recruitment, and total population size.

Under Alternative B, reduced dog walking access on the Tidelands trails would reduce the potential disturbance to endangered species such as the CLRA, by limiting dog walking to only the upland portion of the trails. Expanding the buffer area (e.g., slightly shifting the trail inland) along the trail between the Harrier Spur and Tidelands Spur trails may also reduce disturbance to the adjacent tidal marsh area that is at the same elevation. This separation would create a larger buffer area between dogs on this short, but sensitive section of the trail (see Figure 2), while still accommodating a loop access.

Climate change actions under all alternatives will have added benefit to wildlife. Through climate change modeling and monitoring, staff will identify habitat changes and identify adaptive changes or acquisition needs that may be required to support wildlife. Modeling will help staff identify which species are most at risk of climate change effects and prioritize management actions to protect them.

In Alternative C, the salt marsh harvest and the CLRA will benefit from the possible reintroduction into appropriate habitat and additional partnered research efforts. Additional studies on pepperweed effects on the SMHM will also be beneficial to understanding how to enhance their habitat. Heightening and expanding high marsh and ecotone/transition zone will also benefit listed tidal marsh species. Survey efforts for endangered and threatened plant species will benefit from management and knowledge of these resources.

In both alternatives, prioritization of remaining lands within the approved acquisition boundary and a more active role in acquiring these lands (from willing sellers) will be beneficial to endangered species, particularly those most vulnerable to habitat loss (e.g., tidal habitat) as a result of sea-level rise from climate change.

Increased visitor activities in both alternatives may result in increased disturbance to listed species. Improved access to the Faber-Laumeister, improvements to trails, additional wildlife viewing facilities, launch sites for canoe and kayak, installation of a photography blind, photography permit system, additional fishing facilities, additional vernal pool tours, and a remote camera system in Alternative B may result in more visitors and increased disturbance to endangered species. Added wildlife observation opportunities are likely to increase contact between visitors and wildlife, causing wildlife to temporarily flush. Further public amenities in Alternative C such as interpretive signage, kayak/canoe rental, a Water Trail stop, boat dock, and photography blinds will further increase wildlife and visitor interface. However, these activities generally will not take place in listed species habitat. Also, more public education (through staff training and contact), law enforcement, and signage would complement the increased visitation. Further, signage and fencing will be installed to protect sensitive habitat as needed.

Under Alternative C, the prohibition of dog-walking on all areas of the Refuge, would result in further protection of endangered species habitat, particularly for the CLRA and the SMHM.

Social and Economic Environment

None of the alternatives are expected to adversely affect the social and economic environment of Alameda, Santa Clara, and San Mateo Counties. Tourism revenue is potentially generated through a variety of activities held at the Refuge, such as guided walks and special events. If an increase in visits to the Refuge occurs or there is a net increase in visitors to the area, this could benefit the local economy and employment if visitors utilize local businesses such as gas stations, markets, and restaurants. However, increased visitation can lead to more traffic in the local area as well. Increased visitation also provides an opportunity for public education, which can foster stewardship for these native habitats.

Recreation

Alternative A

Current wildlife-dependent recreational opportunities at the Refuge include wildlife observation, photography, hunting, and fishing. In addition, some non-wildlife dependent opportunities such as jogging, dog-walking, and bicycling are also allowed at certain Refuge locations. There are currently more than 30 miles of trails with multiple access sites and overlooks to facilitate wildlife observation. Guided photography and interpretive walks are offered, as well as hosting on-site special events for National Wildlife Refuge Week, Earth Day, the South Bay Bird Festival, and others. The Refuge has a visitor contact station in Fremont from that provides limited visitor contact services. These recreational opportunities provide some social benefits to nearby communities by providing access to open space. Dog walking is a primary outdoor activity for the surrounding communities; for a significant portion of the population, it may represent the only time during the week that they are outdoors and in nature. Dog walking would also provide an opportunity for this non-traditional user groups to become stewards of the Refuge.

Hunting and fishing are allowed in the open bay waters and navigable sloughs. Shoreline and pier fishing are also offered at the Refuge. Hunting is allowed on 7,500 acres of Refuge land in areas that do not conflict with wildlife observation or photography.

Alternatives B and C

Under Alternatives B and C, there would be increased recreation opportunities and interpretation

programs. In addition to those elements described in Alternative A, Alternative B would provide more refuge support to hunters through additional hunt meetings, an interactive Web site, and hunting materials. Recreational fishing would also be enhanced through updated brochures and wayside exhibits. Fishing would be improved at Coyote Creek Lagoon and Faber-Laumeister with a small fishing platform, and possibly introduced at Alviso Slough. The headquarters fishing pier would also be updated to improve the fishing experience there. Additionally, water-based, wildlife-dependent opportunities would be enhanced. Visitors will benefit from the creation of a launch site and kayak tours where feasible on the Refuge. The creation of a bus stop at headquarters will facilitate access to the Refuge and encourage recreation. Under Alternative B, reduced trail access for dog walkers (less 0.8 miles, or a loss of 38 percent) would result in reduced recreation opportunities for this user group. Conversely, reduced dog walking access could improve other visitors' experience. While dogs are required to be on leash at the Refuge, sometimes owners may not comply with that regulation. In these instances, unrestrained dogs may impact other visitors' enjoyment of the refuge resources. Unrestrained dogs may go off the trail flushing wildlife thus diminishing wildlife observation opportunities. Dogs on leash and off leash may become a threat to other visitors. Lack of physical safety, whether real or perceived, could impact visitors' enjoyment of refuge resources.

Under Alternative C, recreation would be enhanced through increased interpretive events such as vernal pool tours, an additional fishing day event, installation of a boat dock, development of a stop along the Water Trail, installation of additional photography blinds, a youth photography camp, opening of an additional 340 areas to hunting, installation of a universally accessible hunt blind, additional hunting classes/orientation, and equipment (e.g., kayak, canoe, bicycle) rental. The creation of bus stop at the EEC will facilitate access to the Refuge and encourage recreation. Construction of a walking path from the bus stop to the Refuge headquarters will also facilitate access. Also under this alternative, the prohibition of dog walking on all Refuge trails would result in no opportunity for this non-traditional user group, or for this group to become aware of Refuge purposes.

Both alternatives would also considerably expand or enhance environmental education opportunities for the local community. More children and adults will be accommodated through the programs. Programs will also be expanded to include Spanish and other languages as feasible.

Economy

An analysis on the economic impact of the alternatives to the local region (the three counties where the Refuge is located) was done by the Policy Analysis & Science Assistance Branch of the U.S. Geological Survey, Fort Collins, Colorado. The full report is listed as Appendix A. The methods are described as follows.

Economic input-output models are commonly used to determine how economic sectors will and will not be affected by demographic, economic, and policy changes. The economic impacts of the management alternatives for the Refuge were estimated using IMPLAN (Impact Analysis for Planning), a regional input-output modeling system developed by the USDA Forest Service. IMPLAN is a computerized database and modeling system that provides a regional input-output analysis of economic activity in terms of 10 industrial groups involving more than four hundred economic sectors (Olson and Lindall 1999). The IMPLAN model draws upon data collected by the Minnesota IMPLAN Group from multiple Federal and State sources, including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall

1999). The year 2009 IMPLAN data profiles for Alameda, San Mateo, and Santa Clara were used in this analysis. The IMPLAN county level employment data estimates were found to be comparable to the U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System data for the year 2009.

Because of the way industries interact in an economy, activity in one industry affects activity levels in several other industries. For example, if more visitors come to an area, local businesses will purchase extra labor and supplies to meet the increase in demand for additional services. The income and employment resulting from visitor purchases from local businesses represent the direct effects of visitor spending within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending; the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill 2007). In order to increase supplies to local businesses and meet increased demand, input suppliers must also increase their purchases of inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the indirect effects of visitor spending within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from new employee income is the induced effect of visitor spending. The indirect and induced effects are known as the secondary effects of visitor spending. "Multipliers" (or "Response Coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes 1998). The sums of the direct and secondary effects describe the total economic impact of visitor spending in the local economy.
For each alternative, regional economic effects from the IMPLAN model are reported for the following categories:

- **Employment** represents the change in the number of jobs generated in the region from a change in regional output. IMPLAN estimates for employment include both full time and part time workers, which are measured in total jobs.
- **Labor Income** includes employee wages and salaries, including income of sole proprietors and payroll benefits.
- **Value Added** measures contribution to Gross Domestic Product. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product, and is thus net of intermediate sales.

In terms of the CCP, there are several factors that affect the local economy:

- Increased visitors as a result of additional public use opportunities offered on the Refuge, which would result in increases in local spending.
- Increased spending in the local economy as a result of more staff needed to implement CCP actions.
- Increased work-related expenditures (e.g., contracts, materials) as a result implementing the CCP actions.

Table 3 shows the estimated percent of non-local Refuge visits and visitor days under each alternative.

Table 3. Estimated Annual Refuge Visitation by Visitor Activity for Alternatives A, B, and C

Visitor Activity	Total number of visits	Percentage of non-local visits (%)	Total number of non-local visits	Number of hours spent at Refuge	Number of non-local visitor days[a]
Alternative A					
Fishing	3,700	10%	370	4	185
Waterfowl hunting	3,900	10%	390	6	293
Nature trails/other wildlife observation	746,341	10%	74,634	2	18,659
Total Visitation	*753,941*		*75,394*		*19,137*
Alternative B					
Fishing	4,070	10%	407	4	204
Waterfowl hunting	3,900	10%	390	6	293
Nature trails/other wildlife observation	970,243	10%	97,024	2	24,256
Total Visitation	*978,213*		*97,821*		*24,753*
Alternative C					
Fishing	4,070	10%	407	4	204
Waterfowl hunting	4,095	10%	410	6	307
Nature trails/other wildlife observation	1,044,877	10%	104,488	2	26,122
Total Visitation	*1,053,042*		*105,305*		*26,633*

[a]One visitor day = 8 hours.

Alternative A

Table 4 summarizes the direct and total economic impacts in the three-county area of Refuge management activities for Alternative A. Under Alternative A, the Refuge management activities directly related to Refuge operations generate an estimated 17 jobs, $850,100 in labor income, and $1.42 million in value added in the local economy. Including direct, indirect, and induced effects, all the Refuge activities generate a total economic impact of 30 jobs, $1.62 million in labor income, and $2.77 million in value added. In 2009, total labor income was estimated at $190 billion and total employment was estimated at 2.42 million jobs for the local three-county area (IMPLAN 2009 data). Thus, total economic impacts associated with the Refuge operations under Alternative A represent less than one hundredth of one percent of total income (0.0008 percent) and total employment (0.001 percent) in the overall three-county area economy. Total economic effects of Refuge operations play a much larger role in the communities near the Refuge where most of the Refuge-related expenditures and public use-related economic activity occurs.

Table 4. Economic Impacts of the Refuge Management Activities for Alternative A

	Employment (# full & part time jobs)	Labor Income ($ thousands)	Value Added ($ thousands)
Refuge administration[a]			
Direct effects	3.1	$234.6	$395.4
Total effects	9.2	$594.7	$1,035.4
Public use activities			
Direct effects	13.4	$615.5	$1,027.7
Total effects	21.0	$1,022.1	$1,729.7
Aggregate impacts			
Direct effects	16.5	$850.1	$1,423.1
Total effects	30.2	$1,616.8	$2,765.1

[a]Staff salary purchases and work-related purchases.

Alternative B

Table 5 summarizes the direct and total economic impacts in the three-county area of Refuge management activities for Alternative B. Under Alternative B, the Refuge management activities directly related to Refuge operations would generate an estimated 22 jobs, $1.14 million in labor income, and $1.91 million in value added in the local economy. Including direct, indirect, and induced effects, Refuge activities would generate a total economic impact of 43 jobs, $2.34 million in labor income, and $4.02 million in value added. Total economic impacts associated with the Refuge operations under Alternative B represent less than one hundredth of one percent of total income (0.001 percent) and total employment (0.002 percent) in the overall three-county area economy. Total economic effects of Refuge operations play a much larger role in the communities near the Refuge where most of the Refuge-related expenditures and public use-related economic activity occurs.

Table 5. Economic Impacts of the Refuge Management Activities for Alternative B

	Employment (# full & part time jobs)	Labor Income ($ thousands)	Value Added ($ thousands)
Refuge administration[a]			
Direct effects	4.6	$344.1	$579.9
Total effects	16.2	$1020.4	$1786.1
Public use activities			
Direct effects	17.3	$795.3	$1,328.0
Total effects	27.2	$1,320.9	$2,235.4
Aggregate impacts			
Direct effects	21.9	$1,139.4	$1,907.9
Total effects	43.4	$2,341.4	$4,021.6

[a]Staff salary purchases and work-related purchases.

Alternative C

Table 6 summarizes the direct and total economic impacts in the three-county area of Refuge management activities for Alternative C. Under Alternative C, the Refuge management activities directly related to Refuge operations would generate an estimated 27 jobs, $1.5 million in labor income, and $2.51 million in value added in the local economy. Including direct, indirect, and induced effects, all Refuge activities would generate a total economic impact of 53 jobs, $2.97 million in labor income, and $5.1 million in value added. Total economic impacts associated with Refuge operations under Alternative C represent less than one hundredth of one percent of total income (0.002 percent) and total employment (0.002 percent) in the overall three-county area economy. Total economic effects of Refuge operations play a much larger role in the communities near the Refuge where most of the Refuge-related expenditures and public use-related economic activity occurs.

Table 6. Economic Impacts of the Refuge Management Activities for Alternative C

	Employment (# full & part time jobs)	**Labor Income** ($ thousands)	**Value Added** ($ thousands)
Refuge administration[a]			
Direct effects	8.5	$640.0	$1,078.5
Total effects	23.8	$1,550.2	$2,694.1
Public use activities			
Direct effects	18.7	$855.9	$1,429.1
Total effects	29.3	$1,421.5	$2,405.6
Aggregate impacts			
Direct effects	27.2	$1,495.8	$2,507.6
Total effects	53.1	$2,971.6	$5,099.7

[a]Staff salary purchases and work-related purchases.

Cultural Resources

Under Federal ownership, archaeological and historical resources within the Refuge receive protection under Federal laws mandating the management of cultural resources, including, but not limited to, the Archaeological Resources Protection Act; the Archaeological and Historic Preservation Act; the Native American Graves Protection and Repatriation Act; and the National Historic Preservation Act. There are some identified historic and cultural elements on the Refuge, but the Refuge has not been thoroughly surveyed. These known elements are protected from Refuge activities. However, the Refuge is located in an area which was once open water and marsh making it difficult to locate physical evidence of pre-historic human activity. Moreover, archaeological sites also tend to be situated on higher land than the Refuge (N. Valentine, pers. comm.).

Alternative A

Tidal restoration activities could involve ditching, earthmoving, and breaching that could disturb or uncover unknown cultural resources. Invasive weed control activities, particularly mechanical (e.g., mowing, weed whacking, pulling) and cultural (e.g., grazing, burning) methods could also disturb and uncover unknown cultural resources. Any known cultural resource locations will be avoided. Measures to minimize impacts to cultural resources employed include pre-design/pre-

construction surveys and exploratory excavation by a qualified archaeologist as needed before undertaking major management activities. Activities may also be designed to avoid impacting identified or potential cultural resources.

To preserve Refuge historic resources, all undertakings, including, but not limited to, construction activities, will continue to comply with Section 106 of the National Historic Preservation Act of 1966, as amended, as outlined in the existing Programmatic Agreement between the Service and the California State Historic Preservation Officer. Staff will also coordinate with the Service's Regional Archaeologist to comply with Federal laws relating to cultural resources.

Alternatives B and C

Under Alternatives B and C, improving the ecological function at La Riviere Marsh, Mayhew's Landing, New Chicago Marsh, Faber-Laumeister, and Munster sub-units of the Refuge could involve additional ditching, earthmoving, and breaching that could disturb or uncover unknown cultural resources. Invasive weed control activities, particularly mechanical (e.g., mowing, weed whacking, pulling) and cultural (e.g., grazing, burning) methods could also disturb and uncover unknown cultural resources. Marsh-upland ecotone restoration through planting of native vegetation at Faber-Laumeister, La Riviere, EEC, Pond A6, Pond A8, Ravenswood Ponds, and Alviso Ponds could also result in uncovering or disturbance of unknown cultural resources. Any known cultural resource locations will be avoided. Measures to minimize impacts to cultural resources may be employed, including pre-design/pre-construction surveys and exploratory excavation by a qualified archaeologist as needed before undertaking any of these actions. Activities may also be designed to avoid impacting identified or potential cultural resources.

To preserve Refuge historic resources, all undertakings under both alternatives, including, but not limited to, construction activities, will continue to comply with Section 106 of the National Historic Preservation Act of 1966, as amended, as outlined in the existing Programmatic Agreement between the Service and the California State Historic Preservation Officer. Staff will also coordinate with the Service's Regional Archaeologist to comply with Federal laws relating to cultural resources.

Climate Change

Common to All Alternatives

In 2010, the U.S. Fish and Wildlife Service published *Rising to the Challenge: A Strategic Plan for Responding to Accelerating Climate Change.* This Strategic Plan charges comprehensive conservation planning to incorporate climate change into its planning and decision making. Climate change could have a profound effect on the Refuge because most of the area is below sea-level. Sea-level rise as a consequence of climate change could reduce the total land area of the Refuge. Based on a continuous record of mean sea level for the San Francisco Bay Estuary, the rate of relative sea level rise at the Presidio from 1855 to the present is estimated to be 0.12 centimeter per year (Moffatt and Nichol et al. 1988). Neglecting the unusual values associated with all El Niño events during the recent 19-year period from 1967 to 1985, sea-level rose at a rate of 0.18 centimeter per year, which still indicates that the rate of rise is increasing (Moffatt and Nichol et al. 1988). Climate change in conjunction with tidal wetland restoration and non-native vegetation removal activities will result in an increase in wetland or open water habitat, and a decrease in upland habitat. However, much of the diked upland on the Refuge was historically tidal wetland.

A Sea-Level Affecting Marshes Model (SLAMM) was conducted in 2010 to assess habitat changes as a result of climate change on the Refuge (Clough and Larson 2010). The SLAMM identified habitat changes on the Refuge units that may be expected under five sea-level rise scenarios. The middle scenario of a one meter rise in sea level predicts losses in most tidal and upland habitat types (Table 7), but particularly great losses to irregularly flooded marshes. Increases would be in estuarine open water and salt marsh habitats (Clough and Larson 2010). However, there were a number of assumptions that were made in the creation of the SLAMM, suggesting the need to consider other modeling efforts to confirm these findings.

Table 7. Predicted Loss Rates of Land Categories by 2100 Given Simulated Scenarios of Eustatic Sea Level Rise

SLR by 2100 (m)	0.39	0.69	1	1.5	2
Tidal Flat	17%	23%	30%	40%	45%
Brackish Marsh	19%	21%	39%	84%	94%
Inland Fresh Marsh	9%	10%	13%	21%	39%
Undev. Dry Land	12%	12%	13%	13%	14%
Inland Shore	10%	18%	44%	69%	82%

Source: Clough and Larson 2010.

Climate change could also result in changing habitat which would affect wildlife and plant communities. Not only could habitats shift, but also the timing of when birds migrate and leaves begin to bud (IPCC 2007). Climate change could magnify impacts on wildlife habitat, reduce native vegetation, and increase occurrence of non-native (plant and animal) species on the Refuge. Climate change can result in physiological changes, phenological (lifecycle) changes, range shifts, community changes, ecosystem process shifts, and multiple stressor conditions (Parmesan and Galbraith 2004). Climate change may require organisms to migrate at much higher rates than they have done in the recorded past (Malcolm and Pitelka 2000). Native plants may not thrive in the Refuge boundaries due to changing temperatures. Moreover, climate change could result in changes to local food web dynamics, altering prey resources in the bay waters adjacent to the Refuge. The potential changes to food availability near the Refuge could deter or attract wildlife, therefore affecting productivity.

Over time, climate change could result in significant ramifications for wildlife and vegetation. Tidally-influenced habitat for wildlife at the shoreline could disappear, forcing wildlife to move onto higher ground, possibly competing with other wildlife for habitat. Plant communities at the shore could be inundated or be forced to migrate to higher ground, competing with other vegetation (Smerling et al. 2005).

The U.S. Department of Interior issued an order in January 2001 requiring its land management agencies to consider potential climate change impacts as part of long-range planning endeavors. The increase of carbon within the earth's atmosphere has been linked to the gradual rise in surface temperature, commonly referred to as global warming. In relation to comprehensive conservation planning for national wildlife refuges, carbon sequestration constitutes the primary climate-related impact to be considered in planning. The U.S. Department of Energy's report Carbon Sequestration Research and Development (1999) defines carbon sequestration as "…the capture and secure storage of carbon that would otherwise be emitted to or remain in the

atmosphere."

Terrestrial biomes of all sorts—grasslands, forests, wetlands, tundra, perpetual ice, and desert—are effective in preventing carbon emissions and in acting as biological "sinks" for atmospheric carbon monoxide. The Department of Energy's report conclusions note that ecosystem protection is important to carbon sequestration and may reduce or prevent loss of carbon currently stored in the terrestrial biosphere. Preserving natural habitat for wildlife is the heart of any long-range plan for national wildlife refuges. This in turn contributes positively to efforts to mitigate human-induced global climate changes. Several impacts of climate change have been identified (Hassol 2004) that may need to be considered in future project planning and addressed in the future:

- Habitat availability for cold water fish, such as trout and salmon in lakes and streams, could be reduced.
- Forests may change, with some species shifting their range northward or dying out and other trees moving in to take their place.
- Ducks and other waterfowl could lose breeding habitat due to stronger and more frequent droughts.
- Changes in the timing of migration and nesting could put some birds out of sync with the life cycles of their prey species.

Alternative A
Alternative A would have benefits against climate change because restoration and enhancement of tidal marsh would increase carbon sequestration. Public use and management operations (e.g., vehicle emissions, heavy equipment operation) would have a minor impact on climate change. To minimize greenhouse gas emissions that contribute to climate change, we will continue to make energy improvements at our facilities and upgrade the vehicle fleet with energy efficient vehicles whenever possible.

Alternative B
Under Alternative B, increased habitat restoration and reduced carbon footprint (e.g., hybrid transportation, solar technology, and energy efficiency) would result in a positive impact on reducing climate change. Coordination with the Service's LCC and I&M programs on climate change information and projections will help inform habitat restoration planning and implementation, such as creating additional marsh and mudflat habitat in specific locations in light of bay area sea-level rise projections. Increased visitation would result in a negligible impact on increasing climate change effects. Additional visitor opportunities may result in visitors choosing the Refuge as their destination rather than another location offering similar opportunities in the Bay area. The Refuge is one of many locations in the Bay area for wildlife-dependent recreational opportunities. Also, if there are more visitors, a bus stop at headquarters will provide visitors with an alternative travel option with a lower carbon footprint.

Alternative C
Under Alternative C, we would anticipate that further increases in habitat restoration, further reduced climate change impacts, and increased visitation would result in a negligible impact on climate change. In addition to a bus stop at headquarters, Alternative C would also include a bus stop at the EEC to encourage visitors to use public transit to lower their carbon footprint.

Environmental Justice

Executive Order 12898 ("Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations") requires all Federal agencies achieve environmental justice by "identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Environmental justice is defined as the "fair treatment for peoples of all races, cultures, and incomes, regarding the development of environmental laws, regulations, and policies."

The mission of the Service is working with others to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people. The developing environmental justice strategy of the Service extends this mission by seeking to ensure that all segments of the human population have equal access to America's fish and wildlife resources, as well as equal access to information that will enable them to meaningfully participate in activities and policy shaping.

No minority and low-income populations or communities would be disproportionately affected by any of the alternatives. Outreach and environmental education opportunities will be directed to encourage more participation by local minority and low-income populations. The Service has concluded that none of the alternatives would disproportionately affect any one population or community.

Cumulative Effects

Cumulative effects are those effects on the environment resulting from incremental consequences of the Service's proposed actions when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes those actions. Cumulative effects can be the result of individually minor impacts that can become significant when added over a period of time. It is difficult to accurately analyze cumulative effects because one action may increase or improve a resource in one area, while other unrelated actions may decrease or degrade that resource in another area. Moreover, CCP actions may be inhibited or accelerated by other activities or management plans occurring in the same area. This section assesses how these other activities in addition to the CCP actions would affect the physical, biological, cultural, and social and economic environment.

Cumulative effects will take into account several ongoing projects where the Refuge is located. These projects are described in the CCP and include:

South Bay Salt Pond Restoration Project. The SBSPRP is the largest tidal wetland restoration project on the West Coast. When complete, the restoration will convert 15,100 acres of commercial salt ponds at the south end of San Francisco Bay to a mix of tidal marsh, mudflat, managed pond, open water, and other wetland habitats. The property was purchased by the State of California and the Service from Cargill Salt as part of a larger land transaction that included 1,400 acres of salt crystallizer ponds on the east side of the Napa River. The acquisition of the South Bay salt ponds provides an opportunity for landscape-level wetlands restoration, improving the physical, chemical, and biological health of the San Francisco Bay. The goals of the SBSPRP are to restore and enhance a mix of wetland habitats, provide wildlife-oriented public access and recreation, and provide for flood management in the South Bay.

Initial Stewardship Plan. The Initial Stewardship Plan (ISP) was an interim plan to maintain and enhance the biological and physical conditions within the salt ponds acquired from Cargill in 2003 in the interim period between the cessation of salt production and the implementation of the long-term restoration plan (the SBSPRP). The primary objectives of the ISP include:

- cessation of salt concentrating processes within the ponds;
- circulation of bay water through the ponds and tidally-restore the Island Ponds (Alviso Ponds A19, A20, and A21);
- maintain existing open water and wetland habitat for the benefit of wildlife, including habitat for migratory shorebirds and waterfowl and resident breeding species;
- maintain ponds in a restorable condition to facilitate future long-term restoration;
- meet all regulatory requirements, especially discharge requirements to maintain water quality standards in the South Bay;
- work within existing funding constraints; and
- maintain existing levels of flood control

Shoreline Study. The Shoreline Study was originally authorized by Congress in 1976 to assess the need for flood protection in the South Bay. The results of the original Shoreline Study in 1992 concluded that the Army Corps of Engineers could not economically justify developing a Federal flood management project in the South Bay in large part due to commercial salt pond levees that provided some level of flood protection within the Shoreline Study area. The acquisition and eventual restoration planning of 15,100 acres of salt ponds in the South Bay by the Federal and State government in 2003 affected the utilization of those pond levees as flood control structures. In 2002, the U.S. House of Representatives requested that the Corps review its previous 1992 Shoreline Study, expanding the scope to include environmental restoration and protection, as well as tidal and fluvial flood damage reduction and related purposes. Initial reconnaissance analysis conducted by the Corps in 2004 determined that due to current and future anticipated conditions to the South Bay, a Federal flood control and ecosystem restoration project would be justified.

In 2005, the Corps, Santa Clara Valley Water District (SCVWD), and the Conservancy kicked off the first study phase of the South San Francisco Bay Shoreline Study and are now in the preliminary stages of beginning environmental review. The project is currently undertaking "scoping" to determine the range of environmental issues to be addressed in the alternative development and analysis process.

San Francisco Estuary Invasive Spartina Project. The San Francisco Estuary Invasive Spartina Project was created in 2000 by the California State Coastal Conservancy to develop a regionally coordinated project to address the rapid spread of four introduced and highly invasive *Spartina* (cordgrass) species in the San Francisco Estuary. The Spartina Control Program, the "action arm" of the Spartina Project, was created to arrest and reverse the spread of invasive, non-native cordgrass species in the Estuary to preserve and restore the ecological integrity of the Estuary's intertidal habitats and estuarine ecosystem. The Project is currently working with the Control Program to develop a set of "best practices" for tidal marsh restoration to minimize the risk of spreading invasive *Spartina* and its hybrids.

Eden Landing Ecological Reserve Restoration Project. The Eden Landing Ecological Reserve (ELER) Restoration Project was established in May 1996 to restore former salt ponds and crystallizers to tidal salt marsh and seasonal wetlands as well as provide public recreational access. In 1996, CDFG, working with the Wildlife Conservation Board (WCB), East Bay Regional Park District, California Wildlife Foundation, the cities of San Jose, Milpitas and Fremont, and Caltrans, acquired the Baumberg Tract from Cargill Salt Company at the ELER and began efforts to restore more than 830 acres of former salt ponds to vital habitat. In 2003, DFG acquired an additional 5,500 acres of former salt ponds for ELER as part of the SBSPRP acquisition that was accomplished with funding from WCB, USFWS, and four private foundations.

Today, CDFG is actively managing the 6,300 acres of former salt ponds at ELER as part of the SBSPRP and moving forward on its restoration to create a mix of tidal marsh and managed pond habitat. Restoring tidal action to thousands of acres of diked salt ponds throughout the South Bay is essential to bringing back the natural wetland habitat. In April 2004, DFG successfully created an extension of North Creek from the Old Alameda Creek channel. In 2006, North Creek was connected to restore more than 300 acres to tidal action and re-establish several miles of sloughs. The current project will complete the connection of Mt. Eden Creek and restore about 300 acres to tidal action and re-establish several miles of sloughs. Future restoration plans, including linking segments of the Bay Trail, are underway to link more ponds to tidal action and the Bay as part of the SBSPRP.

Alviso Slough Restoration Project. The SCVWD completed an EIR in November 2009 to assess the possible actions for restoring the Alviso Slough. The EIR recommended vegetation removal along the Slough of 3.7 acres with dredging to an 8-foot depth which would provide for two-way boat navigation. Since the 1940s, Alviso Slough has been subject to various changes due to subsidence, dredging activity, and dynamic interaction of the Slough and Bay. Over time, sediment has filled in areas of the Slough and the vegetation has grown and thrived, thereby reducing the extent of open water in the Slough. In 2004, the SCVWD began planning to control vegetation in the Slough, develop long-term plans for providing public access, maintain flood protection, reduce mosquito nuisance, and integrate planning with the SBSPRP.

Lower Guadalupe River Flood Protection Project. This flood protection project was constructed to prepare the channels to handle storm water runoff in the event of a 100-year flood, protect endangered species, preserve fish and migratory bird habitat, and allow for open-space recreation. Beginning in 2003, SCVWD made flood protection improvements along 6.5 miles of the Guadalupe River from the I-880 bridge north to the Union Pacific Railroad bridge in Alviso.

San Francisquito Creek Restoration Project. The San Francisquito Creek Joint Powers Authority (SFCJPA) is a government agency formed in 1999 by the cities of Palo Alto, Menlo Park and East Palo Alto, and the SCVWD and San Mateo County Flood Control District. The SFCJPA implements projects that provide multiple communities flood protection, environmental, and recreational benefits, and it coordinates Creek maintenance and emergency preparedness and response communication. SFCJPA's first major capital project is moving forward with an expedited design and environmental review process to provide increased flood protection for the East Palo Alto and Palo Alto communities along the flood-prone reach of San Francisquito Creek downstream (east) of U.S. Highway 101.

The project is designed to improve stream flow from the downstream face of East Bayshore Road all the way to San Francisco Bay and reduce local flood risks during storm events, as well as provide the capacity needed for upstream flood protection projects being planned by the SFCJPA. It will also be designed to provide ecological enhancements for the endangered and other species that call this watershed home, and to allow for new and improved trails for residents and visitors along the Creek and near the Bay.

Increasing the Creek's flow capacity from San Francisco Bay to 101 will be achieved by widening the Creek channel within the reach to convey peak flows for 100-year storm events; removing an abandoned levee-type structure to allow flood flows from the Creek channel into the Palo Alto Baylands Preserve north of the Creek; and constructing an outlet structure for Caltrans' enlargement of the Highway 101/East Bayshore Road Bridge over San Francisquito Creek. At the time of this writing, the Project is currently in design phase.

Cumulative Effects on the Physical Environment

All the alternatives are anticipated to enhance or restore the natural physical environment of the Refuge to provide long-term benefits to native wildlife and vegetation. The projects mentioned above, such as the SBSPRP, will have the added benefit of providing additional habitat for native tidal marsh wildlife and vegetation. However, the Refuge is surrounded by a heavily urbanized area facing endless development pressures which could result in profound cumulative effects to the physical environment of the area. Any nearby developments (e.g., Cargill Redwood City Saltworks Plan), including residential or commercial projects, could have negative implications on the Refuge environment such as the introduction of invasive vegetation, nuisance wildlife, trash, and contaminants. Projects adjacent to the Refuge also increase human disturbance in the form of foot and vehicle traffic. The Refuge has little control over these external impacts, but has and will continue to work with partners during their planning process to protect and encourage the restoration of important native habitat.

Cumulative Effects on Biological Resources

All proposed alternatives would have long-term benefits for native wildlife species and habitats within the area. The alternatives integrate wildlife conservation activities with compatible wildlife-dependent opportunities that would represent a cumulative benefit for local wildlife, native plant communities, and human communities.

The conversion of neighboring ponds to tidal marsh, as mentioned in the previous projects, could also result in a positive cumulative effect to biological resources. The SBSPRP will restore tidal marsh and other wetlands in the South Bay, providing additional habitat to wildlife resources. These former Cargill salt ponds will provide extensive habitat for endangered species, special status species, migratory waterfowl and shorebirds, and fish and other aquatic species. The project will incorporate a broad, upland transition zone where feasible and may make use of the expansive, compacted former salt ponds for use as seasonal wetlands habitat. This project, along with the objectives described in the CCP, will result in a positive net benefit to the ecosystem by restoring natural habitat for endangered species and migratory birds. Increased tidal wetlands restoration prescribed for both the CCP and SBSPRP will also provide additional fish and invertebrate habitat for nursery and foraging. Enhancing vernal pool/upland grassland habitat in the CCP will benefit the VPTS and the CTS. The activities will cumulatively support the goals of the Refuge and the region in restoring and conserving wildlife resources.

Because the Refuge is surrounded by urban development, development projects have the high likelihood of reducing the added biological benefits that habitat restoration projects previously described will provide. Development projects surrounding the Refuge will potentially result in additional disturbance to wildlife resources and negative impacts to native habitats. It is likely that additional restoration activities will be needed to offset future loss of open space to commercial and residential developments.

Visitor activities prescribed in the alternatives and other public access opportunities such as The Bay Trail (administered by the Association of Bay Area Governments) and the San Francisco Bay Area Water Trail would result in increased visitation to the area in addition to those prescribed in the CCP. The increased visitor uses of hiking, bicycling, boating, guided tours, and environmental education programs combined would add more visits to the Refuge, which could result in increased disturbance to wildlife and degradation of habitat. This increased visitation would add to the total visitation to the area that is already being generated by the Bay Trail system. The Refuge will work with The Bay Trail and Water Trail staff as well other projects to mitigate any potential disturbance and avoid sensitive habitat areas on the Refuge.

In California, 38 refuges provide over 450,000 acres of habitat for wildlife. Eighteen of these refuges, including Don Edwards San Francisco Bay NWR, allow waterfowl hunting. Hunting on Refuge lands as well as hunting on neighboring California Department of Fish and Game lands is an existing activity that took place prior to the Refuge's establishment. The hunt season, type of waterfowl hunted, and hunt limits are regulated under State regulations. These regulations are designed to ensure that harvest does not reduce populations to unsustainable levels. Although hunting will result in direct loss of individuals, this activity is not expected to result in a population-level effect on any of the hunted species. Moreover, the amount of hunting on the Refuge under any of the alternatives is not expected to substantially increase. Any additional lands open to hunting would be negligible. Hunting would be enhanced through more interaction with hunters, improvements to existing hunt blinds, and additional hunt materials.

Cumulatively, visitor activities could potentially increase disturbance to wildlife and damage habitat. Some activities will be guided or supervised such as interpretive and environmental education programs. There are more than 750,000 visits to the Refuge each year. Under the CCP, it is expected that the increase in visitor opportunities will increase visits by 33 percent over 15 years. Because the Refuge already accommodates a large number of visitors, biological resources are not anticipated to be significantly affected by the increased visitation. Additional signage, closure of sensitive areas, and increased law enforcement would be required elements to provide prior to increased visitor access in order to prevent or reduce disturbance and degradation. Fencing as needed will be placed near sensitive sites to deter visitors from disturbing wildlife. Reduced or eliminated access for dog walking may result in reduced disturbance to habitat for wildlife in the Refuge area.

Cumulative Effects on Cultural Resources

In general, the Service adheres to the policies and regulations pertaining to the protection of cultural resources in order to avoid or mitigate for any significant adverse effects resulting from management activities. The actions in the CCP will continue to adhere to those policies and regulations. No adverse effects on cultural resources are anticipated from any of the alternatives or other local activities.

Cumulative Effects on the Social and Economic Environment

Permitting mosquito management activities are expected to result in a positive benefit to public health by reducing the threat of mosquito-borne viruses. Other action alternatives, particularly those involving expansion of wildlife-dependent recreation, interpretation, and environmental education, would provide benefits to the residents of the bay area. In addition, the environmental education and outreach programs would attempt to reach a diverse audience. Additional recreational opportunities in the form of fishing locations, interpretive opportunities, a photography blind, and hunting outreach will act in concert with the Bay Trail and Water Trail systems. Reduced or eliminated access for dog walking may increase recreation pressure on nearby dog walking areas (e.g., Coyote Hills Regional Park).

Tourism dollars could be generated from the increased recreation opportunities. Local restaurants, stores, lodging, and gas stations could benefit under any of the alternatives. Contract work may benefit the local economy, particularly grazing and haying activities contracted to a local farmer or rancher.

Table 8. Summary Impacts of Alternatives

	No Action	Alternative B: **Moderate increase in wildlife management, habitat management, visitor services, and environmental education programs**	Alternative C: **Substantial increase in wildlife management, habitat management, visitor services, and environmental education**
Physical Environment			
Hydrology	Changing hydrological patterns from tidal restoration projects and mosquito management likely to result in short-term erosion and sedimentation, but long-term improved tidal connectivity	Additional tidal restoration and enhancements resulting in additional hydrological benefits	Same as Alternative B
Water Quality/Contaminants	Tidal restoration projects likely to result in temporary increases in turbidity and potential release of embedded contaminants, but long-term benefits such as regular tidal exchange	Additional tidal restoration and habitat creation may result in temporary increases in turbidity as well as potential release of embedded contaminants	Same as Alternative B
Soils and Topography	Erosion from tidal restoration activities, but with long-term sedimentation benefits	Increased erosion due to additional restoration and construction activities, but with long-term sedimentation benefits	Same as Alternative B
Air Quality/Climate	Minor impacts from restoration activities including temporary	Increased minor impacts from additional restoration activities;	Same as Alternative B

	localized dust and vehicle emissions	increased tailpipe emissions from increased visitors	
Hazardous Materials/Safety	No adverse effects from continued use of herbicides and mosquito pesticides, all herbicides and pesticides must go through the Service approval process	Same as Alternative A; positive benefit from increased law enforcement and informational signage	Same as Alternative B
Biological Environment			
Vegetation	Conversion of managed ponds and diked wetlands to tidal habitat; beneficial impact to native plant communities	Additional beneficial improvements to native plant communities; positive impact from tidal enhancements and restoration of ecotone; minor impact due to public use and environmental education activities	Same as Alternative B
Wildlife	Minor loss of habitat for upland species; beneficial impacts to tidal marsh species; minor disturbance due to mosquito management activities; minor disturbance and waterfowl mortality from hunting	Same as Alternative A; improved surveying and monitoring of species; increased weed control, habitat restoration, and enhancement will benefit wildlife; minor impact due to wildlife-oriented activities	Same as Alternative B; beneficial impacts from additional weed control, habitat restoration, and enhancements; minor impact due to public use and environmental education activities
Fish and Marine Invertebrates	Minor impact due to tidal restoration and mortality from fishing; no population-level effect on species; beneficial impact due to increased habitat restored	Same as Alternative A; increased fishing mortality but no population-level effect; beneficial impact from increased habitat restored	Same as Alternative B
Endangered Species	Beneficial impacts due to habitat restoration; minor disturbance due to mosquito management activities; minor disturbance due to habitat and tidal restoration	Same as Alternative A; improved inventory and monitoring of species, minor impact due to wildlife-oriented activities	Same as Alternative B
Social and Economic Environment			
Recreation	Beneficial impact due to recreational opportunities	Beneficial impact due to additional recreational opportunities	Same as Alternative B
Economy	No negative effects	Minor beneficial impact	Same as Alternative B

	identified	due to increased staffing and contract needs, and increased visitation to area due to recreational activities	
Climate Change	Beneficial impact through additional carbon sequestration through tidal marsh restoration; improved energy efficiency in facilities and vehicle fleet	Beneficial impact through further tidal marsh restoration, LEED certification of EEC and headquarters, and bus stops to facilitate public transit	Same as Alternative B
Cultural Resources	Ground disturbing activities from tidal marsh restoration and enhancements may result in impacts to cultural resources	Same as Alternative A	Same as Alternative A
Environmental Justice	No impacts anticipated	Same as Alternative A	Same as Alternative A

Chapter 5. List of Planning Team Members and Persons Responsible for Preparing this Document

Eric Mruz	Refuge Manager, Don Edwards San Francisco Bay NWR
Melisa Helton	Wildlife Refuge Specialist, Don Edwards San Francisco Bay NWR
Winnie Chan	Refuge Planner, San Francisco Bay NWR Complex
Jennifer Heroux	Visitor Services Chief, San Francisco Bay NWR Complex
Cheryl Strong	Wildlife Biologist, Don Edwards San Francisco Bay NWR
Ivette Loredo	Wildlife Refuge Specialist, Don Edwards San Francisco Bay NWR
Rachel Tertes	Wildlife Biologist, Don Edwards San Francisco Bay NWR

Chapter 6. Coordination, Consultation, and Compliance

Agency Coordination and Public Involvement

The draft CCP and EA were prepared with the involvement of technical experts, community groups, and private citizens. The Service has invited and continues to encourage public participation through planning updates and public comment periods.

Notice of Intent

A Notice of Intent to prepare a CCP and EA for Don Edwards San Francisco Bay NWR was published in the *Federal Register* on July 26, 2006.

Environmental Review and Consultation

As a Federal agency, the Service must comply with provisions of NEPA. An EA was developed to evaluate reasonable alternatives that would meet stated goals and assess the possible environmental, social, and economic impacts on the human environment. This EA serves as the basis for determining whether implementation of the preferred alternative would result in a Federal action significantly affecting the quality of the environment. The EA also acts as a vehicle for consultation with other government agencies and interface with the public in the decision-making process.

Other Federal Laws, Regulations, and Executive Orders

In undertaking the preferred alternative, the Service would comply with the following Federal laws, Executive Orders (EOs), and legislative acts: Intergovernmental Review of Federal Programs (EO 12372); Archaeological Resources Protection Act of 1979, as amended; Fish and Wildlife Act of 1956; Fish and Wildlife Conservation Act of 1980 (16 USC 661-667e); Fish and Wildlife Improvement Act of 1978; Endangered Species Act of 1973 (16 USC 1531 et seq.); National Environmental Policy Act of 1969; Federal Noxious Weed Act of 1990; Floodplain Management (EO 11988); Protection of Wetlands (11990); National Historic Preservation Act of 1966, as amended; National Wildlife Refuge System Improvement Act of 1997; Antiquities Act of 1906; Protection and Enhancement of the Cultural Environment (EO 11593); Archaeological and Historic Preservation Act of 1974 (PL 93-291; 88 STAT 174; 16 USC 469); Environmental Justice (EO 12898); Management and General Public Use of the National Wildlife Refuge System (EO 12996); Refuge Recreation Act of 1962, as amended; Invasive Species (EO 13112); Migratory Bird Treaty Act of 1918, as amended (MBTA); and Responsibilities of Federal Agencies to Protect Migratory Birds (EO 13186).

Distribution and Availability

The draft CCP and EA has been sent to various agencies, organizations, community groups, and individuals for review and comment. Copies of this EA are available from the Don Edwards San Francisco Bay NWR, 7715 Lakeville Highway, Petaluma, CA, 94954 (phone 707/769 4200), and San Francisco Bay National Wildlife Refuge Complex, 1 Marshlands Road, Fremont, CA, 94536 (phone 510/792 0222).

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Appendix A. Regional Economic Impacts of Current and Proposed Management Alternatives for Don Edwards San Francisco Bay National Wildlife Refuge

San Francisco National Wildlife Refuge

Description

The Don Edwards San Francisco Bay National Wildlife Refuge was established in 1972 to preserve and protect critical habitat and associated wildlife, to aid migratory waterfowl, and to provide an opportunity for wildlife-oriented recreation and nature study. The refuge currently encompasses 19,000 acres in San Mateo, Alameda, and Santa Clara counties at the southern end of San Francisco Bay in northern California. It is surrounded by an urban population of over 7 million people, making it the largest urban wildlife refuge in the world. The refuge has an extensive environmental education outreach, with a variety of programs geared toward school children, teacher education, and the general public.

The refuge is comprised of a variety of habitats including mudflats, salt marshes, open water, and salt ponds. This range of habitat supports a large variety of wildlife including five endangered species. The refuge provides major habitat for the endangered California clapper rail and salt- marsh harvest mouse. San Francisco Bay is a key wintering area for diving ducks along the Pacific Flyway; the south bay is used primarily by scaup, surf scoters, and ruddy ducks. The south bay wetlands support hundreds of thousands of shorebirds along with the largest wading-bird rookery in San Francisco Bay.

The refuge has a visitor center at its administrative headquarters in the city of Fremont, and an environmental education center in Alviso on the southeastern edge of the refuge. Boating is a popular activity on the Bay, and a number of launch facilities are adjacent to the refuge. Hiking trails are numerous throughout the refuge. Wildlife observation, fishing, and waterfowl hunting are popular activities.

Area Economy

San Francisco NWR is located at the southern end of San Francisco Bay in northern California. Table 8-16 shows the area economy. The area population increased by 5.6 percent from 1995 to 2005, compared with a 14.1 percent increase for the state of California and a 11.4 percent increase for the U.S. as a whole. Area employment increased by 7.7 percent from 1995 to 2005, with the state of California showing a 20.5 percent increase and the U.S. a 17.0 percent increase. Area per capita income increased by 25.9 percent over the 1995-2005 period, while the state of California and the U.S. increased by 15.8 and 13.2 percent respectively.

Table 8-16. San Francisco NWR:
Summary of Area Economy, 2005
(Population & Employment in 000's; Per Capita Income in 2006 dollars)

	Population		Employment		Per Capita Income	
County	2005	Percent change 1995-2005	2005	Percent change 1995-2005	2005	Percent change 1995-2005
Alameda CA	1,451.1	7.8%	896.0	12.8%	$42,956	22.9%
Santa Clara CA	1,705	7.9%	1,117.2	5.0%	$51,112	22.0%
San Mateo CA	701.2	3.2%	462.5	12.8%	$59,213	25.8%
San Francisco CA	741.0	-0.7%	698.6	2.9%	$62,614	31.6%
Area Total	**4,598.4**	**5.6%**	**3,174.3**	**7.7%**	**$53,974**	**25.9%**
California	36,154.1	14.1%	20,548.6	20.5%	$36,936	15.8%
United States	266,278.4	11.4 %	174,249.6	17.0 %	$34,471	13.2 %

Source: U.S. Department of Commerce 2007.

Activity Levels

Table 8-17 shows the recreation visits for San Francisco NWR. The Refuge had 1,505,410 visits in 2006. Non-consumptive recreation accounted for 1,497,911 visits, hunting 3,800 and fishing 3,700 visits. Residents accounted for 1,279,547 visits, or 85 percent of Refuge visits.

Table 8-17. San Francisco NWR: 2006 Recreation Visits

Activity	Residents	Non-Residents	Total
Non-Consumptive:			
Nature Trails	636,612	112,343	748,955
Observation Platforms	0	0	0
Birding	572,951	101,109	674,060
Other Wildlife Observation	63,661	11,234	74,896
Beach /Water Use	0	0	0
Other Recreation	0	0	0
Hunting:			
Big Game	0	0	0
Small Game	0	0	0
Migratory Birds	2,660	1,140	3,800
Fishing:			
Freshwater	0	0	0
Saltwater	3,663	37	3,700
Total Visitation	***1,279,547***	***225,864***	***1,505,410***

Regional Economic Analysis

The economic area for the Refuge is comprised of the following California counties: Alameda, Santa Clara, San Mateo, and San Francisco. It is assumed that visitor expenditures occur primarily within this area. Visitor recreation expenditures for 2006 are shown in Table 8-18. Total expenditures were $16.0 million with residents accounting for 9.7 million or 61 percent of total expenditures. Expenditures on non-consumptive activities accounted for 98percent of all expenditures, followed by hunting and fishing at 2 and less than 1 percent respectively.

Table 8-19 summarizes the local economic effects associated with recreation visits. Final demand totaled $15.1 million with associated employment of 196 jobs, $8.3 million in employment income and $3.8 million in total tax revenue.

Table 8-18. San Francisco NWR: Visitor Recreation Expenditures (2006 $,000)

Activity	Residents	Non-Residents	Total
Non-Consumptive:			
Birding	$4,281.5	$2,754.4	$7,035.9
Other Non-Consumptive	$5,233.0	$3,366.5	$8,599.4
Total Non-Consumptive	$9,514.5	$6,120.8	$15,635.3
Hunting:			
Big Game	—	—	—
Small Game	—	—	—
Migratory Birds	$99.4	$147.7	$247.0
Total Hunting	$99.4	$147.7	$247.0
Fishing:			
Freshwater	—	—	—
Saltwater	$123.9	$4.1	$128.0
Total Fishing	$123.9	$4.1	$128.0
Total Expenditures	***$9,737.7***	***$6,272.7***	***$16,010.4***

Table 8-19. San Francisco NWR: Local Economic Effects Associated with Recreation Visits (2006 $,000)

	Residents	Non-Residents	Total
Final Demand	$15,083.4	$9,712.5	$24,795.9
Jobs	123	73	196
Job Income	$5,071.3	$3,226.2	$8,297.5
Total Tax Revenue	$2,324.3	$1,505.4	$3,829.7

Table 8-20 shows total economic effects (total recreation expenditures plus net economic value) compared with the refuge budget for 2006. For an individual, net economic value is that person's total willingness to pay for a particular recreation activity minus his or her actual expenditures for that activity. The figure for economic value is derived by multiplying net economic values for hunting, fishing, and non-consumptive recreation use (on a per-day basis) by estimated refuge visitor days for that activity. This figure is combined with the estimate of total expenditures and divided by the refuge budget for 2006. The $43.55 means that for every $1 of budget expenditures, $43.55 of total economic effects are associated with these budget expenditures. This ratio is provided only for the purpose of broadly comparing the magnitude of economic effects resulting from refuge visitation to budget expenditures and should not be interpreted as a benefit-cost ratio.

Table 8-20. San Francisco NWR: Summary of Local Economic Effects of Recreation Visits (2006 $,000)

	FY 2006 Budget	Expenditures	Economic Value	Total economic effects per $1 budget expenditure
San Francisco NWR	$763.0	$16,010.4	$17,221.7	$43.55

Appendix C. Compatibility Determinations

Compatibility determinations are available for:

- Research and Monitoring
- Livestock Grazing
- Mosquito Management Plan
- Wildlife Observation and Photography
- Environmental Education and Interpretation
- Waterfowl Hunting
- Recreational Boating
- Recreational Fishing

Compatibility Determination for Research and Monitoring
Don Edwards San Francisco Bay NWR

Use: Research and Monitoring

Refuge Name: Don Edwards San Francisco Bay National Wildlife Refuge, Alameda, Santa Clara and San Mateo Counties, California.

Establishing and Acquisition Authorities:
86 Stat. 399, dated June 30, 1972

An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes (16 U.S.C. 667b)

Endangered Species Act of 1973 (16 U.S.C. 1534)

Fish and Wildlife Act of 1956 (16 U.S.C. 742f)

Refuge Purpose(s):
"... for the preservation and enhancement of highly significant wildlife habitat ... for the protection of migratory waterfowl and other wildlife, including species known to be threatened with extinction, and to provide an opportunity for wildlife-oriented recreation and nature study ..." (86 Stat. 399, dated June 30, 1972).

"... particular value in carrying out the national migratory bird management program" 16 U.S.C. 667b (An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes).

"... 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).

"... 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).

National Wildlife Refuge System Mission: The mission of the National Wildlife Refuge 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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-668ee]).

Description of Use: This compatibility determination is done as a review of the existing compatibility determination (1994) for research and monitoring, and in concert with the Don Edwards San Francisco Bay NWR Comprehensive Conservation Plan. This compatibility determination replaces the previous 1994 compatibility determination for research and monitoring.

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.

The Refuge receives numerous requests each year to conduct scientific research. The Refuge issues Special Use Permits (SUP) for approved research and monitoring projects. SUPs are only 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 refuge manager to formally authorize any project.

Specific rules for research at the vernal pools that are located at the Warm Springs sub-unit of the Refuge are:

- Research related to vernal pool vegetation/phylogeny and habitat characteristics
- Basic research on vernal pool invertebrates and their habitat requirements
- Research on California tiger salamanders
- Research on the effects of grazing on vernal pool habitat and native vegetation
- Restoration science research

Examples of specific research and monitoring being conducted by non-Refuge staff as listed in the draft CCP include the following:

Salt Marsh Harvest Mouse
Research on the feasibility and ease of the restoration of high tide refugia for salt marsh harvest mice and clapper rails is happening on the Refuge around the levees of the newly tidal Pond A6. Aerial seeding and subsequent monitoring will begin in fall 2011.

Migratory Bird Surveys
As part of the South Bay Salt Pond Restoration Project, the Refuge is partnering with San Jose State University, SFBBO, and USGS to: 1) study waterbird response to trail use along new and existing trails in the South Bay; 2) determine the impacts of California gulls to nesting waterbirds including the snowy plover; 3) determine the carrying capacity of mudflats and ponds for foraging by shorebirds; and 4) determine the importance of islands for roosting waterbirds. Biofilm (microbes growing on the surface of the mudflats and potentially important for shorebird diet) is also being researched in South Bay mudflats in order to determine importance and distribution.

Other Research Projects
A number of other research projects occur on the Refuge in support of the SBSPRP or in support of other management goals. These projects include the following.

- Radio telemetry of harbor seals (*Phoca vitulina*) and determination of selenium contamination in the fur of harbor seals (Moss Landing Marine Lab)
- Distribution and abundance of western pond turtles (*Clemmys marmorata*) in the Moffett channel (NASA-Ames)
- Assessing mercury levels and its impacts to wildlife in SBSPRP ponds (USGS, U.C. Davis, San Francisco Estuary Institute)
- Sediment dynamics: accretion in natural and restored wetlands of south San Francisco Bay (University of San Francisco); interaction between bay and marsh waters (Stanford); analyzing and predicting sediment transport in newly restored ponds (Stanford); and sediment accretion and carbon sequestration (USGS)

In addition, a few projects happen on the highly saline ponds located on the Refuge due to the unique landscape they provide: a study of the haloviruses of the hypersaline waters in California (U. C. Santa Cruz) and high salinity methane sampling (NASA).

In evaluating research proposals submitted to the Refuge, priority would be given to research that contributes to the enhancement, protection, preservation and management of migratory birds, listed species, habitat and wildlife on the Refuge. Research proposals are reviewed by Refuge staff and conservation partners, as appropriate. If the proposal is approved, a Refuge SUP would be issued by the Refuge manager or biologist.

Research proposals would be assessed based on criteria including, but not limited to:

- Research and monitoring that will contribute to specific Refuge management challenges, CCP goals, or purposes for which the Refuge was established will be encouraged;
- Research and monitoring must be designed to minimize disturbance to the wildlife and habitat on the Refuge as well as the surrounding human environment;
- Research and monitoring that will not conflict with other ongoing research, monitoring, or management programs;
- Research that can be accomplished off-Refuge is less likely to be approved;
- Research which causes exceptional disturbance to wildlife or undue habitat degradation will not be granted;
- If staffing or logistics make it impossible for the Refuge to monitor research activity in a sensitive areas, proposal will not be granted; and
- Research would not be allowed to be conducted open-ended, but will be reviewed annually.

Availability of Resources: Some staff time would be required to review research requests and manage research activities. However, refuge staff would not be expected to commit weekly staff time to managing this use. Oversight and review of proposals, study plans, and reports require an estimated $10,000 in staff time. There is currently sufficient Refuge staffing to meet this estimated cost. Approving proposals will be based upon available staff to monitor the research. If there are not sufficient staff resources to monitor a specific proposed research project, it will not be approved. Other than staff time, no special equipment, facilities, or improvements are necessary to support this proposed use. Some equipment (e.g. kayaks, paddles) is loaned out on a case-by-case basis in support of research projects.

Item	One-time Cost	On-going Cost
Review of Proposals/Issuance of SUPs	$0	$4,000.00
Monitoring of SUPs	$0	$6,000.00
Total	**$0**	**$10,000.00**

Anticipated Impacts: Conducting research activities at the Refuge can result in gaining information that benefits to management of habitat and wildlife populations. Monitoring of wildlife and habitat on the Refuge would provide feedback on the effectiveness of activities taking place allowing adaption of, and improvement of management activities. Some level of disturbance is expected from this use because they could occur in sensitive areas and may involve collecting samples or handling wildlife. Researcher disturbance would include altering wildlife behavior, going off designated trails, collecting soil and plant samples. Most of these effects would be short-term because only the minimum of samples required for identification and/or experimentation and statistical analysis would be permitted. Captured and marked wildlife would be released. Sensitive periods, such as nesting season, will be avoided when possible. Individual animals may be temporarily flushed from their habitat during such monitoring. In addition, native vegetation, rare plants and newly planted native seedlings may be trampled. Non-native plants may also be introduced through researchers' clothing, footwear, and equipment.

Overall, proper review and approval of appropriate research proposals should result in limited disturbance to wildlife and habitat, while resulting in maximum benefit to refuge management and scientific data on the San Francisco Bay Area ecosystem.

Public Review and Comment:
Public review and comments were solicited in conjunction with distribution of the Draft CCP/EA for Don Edwards San Francisco Bay NWR, released in May 2012. No comments were made directly in regard to this compatibility determination.

Determination:

_____ Use is Not Compatible

___X___ Use is Compatible with Stipulations

The following stipulations are required to ensure compatibility: Research and monitoring proposals would be assessed for approval based on criteria including, but not limited to:

- Research that will contribute to Refuge purposes and the National Wildlife Refuge System mission.
- Research will contribute to specific Refuge management challenges and/or CCP goals.
- Research must be designed to minimize disturbance to the wildlife and habitat on the Refuge as well as the surrounding human environment;
- Research that will not conflict with other ongoing research, monitoring, or management programs/operations;
- Research that can be accomplished off-Refuge with less impact on wildlife is less likely to be approved;
- Research which causes exceptional disturbance to wildlife or undue habitat degradation will not be granted;

- If staffing or logistics make it impossible for the Refuge to monitor research activity in a sensitive areas, proposal will not be granted; and
- Research would not be allowed to be conducted open-ended and will be reviewed annually.
- All researchers will be required to engage in procedures that will limit transport of non-native species onto the Refuge (e.g., cleaning shoes and clothing prior and after entry on Refuge lands, vehicle tire checks prior to entry onto Refuge lands).
- Some research will be subject to a Section 7 and/or Section 10 consultation of the Endangered Species Act, as appropriate.
- Stipulations that typically apply to Warm Springs researchers:
    - Researchers are required to drive along the gravel roads or walk. No off-road motorized vehicle use is permitted within Warm Springs.
    - Researchers are required to provide 48-hours' notice to the Warm Springs manager before accessing Warm Springs.
    - Upon entering gated areas, each gate must be immediately closed and locked
    - Extreme care will be taken to avoid or minimize stepping on vernal pool vegetation.

Justification: Research and monitoring are needed to understand both positive and negative impacts of management activities on the Refuge as well as improve the understanding of the San Francisco Bay Area ecosystem. Results of monitoring and research provide the information needed to adjust management activities to lessen their impact on Refuge resources and/or improve activities to better achieve management objectives. Though research and monitoring can have negative impacts on wildlife and habitat, following the listed stipulations will result in only minimally invasive work being approved on the Refuge. Often research can be accomplished at substantial cost savings to the Refuge. After assessing the potential impacts from the uses proposed for the Refuge, we have found that allowing these uses would not materially interfere with or detract from the purposes for which the Refuge was established or the mission of the National Wildlife Refuge System.

Mandatory Reevaluation Date (provide month and year):

_____ Mandatory 15-Year Reevaluation Date (for priority public uses)

___X___ Mandatory 10-Year Reevaluation Date (for all uses other than priority public uses)

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

Conducted with Comprehensive Conservation Plan

_____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

Refuge Determination

Prepared by:	(Signature)	9/24/12 (Date)
Refuge Manager:	(Signature)	9/26/12 (Date)
Project Leader Approval:	(Signature)	9-26-2012 (Date)
Concurrence Refuge Supervisor	(Signature)	10/1/2012 (Date)
Assistant Regional Director, Refuges	(Signature)	10/1/2012 (Date)

Compatibility Determination for Livestock Grazing
Don Edwards San Francisco Bay NWR

Use: Livestock Grazing

Refuge Name: Don Edwards San Francisco Bay National Wildlife Refuge, Alameda, Santa Clara and San Mateo Counties, California.

Date Established: June 30, 1972

Establishing and Acquisition Authorities:
86 Stat. 399, dated June 30, 1972

An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes (16 U.S.C. 667b)

Endangered Species Act of 1973 (16 U.S.C. 1534)

Fish and Wildlife Act of 1956 (16 U.S.C. 742f)

Refuge Purpose(s):
"... for the preservation and enhancement of highly significant wildlife habitat ... for the protection of migratory waterfowl and other wildlife, including species known to be threatened with extinction, and to provide an opportunity for wildlife-oriented recreation and nature study ..." (86 Stat. 399, dated June 30, 1972).

"... particular value in carrying out the national migratory bird management program" 16 U.S.C. 667b (An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes).

"... 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).

"... 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).

National Wildlife Refuge System Mission: The mission of the National Wildlife Refuge 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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-668ee]).

Description of Use: This compatibility determination is done as a review of the existing compatibility determination (2004) for grazing and in concert with the Don Edwards San Francisco Bay NWR Comprehensive Conservation Plan. This compatibility determination replaces the previous 2004 compatibility determination for grazing, described as follows.

Cattle grazing currently occurs at the Warm Springs Sub-Unit and has occurred there throughout much of the 20th century. However, upon acquisition of Warm Springs in 1992, the Refuge ceased all grazing practices in the absence of a formal management plan. Over the next ten years, non-native annual grasses accumulated in vernal pools, significantly altering plant community dynamics and wildlife habitat. Observations by Refuge staff revealed an apparent decline in abundance of native vernal pool plants and wildlife after suspension of grazing. These negative trends were consistent with available information from other vernal pool ecosystems that have experienced a sudden cessation of grazing. After extensive literature review and consultation with rangeland and vernal pool experts, the Refuge began the process to re-introduce grazing to Warm Springs.

In 2004, cattle grazing was reintroduced to the site and biological monitoring was expanded. The herd grew slowly each year as new pastures were added to the program, from 20 cows in 2004 to 105 cows in 2010. Grazing occurs year-round at Warm Springs, in that cows will remain in at least three pastures throughout the year and will not be moved off-site. Currently, there is a large herd of spring-calving cows, a smaller herd of fall-calving cows, and one or more small groups of heifers/steers (young animals). Additional pastures on adjacent lands, formerly known as the Pacific Commons Preserve, became part of the Refuge in 2008. The entire area is now known as Warm Springs. The Refuge is expected to begin management of the former Pacific Commons Preserve lands in 2012. Cows will be kept in several small herds and will be rotated seasonally throughout ten different refuge pastures, totaling approximately 700 acres. Pastures are separated with barbed wire fencing and are between 20 and 100 acres in size, allowing for a more uniform distribution of grazing pressure throughout Warm Springs.

Since the original goals were established in 2004, the Refuge has acquired over 440 acres of restored vernal pool habitat (the former Pacific Commons Preserve). This acreage supports native vegetation but has higher cover of weeds than the original Warm Springs Unit. In addition, we have gained knowledge of the system through extensive monitoring of vegetation and sensitive species as well as the effects of grazing. Finally, we are more aware of the logistic limitations of monitoring. Consequently, the goals of the program have been revised to the following (as discussed in this CCP):

1) Over the next five years, reduce biomass of residual dry matter (RDM) to 1000-1200 pounds/acre over each of the Warm Springs subunits in order to improve germination conditions for native plant species and enhance vernal pool hydrologic function.
2) Over the next ten years, increase cover of native upland plants and native vernal pool forbs on Warm Springs by 10%.
3) Over the next fifteen years, reduce the cover of invasive plants on Warm Springs (excluding non-native annual grasses) to less than 20%.

Cattle grazing is a refuge management economic activity. The grazing program at Warm Springs is conducted through a Cooperative Land Management Agreement with a local rancher. In exchange for grazing rights on the land, the cooperator currently provides, and will continue to provide, the Refuge with services-in-kind equivalent to 100% of the value of the grazing land. The value of an Animal Unit Month (AUM) was determined in conjunction with a University of California Extension Grazing Advisor based on comparable grazing fees in the local area. One Animal Unit equals the dry forage consumption of a 1000-pound animal, or one mature cow with or without calf, assumed to average 30 pounds per day. In-kind services typically include herbicide spraying, fence repair, and road repair. Grazing fees will be re-examined every five years with the

renewal of the Cooperative Land Management Agreement.

Prior to the beginning of the grazing season (October 1st), the Warm Springs manager will meet with the grazer to develop a grazing plan for the year. A general timeframe for grazing rotations will be determined, but the timing for moving cattle on and off the different Warm Springs pastures will not be tied to specific dates. Instead, there will be flexibility in the plan to allow for the variable response of vegetation to annual rainfall and temperature conditions and ensure that no pastures are over or undergrazed. Additionally, the stocking rate (the number of animals grazing a unit for a specific time) will continue to vary from year to year, depending on annual precipitation. Because the program was purposely begun with a small herd and a conservative stocking rate, it is only in the last year or two that the stocking rate has approached target levels. The grazer will have some flexibility in increasing or decreasing stocking rates by deciding how many cows to sell each year. During drought years, for example, more cows would be sold than during normal or above-average rainfall years.

Target stocking rates were initially developed for each pasture based on using 75% of the estimated grazing carrying capacity of a favorable year (Natural Resources Conservation Service (NRCS) estimates using soil types). However, it was determined that actual forage production at Warm Springs is much higher than the NRCS estimates (WRA 2010). Actual forage production was calculated for each pasture using RDM measurements (residual dry matter samples - the amount of old plant material left on the ground at the beginning of a new growing season) and grazing data (estimated forage intake by cattle can be calculated using known stocking rates). The initial NRCS target stocking rates were resulting in RDM levels substantially above the RDM targets. Therefore, the proposed modified target stocking numbers will be equal to 100% of the estimated carrying capacity for a favorable year. The Refuge will continue to monitor RDM and refuge resources and make changes to target stocking rates as needed.

In order to closely monitor the grazing program and other Refuge management, extensive hydrological and biological monitoring will continue to occur annually on Warm Springs. Aquatic dip-net surveys are conducted in the winter to document habitat use by vernal pool fairy shrimp (*Branchinecta lindahli*), endangered vernal pool tadpole shrimp (*Lepidurus packardi*), and threatened California tiger salamanders (*Ambystoma californiense*). Pool inundation times and maximum depths are recorded. In the spring, vernal pool vegetation data are collected using aerial cover classes in large plots. In addition, a grazing exclosure experiment was established in 2002, prior to the initiation of grazing, and this survey provides the most valuable information on the effects of grazing on vernal pool vegetation. Refuge staff set up four paired plots within vernal pools in a grazed pasture. In each pair, one plot was randomly selected to be fenced to exclude cattle and one was left open. Plots are situated a few meters from each other within the same vernal pool and are monitored during peak bloom. Later in the spring vegetation data is collected from upland portions of the Refuge, and invasive species data is collected in the summer. Permanent photo points are set up in each pasture and are photographed twice a year, in March/April and October. Finally, the monitoring season ends with collection of RDM samples in late September or early October.

Changes to the grazing program (compared to those described in the 2004 compatibility determination) will be minimal and consist of opening up one previously ungrazed pasture, adjusting the stocking rate to reflect actual forage production, and allowing cattle to graze year-round. The 2008 acquisition of the former Pacific Commons Preserve has expanded the grazed Refuge acreage from approximately 200 acres to approximately 700 acres, giving the Warm

Springs manager and the cooperative grazer more flexibility in adjusting cattle rotations and stocking rates.

Availability of Resources: Funding and staffing exists to manage the grazing program. Since the grazing of livestock is conducted under a Cooperative Land Management Agreement, a rancher provides the livestock and maintains the infrastructure at no cost to the Refuge in exchange for the right to graze on Warm Springs. The cost to the Refuge for the grazing program is oversight and monitoring of the grazing to minimize any potential negative impacts and achieve the Refuge goals. All costs for monitoring and oversight of the grazing program, including salaries of Refuge staff, is funded through a permanent endowment that was established as part of a mitigation program. Funds are not taken out of the annual Refuge budget.

Item	Annual Costs
Wildlife Refuge Specialist GS-0485-11 (0.2 FTE)	$18,200.00
Botanist GS-404-7/9 (0.3 FTE)	$19,350.00
Monitoring equipment/supplies/special projects	$500.00
TOTAL	**$37,550.00**

Anticipated Impacts:
Grazing at Warm Springs has improved vernal pool habitat, contributing to a reduction in non-native vegetation, particularly annual grasses, and an increase in native vegetation over ungrazed areas (WRA 2011, FWS 2010, pers. Comm., Ivette Loredo, Warm Springs Manager, 2011). In 2011, the effects of the grazing program were comprehensively analyzed using years of collected biological monitoring data to determine if grazing was meeting/approaching the initial goals set out in the program (WRA 2011). These original goals were (USFWS 2004):

1) Over the next ten years, reduce biomass of RDM to 200-500 pounds per acre in vernal pools and 800-1000 pounds per acre in uplands.
2) Increase vernal pool surface area, depth, and inundation time by 10-25% over the next ten years
3) Increase the cover of native vernal pool and upland plants by 15%.
4) Reduce the cover of invasive species to less than 10 % cover over the next ten years.
5) Establish short grass prairie habitat throughout the upland areas of Warm Springs to provide habitat that supports more than 5 pairs of burrowing owls within ten years.

Although it has only been six full years of monitoring since grazing has been reintroduced, the results of the grazing analysis support that grazing at Warm Springs has contributed to the achievement of the program's ten-year goals (WRA 2011). Grazing has substantially reduced RDM, increased native species cover, and maintained Contra Costa goldfield (CCG) populations and low invasive species cover. Although the target 15% increase for CCG cover was not met, grazing did succeed in maintaining CCG cover, while in the ungrazed plots, its cover approached and often fell to zero. Invasive species cover has been maintained below the Goal 4 target of 10% through a combination of grazing and invasive plant control efforts.

Grazing is expected to continue to result in beneficial effects to native vegetation. Primary benefits associated with the grazing program include a reduction in the accumulation of dead plant material.

This residual dry matter, or RDM, is measured annually at the end of the growing season to assist in monitoring the grazing program. High RDM values, which consist primarily of non-native annual grasses, have been associated with reduced native plant diversity in vernal pools (Barry 1998). By preferentially consuming the taller, more palatable non-native grasses, cattle effectively increase light and nutrient availability for the native forbs during a key stage in their development. RDM measurements at Warm Springs have gone from approximately 5,000-6,000 pounds per acre in the absence of grazing to approximately 1,250-3,000 pounds per acre in 2009 and 2010 (the last two years of data). Although target RDM levels have not quite been reached, RDM is substantially lower in the grazed pastures and is approaching target levels. Further reductions in RDM levels are expected by adjusting stocking rate slightly higher, by approximately 5-8% (WRA 2011).

It is expected that the grazing program is improving habitat for the endangered vernal pool tadpole shrimp (VPTS) and the threatened California tiger salamander (CTS) by increasing maximum pool depths and inundation times. However, the effect of grazing on pool depths and inundation times is very difficult to measure due to the overwhelming influence of annual rainfall amounts and patterns on these variables. Accordingly, at Warm Springs, this annual climatic variation and the high variation among the pools themselves in size and depth made it impossible to determine whether grazing has had an effect on pond depth or duration (WRA 2011). Because of the inherent difficulty in measuring this effect, it has been eliminated as a measurable goal for the grazing program. However, the effect has been documented elsewhere and is expected to occur at Warm Springs. In a published study using a controlled large-scale experimental design, it was demonstrated that year round grazing in vernal pools increased pool inundation times and aquatic invertebrate diversity when compared to seasonal grazing or complete rest from grazing (Marty 2005). Due to their high productivity, non-native annual grasses produce heightened levels of plant biomass along vernal pool edges as compared to native vernal pool species. As it accumulates, this organic matter decreases the net amount of water available for native species by increasing evapotranspiration rates, resulting in an overall reduction in pool inundation period (Bremer et al. 2001, Frank 2003). By consuming the organic matter before it accumulates, cattle minimize these negative impacts of non-native annual grasses (Barry 1998, Robins and Vollmar 2001). At Warm Springs, pool inundation time has been the most reliable indicator of which pools will support VPTS and CTS because these species need a minimum amount of time (several weeks to several months) to complete their aquatic life stage. Marty (2005) hypothesizes that increased inundation time was the reason grazed pools had higher invertebrate diversity at her study site.

The potential negative effects of grazing on VPTS and CTS are generally the result of over-grazing and include excessive trampling in vernal pools, increased nitrogen addition to pools, and the potential for cattle to cause pools to dry early by drinking from them. These effects have been hypothesized or observed in overgrazed study sites but most researchers and land managers currently agree that some level of grazing is important for maintaining ecosystem health within vernal pools (Robins and Vollmar 2001). Grazing generally is compatible with the continued use of rangelands by the CTS as long as best management practices are followed, intensive burrowing rodent control programs are not implemented in these areas, and grazing is not excessive (USFWS 2009, Shaffer et al. 1993). At Warm Springs, the grazing program has been carefully managed to avoid over-grazing. The installation of 16 water troughs, placed in upland areas throughout Warm Springs, has been successful in preventing cattle from using pools as water sources (I. Loredo, pers. comm., 2011). Also, there is no evidence that grazing has negatively affected populations of VPTS or CTS at Warm Springs. In fact, since annual aquatic dip-net surveys began in 1999, the two best years for VPTS were in 2010 and 2011 and for CTS were in 2008 and 2010 (USFWS 2011, USFWS 2010), long after the initiation of grazing.

Prior to the reintroduction of grazing, there was concern that grazing could negatively impact vernal pool vegetation, particularly the endangered CCG. However, cattle are known to selectively forage on grasses (Kie & Boroski 1996; Stoddart et al 1975) and help maintain a more open canopy (Weiss 1999) which benefits native vernal pool plants. Refuge staff have similarly observed that cows have shown a substantial preference for grazing on grasses and wild mustard over native vernal pool plants (I. Loredo, pers. comm., 2011). The experimental grazing exclosures within vernal pools have consistently shown that grazing reduces cover of non-native annual grasses and increases cover of native vernal pool forbs (see USFWS Annual Reports 2006-2011). Ungrazed plots are dominated by non-native annual grasses, while grazed plots have, on average, 2.5 times higher cover of native vernal pool plants (WRA 2011). Vernal pool vegetation can vary dramatically both spatially (between pools within the same year) and temporarily (between years within the same pool). Therefore, the exclosure data is highly valuable because it allows managers to look at the same vernal pool during the same year, with and without grazing. Finally, in a large-scale vernal pool grazing study, the continuously grazed pools had the highest relative cover of native species across all 3 years of the experiment, higher than both the ungrazed and seasonally grazed treatments (Marty 2005); similarly, Robins and Vollmar (2001), in a comprehensive review of grazing in vernal pool habitats, concluded that CCG populations thrived in regularly grazed or mowed sites and that ungrazed sites generally had smaller populations. As for upland plants, Refuge data show that grazed pasture have consistently higher cover of native plants than ungrazed pastures (WRA 2011).

By reducing the thick layer of annual grass thatch, grazing may favor rodent species that require areas of open ground to forage and escape from predators (U.S. Geological Survey 2001). There also appears to be a strong association between grazed communities, burrowing rodents, and the presence of tiger salamanders (DiDonato 2006). Since grazing was reestablished in 2004, the abundance of ground squirrel burrows has notably increased (I. Loredo, pers. comm., 2011). Ground squirrel burrows are known habitat for CTS during the non-breeding season (Loredo et al. 1996) and also provide habitat for the California burrowing owl. The presence of California ground squirrels may be the single most important determinant of whether burrowing owls use a given site (Barclay 2001). Although annual surveys for burrowing owls have not been regularly conducted at Warm Springs, burrowing owls have continuously been observed breeding at Warm Springs and annual monitoring of the adjacent Pacific Commons Area (prior to Refuge acquisition) demonstrated an expansion of the burrowing owl population (WRA 2007 and 2006). Indeed, properly managed livestock grazing has been shown to benefit burrowing owls (Kantrud and Kologiski 1982, MacCracken et al. 1985) and may favor other bird species as well, including ground-foraging birds such as killdeer and American Robin (Bock et al. 1993).

Longer vernal pool inundation periods that result from grazing would also expand available habitat for shorebirds, wintering waterfowl, and neotropical migratory birds. Warm Springs supports breeding shorebirds and waterfowl, such as the American avocet, black necked stilt, killdeer, mallard, and Canada goose, that often begin nesting on vernal pool shorelines or islands while pools are still inundated (I. Loredo, pers. comm., 2011).

Grazing can have both negative and positive effects on birds. In riparian areas and prairies, some species of nesting waterfowl and songbirds may be negatively impacted by grazing (Krueper 1993, Kirsch 1969). However, certain guilds of migratory shorebirds require short and/or sparse foraging habitat (Baker and Baker, 1973; Helmers, 1992). Colwell and Dodd (1995) found greater shorebird species diversity and abundance in grazed pastures in coastal California. Grazing at

Warm Springs produces a mosaic of plant heights and therefore continues to provide available habitat for grass-nesting species (I. Loredo, pers. comm., 2011). Grazing improves plant species composition and structure so that short-term or species-specific impacts to wildlife and habitat are expected to be mitigated by long-term benefits to Refuge vegetation, native plants, and overall wildlife habitat quality.

Potential impacts of grazing activities on the Refuge's resources will be minimized because sufficient restrictions are and will be included in the Cooperative Land Management Agreement and as part of the annual grazing rotation plans.

Public Review and Comment:
Public review and comments were solicited in conjunction with distribution of the Draft CCP/EA for Don Edwards San Francisco Bay NWR, released in May 2012. No comments were made directly in regard to this compatibility determination.

Determination:

_____ Use is Not Compatible

___X___ Use is Compatible with Stipulations

The following stipulations are required to ensure compatibility:

- Cattle will be the only livestock species permitted to graze at Warm Springs. Beef cattle will continue to be used over dairy cattle because their less social habits reduce the chance of excessive trampling in one area.

- Cattle will only be permitted on Warm Springs when used to accomplish a specific, pre-defined habitat objective.

- Water troughs will be available in each pasture in the upland habitat to ensure that cows do not use the vernal pools as a water source.

- The livestock operator must have undisputed ownership of the livestock.

- A cooperative land management agreement will continue to be used to provide livestock for the grazing program and management of infrastructure. The agreement will be administered to adjust grazing levels to match yearly conditions (mainly different levels of precipitation) to assure Refuge goals are achieved and no pastures are being overgrazed.

- Monitoring of compliance, impacts, and condition trends will be executed by Refuge staff. Populations of threatened/endangered species as well as upland and vernal pool plant composition will be monitored to determine both positive and negative impacts from grazing. This will allow the Refuge to determine if habitat objectives are being met and detect the first sign of any negative effects of livestock on special status species and adapt grazing prescriptions accordingly.

- Staff will make management changes as necessary to adapt to changing conditions and new

information and can, at any time, direct the cooperative grazer to rotate cows out of pastures and/or reduce the total stocking rate.

- Periodic review of the grazing program could result in additional measures to eliminate or reduce grazing impacts to refuge.

Justification: The grazing program contributes to the enhancement, protection, conservation, and management of native Refuge wildlife populations and their habitats. When Warm Springs was acquired by the Refuge, the suspension of grazing at the site resulted in vernal pool habitat degradation. Similarly, in other study sites, exclusion of livestock from vernal pool habitat has been shown to result in increased cover of non-native annual grasses around pool margins and within pool bottoms, as well as reductions in the diversity and abundance of native species (Marty 2005, Robins and Vollmar 2001, Lis and Eggeman 2000). After extensive research and planning, a supervised grazing program was established at Warm Springs in 2004. Grazing has had an overall beneficial impact to refuge resources including vernal pool vegetation. Grazing has decreased RDM, decreased cover of non-native annual grasses in vernal pools, increased cover of native vegetation, and improved habitat for aquatic species (WRA 2011, USFWS 2010). Grazing is closely monitored to minimize potential negative impacts on Refuge resources and to adapt to changing conditions. In our opinion, grazing will not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the Refuge (601 FW 3). It is determined that grazing within the Refuge, as described herein, will not materially interfere with or detract from the purposes for which the Refuge was established or the mission of the Refuge System.

Mandatory Reevaluation Date (provide month and year):

_____ Mandatory 15-Year Reevaluation Date (for priority public uses)

___X___ Mandatory 10-Year Reevaluation Date (for all uses other than priority public uses)

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

Conducted with Comprehensive Conservation Plan

_____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) 9/24/12 (Date)

Refuge Manager: _____ (Signature) 9/26/12 (Date)

Acting Project Leader Approval: _____ (Signature) 9-26-2012 (Date)

Concurrence
Refuge Supervisor _____ (Signature) 9/24/2012 (Date)

Assistant Regional Director, Refuges _____ (Signature) 10/1/2012 (Date)

Compatibility Determination for Mosquito Management on Don Edwards San Francisco Bay National Wildlife Refuge

Use: Mosquito Management Plan

Refuge Name: Don Edwards San Francisco Bay National Wildlife Refuge, Alameda, San Mateo and Santa Clara Counties, California

Establishing and Acquisition Authorities:
86 Stat. 399, dated June 30, 1972

An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes (16 U.S.C. 667b)

Endangered Species Act of 1973 (16 U.S.C. 1534)

Fish and Wildlife Act of 1956 (16 U.S.C. 742f)

Refuge Purpose(s):
"... for the preservation and enhancement of highly significant wildlife habitat ... for the protection of migratory waterfowl and other wildlife, including species known to be threatened with extinction, and to provide an opportunity for wildlife-oriented recreation and nature study ..." (86 Stat. 399, dated June 30, 1972).

"... particular value in carrying out the national migratory bird management program" 16 U.S.C. 667b (An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes).

"... 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).

"... 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).

National Wildlife Refuge System Mission: The mission of the National Wildlife Refuge 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." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd - 668ee.]

Description of Use(s): This compatibility determination is done as a review of the existing compatibility determination (1994) for mosquito management, and in concert with the Don Edwards San Francisco Bay NWR Comprehensive Conservation Plan and Mosquito Management Plan. This compatibility determination replaces the previous 1994 compatibility determination for mosquito management.

Mosquito management is an existing use conducted primarily to protect public health and safety. Since establishment of the Don Edwards National Wildlife Refuge (Refuge) in 1972, mosquito management on the Refuge has been conducted by local mosquito abatement districts (MADs/Districts), and monitored and regulated through annual U.S. Fish and Wildlife Service (Service) Pesticide Use Proposals. The Refuge lies within the jurisdiction of three MADs: Alameda County Mosquito Abatement District, San Mateo County Mosquito and Vector Control District, and Santa Clara County Vector Control District. Although the mosquito abatement districts do not have comparable funding, each district operates under similar policies and management directives set by their individual boards. The disparity in budgets leads to different approaches in mosquito management on the Refuge, particularly with reference to source reduction projects.

The proposed use is the implementation of a Mosquito Management Plan (Mosquito Plan) (USFWS 2012) that will be used as a guide for mosquito assessment and control activities on the Refuge. The Mosquito Plan contains a protocol for the surveillance of mosquito populations and describes the health threat criteria for determining when and how to allow the MADs to manage mosquito populations on the Refuge. The Mosquito Plan was developed in coordination with the Districts that will be responsible for conducting monitoring, surveillance, and treatment activities. In addition to the Mosquito Plan, the Districts will follow protocols identified in the Statement of Best Management Practices Proposed Monitoring Plan for Coastal Region Mosquito and Vector Control Districts (Appendix K2 of the Mosquito Plan).

Background and Rationale for the Use

Mosquito management activities are conducted throughout the San Francisco Bay region due to a large (>7 million) human population and a long history of mosquito-borne disease transmission to humans and wildlife. Mosquitoes are well known vectors of disease to both humans and wildlife, and in some cases these diseases can cause death. Ten California species of mosquito that are known vectors of arboviruses (arthropod-borne) were evaluated for West Nile Virus (WNV) transmission in 2002. In laboratory testing, all ten species were infected with WNV and were able to transmit the disease at some level (Goddard et al. 2002). *Culex tarsalis* is abundant in California and much of western North America, where the species is involved in the maintenance and amplification of western equine encephalomyelitis virus (WEEV) and Saint Louis encephalitis virus (SLEV) (Goddard et al. 2002). Of the ten mosquito species studied by Goddard et al. 2002, *Culex tarsalis* showed the greatest potential to amplify and maintain WNV in California. Mosquito species frequently found breeding on the Refuge include *Aedes dorsalis* (summer salt marsh mosquito), *Aedes squamiger* (winter salt marsh mosquito), *Aedes washinoi* (Washino's mosquito), *Culex erythrothorax* (Tule mosquito), *Culex tarsalis* (encephalitis mosquito), and *Culiseta inornata* (winter mosquito).

California reporting for WNV dates back to 2005. There has been 16 reported human case of WNV in Santa Clara County since 2005; four reported human cases for Alameda County since 2005; and one reported human case of WNV in San Mateo County since 2005 (http://www.westnile.ca.gov, accessed June 27, 2012). Table 1 summarizes information on WNV cases in the three counties where the Refuge is located.

Table 1. Cases of West Nile Virus by County, 2005-2011.

County	Human cases	Dead birds	Mosquito samples	Sentinel chickens	Squirrels
Alameda					
2011	-	-	-	-	1
2010	1	1	-	-	-
2009	-	10	1	-	-
2008	1	12	1	-	1
2007	-	19	1	-	1
2006	1	41	9	-	2
2005	1	48	8	-	n/a
San Mateo					
2011	-	-	-	-	-
2010	-	-	-	-	6
2009	-	1	-	-	-
2008	-	2	-	-	-
2007	-	2	-	-	1
2006	-	7	-	-	2
2005	1	10	-	-	n/a
Santa Clara					
2011	1	36	16	-	1
2010	-	32	10	-	6
2009	-	14	14	-	2
2008	1	13	1	-	-
2007	4	83	10	-	6
2006	5	224	9	1	2
2005	5	144	3	-	n/a

As of 2011, 326 bird species have been listed in the Center for Disease Control WNV avian mortality database (http://www.cdc.gov/ncidod/dvbid/westnile/birdspecies.htm, accessed May 2, 2011). The list includes wildlife that inhabit tidal marsh such as waterfowl, grebes, heron, egrets, cormorants, songbirds (wrens, yellowthroats, song sparrows), and rails (California clapper rail (*Rallus longirostris obsoletus*), Virginia rail (*Rallus limicola*), common moorhen (*Gallinula chloropus*), American coot (*Fulica americana*). Other vertebrates known to be infected by WNV include horses, bats, chipmunks, skunks, rabbits, and squirrels.

With the spread of WNV and the potential for spread of other mosquito-borne diseases across the country, pressure is increasing to manage mosquito populations that occur on lands of the National Wildlife Refuge System (NWRS), especially in urban areas such as the San Francisco Bay region. Managers of National Wildlife Refuge lands recognize that mosquitos are vectors of human and wildlife disease but also understand that mosquitoes are a natural component of wetlands, providing an important component of aquatic ecosystems. Because large populations of mosquitoes impose an elevated risk of disease for both humans and wildlife, monitoring and control of mosquito populations on the Refuge will be allowed. However, control will be limited to help ensure mosquito abatement activities are compatible with the establishing purposes of the Refuge.

Mosquito management on the Refuge will involve baseline actions of monitoring and surveillance of mosquito populations. A disease threat approach will inform management activities aimed at

controlling mosquito populations. Activities will include those such as removal of artificial mosquito breeding habitat (such as tires, open containers, and other objects that pool water); tidal circulation enhancements and restoration; and chemical/biological applications based on a threat only when necessary (larvicide, pupacide, and adulticide) (see Table 2). Because mosquito population densities and disease incidence and prevalence will vary from year to year, mosquito management on the Refuge will not likely include all health threat levels in a given year. Access for mosquito population monitoring and control activities will be limited in sensitive species habitats and along tidal channels and sloughs. The improvement of hydrology within tidal marsh will be the primary and preferred mechanism for minimizing mosquito production. Actions will focus on improving habitat for native wildlife and plants as well as for decreasing mosquito breeding to below treatment threshold levels. While the Refuge's Mosquito Management Plan (USFWS 2012) calls for follow similar control measures used over the past 10 years, there will be greater emphasis placed on communication/consultation between Refuge and vector control agency personnel and additional documentation needed for both strategic habitat conservation and adaptive management. Program managers of the MADs will coordinate with the Refuge manager prior to surveillance, monitoring, and control activities on the Refuge.

Table 2. Larval and Pupal Mosquito Thresholds for Alameda, Santa Clara, and San Mateo Mosquito and Vector Control Districts.

Species	Common Name	Most Common Habitats	Distance to Populated Area	Larval/Pupal Threshold	Notes
Aedes dorsalis	Salt marsh mosquito	Salt marshes	0 meters - 5 miles	≥1 per 10 dips	High pest significance
Aedes squamiger	Winter salt marsh mosquito	Salt marshes, reclaimed marshes	0 meters - 10 miles	≥1 per 10 dips	High pest significance
Aedes washinoi	Woodland pool mosquito	Temporary woodland pools	0 meters - 5 mile	≥1 per 10 dips	High pest significance
Culex erythrothorax	Tule mosquito	Lakes and ponds associated with tules	0 - 500 meters	≥1 per dip	High pest significance, vector of encephalitis, WNV
Culex tarsalis	Encephalitis mosquito	Creeks, marshes, temporary pools, roadside ditches, fresh water	0 meters - 5 miles	≥1 per 10 dips	Moderate pest significance, vector of encephalitis, WNV
Culiseta inornata	Winter salt marsh mosquito	Marshes, temporary pools, roadside ditches	0 meters - 1 mile	≥1 per dip	High pest significance

Description of the Mosquito Management Plan

Table 3, Health Threat Criteria for Mosquito Management on the Refuge shows the 5-tier health threat-response for mosquito management.

Table 3. Health Threat Criteria for Mosquito Management for the Refuge.

Threat Level	Condition	Response
1	No documented existing health threat[1]. Mosquito management issues have not been reported or identified by the appropriate public health authority[4] or vector control district(s).	Monitoring and surveillance of areas surrounding the Refuge to inform management actions on the Refuge. Remove/manage artificial breeding sites such as tires, tanks, or similar debris/containers. Consult with MADs when planning wetland enhancement or restoration projects.
2	Potential human or wildlife (incl. threatened and endangered species) health threat[1] (presence of vector spp., historical health threat, etc.), as documented by appropriate public health authority(ies) or vector control district(s).	Response as in threat level 1, plus: allow compatible monitoring and disease surveillance. Consider compatible non-pesticide management options to reduce the potential for above-normal mosquito production (e.g., restore/enhance tidal marsh hydrology).
3	Mosquito larvae threshold exceeded for human and/or wildlife health[2] on the Refuge as determined by standardized monitoring. Documented potential human or wildlife health threat (historic health threat, presence of vector species).	Response as in threat level 2, plus: allow compatible site-specific application of larvicide in areas with above average mosquito populations, as determined by monitoring. Conduct post larvicide monitoring to determine efficacy.
4	Mosquito larvae have begun to reach last instar stages or pupate reducing the efficacy of larvicides. Mosquito larval and pupal population thresholds[2] exceeded on the Refuge. Mosquitoes produced by the Refuge pose a health threat[1,4] as determined by the appropriate public health authority(s).	Response as in threat level 3, plus: if appropriate, increase the intensity and frequency of larvicides, allow compatible site-specific use of pupacides in areas with above average mosquito populations, determined through monitoring to be beyond control with larvicides. Increase monitoring and disease surveillance. Conduct post larvicide and pupacide monitoring to determine efficacy.
5	Mosquito-borne disease is documented on the Refuge or within flight range of vector mosquitoes on the Refuge. Risk Assessment rating is at least 2.6[3]. High risk for mosquito-borne disease (imminent risk of serious human disease or death, or an imminent risk of serious disease or death to populations of wildlife) within communities surrounding the Refuge has been documented by the appropriate public health authority[4].	Response as in threat level 4, plus: Consider site-specific adulticiding in areas with above average mosquito populations as determined by monitoring. Conduct post adulticide monitoring to determine efficacy.

[1]An adverse impact to the health of human or wildlife populations from mosquito-borne disease identified and documented by Federal, State, and/or local public health authorities. Health threats are locally derived and are based on the presence of endemic or enzootic mosquito-borne diseases, including the historical incidence of disease, and the presence and abundance of vector mosquitoes. Health threat levels are based on current monitoring of vectors and mosquito-borne pathogens.

[2]See Table 2.

[3]Risk Assessment is calculated by considering several factors as determined by California Mosquito-Borne Virus Surveillance and Response Plan (Appendix K8).

[4]Appropriate public health authority(s) is a Federal, State, or local public health or wildlife management authority with jurisdiction inclusive of Refuge boundaries and/or neighboring public health authorities.

In *Threat Level 1*, an existing health threat has not been identified and mosquito management issues have not been reported or identified by the appropriate public health authority or MADs. To avoid possible increases in mosquito populations, the Refuge will eliminate *artificial* mosquito breeding habitat throughout the Refuge, such as tires, open containers, and other equipment or

objects that pool water where mosquitoes may breed. Refuge staff will also consult with officials from the MADs whenever wetland enhancement or restoration projects (to increase tidal water exchange) are being planned on the Refuge. Consultation will allow the Refuge and the MADs to identify potential problems or opportunities related to mosquito production and management in the future. These projects could involve mechanical changes to the topography within the marsh that allow for unrestricted tidal flow and exchange across the marsh. These improvements can include ditching (currently performed by some MADs), lowering of berms within the marsh, breaching of berms or levees within the marsh, or complete removal of berms, levees or any other structures that may inhibit water flows through the marsh. These activities may require additional NEPA analysis, federal and state permitting, as well as Endangered Species Act consultations.

In *Threat Level 2*, refuge management will focus on developing a proactive mosquito prevention and management program for mosquitoes is to determine mosquito species presence, locations, and abundance on refuge lands, and to identify potential or documented vectors of mosquito-borne diseases that represent a potential human health threat. Monitoring and surveillance activities on the Refuge will be well documented and annually submitted to Refuge staff by the MADs. To access traps and sampling stations MAD personnel will comply with best management practices enumerated in the Refuge's Mosquito Management Plan.

Refuge staff and visitors would be informed of an increased health threat associated with mosquito-borne disease activity. Personal protection measures such as wearing long sleeves, long pants, and mosquito repellant would be recommended to staff and visitors.

In order to avoid or minimize the use of pesticides, habitat management practices or wetland enhancement/restoration projects that improve wildlife habitat and reduce seasonal abundance of larval and adult mosquitoes should be implemented where possible.

Mosquito population monitoring involves activities associated with collecting quantitative data to determine mosquito species composition and to estimate relative changes in mosquito population sizes over time.

The purpose of mosquito-borne disease surveillance involves activities associated with detecting pathogens causing mosquito-borne diseases, such as testing adult mosquitoes for pathogens or testing reservoir hosts for pathogens or antibodies. These activities assist in determining public health risks associated with mosquito-borne pathogens on or near the Refuge.

Monitoring of immature mosquitoes will be conducted by the MADs. The Mosquito Management Plan describes the methods the MADs will use for monitoring and surveillance. Monitoring and surveillance will be conducted primarily by foot. The use of motorized vehicles (ARGOs) is authorized, but will be limited to non-sensitive habitats, unless coordinated with Refuge staff. Field technicians within these agencies will maintain a list of known mosquito developmental sites on the Refuge and visit them during predominant periods of mosquito production. The timing and frequency of monitoring is based on a number of factors including history of mosquito production, tidal cycles, precipitation levels, and available resources. Mosquito populations are sampled using established protocols. Samples are examined in the field or laboratory by the MADs to determine the abundance, species, and life-stage of mosquitoes present. This information is compared to historical records and established thresholds and used to prescribe treatment to reduce risk of mosquito-borne disease outbreaks.

Although larval mosquito control is preferred, identifying all larval sources is not possible. Therefore, adult mosquito monitoring is also needed to pinpoint problem areas and locate previously unrecognized or new larval developmental sites. Adult mosquitoes are sampled using carbon dioxide traps on and off the Refuge. Mosquitoes collected using these methods are counted and identified to species. Information on adult mosquito abundance from traps is augmented by testing of dead birds and squirrels to detect WNV in the area. Sentinel chickens are also an indirect way of monitoring for the presence of virus in the mosquito population. Chickens are maintained in outdoor cages where they are exposed to host-seeking mosquitoes. If bitten by an infected mosquito, these birds will develop an immune response. Blood samples are taken from the chickens every bi-weekly to every two weeks to test for exposure to WNV, WEE, or SLE. No sentinel flocks are maintained on the Refuge; instead flocks are maintained in areas neighboring the Refuge.

If non-pesticide attempts to reduce mosquito populations are unsuccessful or are not feasible and mosquito larvae thresholds (See Table 2) have been exceeded (varies by district), application of larvicides would be considered. In *Threat Level 3* locations of larvicide treatments would be based on standardized monitoring results (see Mosquito Plan). The preferred larvicide treatments are biorationals *Bacillus thuringiensis israelensis* (Bti) or *Bacillus sphaericus* (Bs), because of the bacterium's limited non-target effects (Appendix K3 and K4 of the Mosquito Plan). Chemical larvicides treatments (methoprene) would be the second preferred method for larval control. Post larvicide monitoring would be conducted to determine efficacy.

Larvicides (Bti or Bs, and methoprene) are only effective on mosquitoes during early instar stages (up to the fourth) and do not control pupae. In *Threat Level 4*, if developing mosquitoes have reached the last instar stages or have pupated, then the application of site-specific pupacides in areas with above average mosquito populations would be considered. Because pupacides can negatively affect all invertebrates that require surface air (e.g., act as surfactants). For this reason, pupacides (Agnique) would only be used if large numbers of infected mosquitoes are considered an immediate threat to human health and thresholds developed by the appropriate public agency have been exceeded. Post larvicide and pupacide monitoring would be conducted to determine efficacy.

At the Threat Level 5, a risk of serious mosquito-borne human disease or death has been documented by the appropriate public health authority. Disease surveillance determines that there is a high risk for mosquito-borne disease within the vicinity of the Refuge. For example, pathogen presence in mosquito pool(s), wild birds, sentinel chicken flock(s), horses, or humans has been documented within the flight range of vector mosquito species present on the Refuge. These conditions in combination with adult mosquito populations above threshold levels on the Refuge would trigger consideration of a more aggressive treatment strategy, including the use of adulticides.

Further, the use of adulticide would be considered in relation to the Mosquito-borne Virus Risk Assessment in the most current version of the California Mosquito-borne Virus Surveillance and Response Plan. The MADs would be required to include a risk assessment as part of their request to apply adulticides. The risk assessment evaluates a number of factors including environmental conditions, mosquito species presence, virus infection rate, sentinel chicken seroconversion, dead bird presence, and human cases to determine whether adulticide should be used or not.

In order to limit human contact with adulticides, visitors would not be allowed in those parts of the Refuge that are being treated with adulticides. Information about treatment scheduling, location, and pesticide would be posted on the Refuge website, at the Refuge Headquarters, and at the treatment location. Post adulticide monitoring would be conducted to determine efficacy.

In summary, application of adulticides on the Refuge would require the following steps:

- Prior approval from the National IPM Coordinator via Pesticide Use Proposal (PUPS)
- The MAD must present the Refuge manager with data supporting presence of a arboviral disease on the Refuge or within flight range of the vector mosquito species on the Refuge, including a Risk Assessment in the region
- The MAD must provide the Refuge manager with types/quantities of adulticides proposed and locations
- If beneficial, the MAD should conduct simultaneous application of larvicides with the adulticide application to prevent future adult outbreaks

Pesticide Approval Process

As a result of statute authority under the Migratory Bird Treaty Act, the Endangered Species Act and Service policy, the Service is required to consider whether use of specific pesticides would harm trust species (e.g., threatened and endangered species, migratory birds). The Service evaluates approval of specific pesticide use based on histories of adverse effects on non-target species and persistence in the environment.

PUPs are prepared on an annual basis for Regional Office Integrated Pest Management Coordinator and National IPM Coordinator approval. The PUPs would include pesticides that MADs or other permitted groups propose for use as part of a mosquito management program on the Refuge. Pesticide Use Reports (PUR) are prepared by Refuge staff by the end of each calendar year following application of pesticides to control mosquitoes on the Refuge. To assist in tracking the use of pesticides in conjunction with mosquito management activities, the Refuge Manager will require MADs to prepare an annual quantitative summary of refuge mosquito monitoring and surveillance results, control activities on the Refuge (e.g., pesticides applied, amount of pesticides applied, locations of application, method of application), and regional disease surveillance. The report should be accompanied by maps showing specific areas where management activities occurred. Comparisons of mosquito management within and among years will be included to permit analysis of patterns that may indicate success of habitat management efforts or suggest the need for a new management approach.

Methods used to reduce mosquito populations are primarily based on efficacy, cost, and minimal ecological disruption, including minimum effects on non-target organisms and natural systems of the Refuge. "Chemical pesticides should be used only where practical physical, cultural, and biological alternatives or combinations thereof, are impractical or incapable of providing adequate mosquito population control. Furthermore, chemical pesticides would be used primarily to supplement, rather than as a substitute for, practical control measures of other types. Whenever a chemical is needed, the most narrow ranging and specific pesticide available for the target organism in question should be chosen, unless consideration of persistence or other hazards would preclude that choice." (7 RM 14.2).

Special Use Permit Process

Long-standing NWRS policy addressing Administration of Specialized Uses (5 RM 17) guides issuance of special use permits (SUP) for economic uses, special events, access to closed areas, and other privileged uses. Conduct of mosquito management on a refuge by a MAD or other party is a specialized use and requires issuance of an SUP.

Each year, Refuge staff will work with the MADs to develop the SUP that will cover the surveillance, monitoring, and control activities allowed on the Refuge that year. An annual meeting between the Refuge and MAD managers will ensure that permits are current, communication is continuous, and concerns related to mosquito populations and other biological resources of the Refuge are addressed. In addition, prior to issuing the SUP, we will review the proposed yearly activities in relation to the Section 7 consultation, cultural resource compliance, and the Environmental Assessment to determine if any additional documentation will be necessary.

Mosquito Control Pesticides

Mosquito control pesticides can be categorized into 3 groups: larvicides, pupacides (surface films/surfactants), and adulticides. Compared with other forms of pest control, relatively few pesticides are available within each of these categories, and all differ with regard to efficacy and effects on non-target organisms. Additional information on pesticides presented here can be found in Appendices K3, K4, K5, K6, and K7 in the Refuge's Mosquito Management Plan (USFWS 2012).

The use of larvicides and pupacides will be routinely approved subject to review by the Regional Office Integrated Pest Management Coordinator acting under the authority of the National IPM Coordinator. Data from various sources (e.g., scientific literature) will be used to identify whether new preferred chemicals exist, as they become available.

Before applying pesticides to Refuge lands in a non-emergency situation:

- Current monitoring data for larval, pupal, and adult mosquitoes which documents the need for mosquito management must be presented.
- The most appropriate pesticide treatment options based on monitoring data for the relevant mosquito life stage must be determined.
- Consideration must be made as to whether the pesticide will harm trust species and;
- The PUP must be approved.

Pesticides currently allowed under this CD are described briefly in the following Tables 4, 5, and 6. More detailed information on these pesticides is presented in the Mosquito Management Plan (USFWS 2012).

Table 4. Pesticides Permitted for Use on the Refuge in 2012 by the Alameda Mosquito Abatement District.

Trade Name	Type	Rate & Unit	Method	Equipment	Applications per year
VectoLex CG	Larvicide, Bs	20 lbs/acre	Hand	Hand broadcast	Not to exceed 10
VectoLex WDG	Larvicide, Bs	1.50 lbs/acre	Hand	Hand broadcast	Not to exceed 10
VectoLex WSP	Larvicide, Bs	50 ITUs/mg	Hand	Hand broadcast	Not to exceed 10
VectoBac 12AS	Larvicide, Bti	16 oz/acre	Backpack spray, low-volume spray, aerial	ATV, helicopter	Not to exceed 20
VectoBac G	Larvicide, Bti	10 lbs/acre	Hand, herd seeder, aerial	ATV, helicopter	Not to exceed 20
Altosid Liquid Concentrate SR-20	Larvicide, methoprene	1 oz/acre	Backpack spray, boom spray, aerial	ATV, helicopter	Not to exceed 10
Altosid Pellets WSP	Larvicide, methoprene	10 lbs/acre	Hand	ATV	Not to exceed 10
Altosid XR Extended Residual Briquets	Larvicide, methoprene	35 lbs/acre	Hand	ATV	Not to exceed 10
Altosid Briquets	Larvicide, methoprene	4.90 lbs/acre	Hand	ATV	Not to exceed 10
Altosid XR-G	Larvicide, methoprene	20 lbs/acre	Hand	Hand-held	Not to exceed 10
Mosquito Larvicide GB-1111 (Clarke)	Larvicide, oil	640 oz/acre	Backpack spray, boom spray	ATV, truck	Not to exceed 5
Agnique MMF	Pupacide, monomolecular film	128 oz/acre	Backpack spray, boom spray	ATV, truck	Not to exceed 2
Pyrenone 25-5	Adulticide, pyrethrin	0.87 oz/acre	Backpack spray, boom spray	ATV	Not to exceed 5

Table 5. Pesticides Permitted for Use on the Refuge in 2012 by the San Mateo Mosquito and Vector Control District.

Trade Name	Type	Rate & Unit	Method	Equipment	Applications per year
VectoBac 12AS	Larvicide, Bti	32 oz/acre	Backpack spray, boom spray, low-volume spray, aerial	ATV, helicopter	Not to exceed 20
VectoBac G	Larvicide, Bti	10 lbs/acre	Hand, herd seeder	truck	Not to exceed 20
Teknar HP-D	Larvicide, Bti	0.16 oz/acre	Backpack spray, boom spray, low-volume spray	truck	Not to exceed 20
VectoBac WDG	Larvicide, Bti	0.44 lbs/acre	Backpack spray, boom spray, low-volume spray	ATV	Not to exceed 20
Altosid Liquid Concentrate SR-20	Larvicide, methoprene	1 oz/acre	Backpack spray, boom spray, low-volume spray, aerial	ATV, helicopter	Not to exceed 20
Altosid Liquid Larvicide Mosquito Growth	Larvicide, methoprene	4 oz/acre	Backpack spray, boom spray, low-volume spray, aerial	ATV, helicopter	Not to exceed 20

Regulator					
Altosid Pellets WSP	Larvicide, methoprene	5 lbs/acre	Hand	ATV	Not to exceed 20
Altosid XR-G	Larvicide, methoprene	20 lbs/acre	Hand	Hand broadcast	Not to exceed 20
Mosquito Larvicide GB-1111 (Clarke)	Larvicide, oil	640 oz/acre	Backpack spray, boom spray	ATV, truck	Not to exceed 5
Agnique MMF	Pupacide, monomolecular film	128 oz/acre	Backpack spray, boom spray	ATV, truck	Not to exceed 2
Pyrenone 25-5	Adulticide, pyrethrin	0.87 oz/acre	Backpack spray, boom spray	ATV	Not to exceed 5

Table 6. Pesticides Permitted for Use on the Refuge in 2012 by the Santa Clara County Vector Control District.

Trade Name	**Type**	**Rate & Unit**	**Method**	**Equipment**	**Application per year**
VectoLex CG	Larvicide, Bs	20 lbs/acre	Hand	Hand broadcast	Not to exceed 10
VectoLex WDG	Larvicide, Bs	1.50 lbs/acre	Hand	Hand broadcast	Not to exceed 10
VectoLex WSP	Larvicide, Bs	50 ITUs/mg	Hand	Hand broadcast	Not to exceed 10
VectoBac 12AS	Larvicide, Bti	32 oz/acre	Backpack spray, boom spray, low-volume spray, hand, aerial	Truck, Helicopter	Not to exceed 10
VectoBac G	Larvicide, Bti	10 lbs/acre	Hand	Truck	Not to exceed 10
Teknar HP-D	Larvicide, Bti	16 oz/acre	Backpack spray, boom spray, low-volume spray, hand	Truck	Not to exceed 10
Bactimos pellets	Larvicide, Bti	8 lbs/acre	Hand	Truck	Not to exceed 10
Summit B.t.i. Briquets	Larvicide, Bti	7000 ITUs/mg	Hand	Hand broadcast	Not to exceed 10
Altosid Pellets WSP	Larvicide, methoprene	5 lbs/acre	Hand	Hand broadcast	Not to exceed 10
Altosid XR-G	Larvicide, methoprene	20 lbs/acre	Hand	Hand broadcast	Not to exceed 10
Altosid Briquets	Larvicide, methoprene	4.90 lbs/acre	Hand	ATV	Not to exceed 10
Altosid XR Extended Residual Briquets	Larvicide, methoprene	35 lbs/acre	Hand	ATV	Not to exceed 10
Altosid Liquid Larvicide Mosquito Growth Regulator	Larvicide, methoprene	4 oz/acre	Aerial, backpack spray, low volume spray, boom spray, hand	Helicopter, Truck	Not to exceed 10
Altosid Liquid Concentrate SR-20	Larvicide, methoprene	1 oz/acre	Aerial, backpack spray, Low volume spray, boom spray, hand	Helicopter, Truck	Not to exceed 10

Availability of Resources:
Monitoring and control will be conducted by the MADs and coordinated through the Refuge Manager on an annual basis. Existing funds are available to support the Refuge Manager and other staff in coordinating this use. Refuge staff will take an active and, in most cases, a lead role in planning and implementing tidal circulation enhancement and wetland restoration projects aimed at improving wildlife habitat while reducing mosquito production. These restoration projects will be pursued as funding becomes available.

Anticipated Impacts:
Direct impacts of mosquito monitoring and control activities, by their very nature have no positive on target species. In addition to intentional adverse effects on mosquito populations, monitoring and control activities will result in temporary disturbance to possible deleterious effects to non-target wildlife and habitat. Areas of vegetation may be crushed under foot or by use of ARGOs, with impacts ranging from temporary in nature to loss of habitat over time. Invasive weeds may be introduced or spread by ARGOs and by foot. Indirect effects associated with mosquito control include reducing mosquito populations and other non-target species that serve as the base of food chains for wildlife species.

To avoid harm to wildlife or habitats, access to traps and sampling stations will comply with the *Stipulations Necessary to Ensure Compatibility* in a section near the end of this document. Prior to implementation of the Mosquito Management Plan, an Intra-Service Section 7 consultation with Ecological Services will be conducted to evaluate the biological impacts on listed species. The terms and conditions identified in the Section 7 consultation will be a requirement of the SUP.

Tidal Circulation Enhancement and Restoration Effects to Non-target Organisms
Effects of mechanical tidal circulation enhancements and restoration to non-target organisms could include at a minimum temporary disturbance or displacement from their habitat. In the event that ditching, berm or levee breaching, or removal actions are conducted, effects could include injury or death to some mammal and bird species. In order to avoid impacts to salt marsh harvest mouse and other mammal species and California clapper rail or other bird species, construction will be scheduled to avoid reproductive periods or extreme high tides. Other measures may include removal of vegetation within the construction area during low tide to significantly reduce the likelihood of mammal or bird presence. As site-specific projects are identified, potential effects to wildlife will be further analyzed. Best management practices or conservation measures to eliminate or minimize any negative effects will be identified in a restoration and enhancement project-specific environmental planning documents.

Pesticide Toxicity and Other Effects to Non-target Organisms

Areas of the Refuge that require pesticide application for the purpose of mosquito management typically support lower quality habitat for native wildlife and plants typically due to poor tidal circulation. Therefore, potential indirect adverse impacts on the relative availability food resources as a result of pesticide application within these areas is likely to be limited.

Birds
Impacts to birds may occur as a result of ground access via foot or mechanized vehicle (ARGO). Use of mechanized vehicles can trample vegetation where these species may occur. However, impacts are considered limited because areas that need mosquito management typically provide poor habitat quality to most birds and access to the sites will be limited to the non-breeding season.

The use of pesticides for the purpose of mosquito management may directly or indirectly affect resident and migratory bird populations of the Refuge. Direct effects may occur from the direct contact of the pesticides on the birds. Indirect effects are related to the potential reduction in the invertebrate food supply. Bti has practically no acute or chronic toxicity to mammals, birds, fish, or vascular plants (USEPA 1998) (Appendix K3 and K4 of the Mosquito Plan [USFWS 2012]). Potentially, Bti may kill midge larvae (family chironomidae). Chironomid (non-biting midge) larvae can be abundant in wetlands and form a significant portion of the food base for other wildlife, including birds (Batzer et al. 1993; Cooper and Anderson 1996; Cox et al. 1998).

Methoprene showed no toxicity to slight toxicity to birds at high concentrations and repeated exposure (Appendix K3 and K6, USEPA 2001). As with Bti, concerns regarding potential negative impacts to chironomid larvae from methoprene exist. Some studies have suggested methoprene impacts other organisms that may form part of the food base for birds. McKenney and Celestial (1996) noted significant reductions in number of young produced in mysid shrimp at 2 ppb. Sub-lethal effects on the cladoceran, *Daphnia magna*, in the form of reduced fecundity, increased time to first brood, and reduced molt frequency have also been observed at concentrations 0.1 ppb (Olmstead and LeBlanc 2001).

Monomolecular film is not known to cause direct chronic or acute avian toxicological effects to birds (Appendix K4). Monomolecular films are potentially lethal to any aquatic insect that lives on the water surface or requires periodic contact with the air-water interface to obtain oxygen, and therefore may result in a negative impact to the avian food base (e.g., Chironomid invertebrates) (see Appendix K3 and K4 in the Mosquito Plan [USFWS 2012]).

Pyrethrins are not considered toxic to birds (Milam et al. 2000, USEPA 2006) when applied at labeled rates. A terrestrial exposure model showed no acute or chronic risks to mammal or bird species (USEPA 2006). However, non-target effects to birds from pyrethrin application may occur as a result of reduced food base (e.g., Chironomid invertebrates) (see Appendix K4 and K7 in the Mosquito Plan [USWFWS 2012]). Pyrethrums (natural adulticides) are known to significantly reduce invertebrate populations, especially among Chironomids.

Impacts to birds as a result of physical access (trampling of vegetation, nests) and application of pesticides (food chain effects) as a result of mosquito management could occur, but is unlikely as these actions would not significantly affect bird populations of the Refuge given poor habitat conditions that exist in areas requiring mosquito management and limitations on access. The potential also exists for transmission of mosquito-borne disease that has been shown to cause mortality in birds (e.g., West Nile virus).

Mammals

Mosquito control has the potential to impact mammals in two ways – first, through physically accessing the site with mechanized vehicles, and second through the application of pesticides. The federally endangered salt marsh harvest mouse (SMHM) occurs throughout tidal marsh of the Refuge. In a report on SMHM of the Mare Island Naval Shipyard, Bias and Morrison (1993) reported direct and indirect adverse effects on SMHM habitats and populations caused by the use of mechanized vehicles in the tidal marsh. According to their personal observations, vehicle effects on habitat include compacted soil, destroyed vegetation, and documented the destruction of one salt marsh harvest mouse nest (Bias and Morrison 1993). In addition, repeated vehicle travel over the same areas creates paths through the pickleweed that increase access for predators. Lastly, they reported that vehicle travel can disrupt daily activity (e.g. movements) and has the potential

to cause mortality of individual SMHM. Past and current aerial imagery from a variety of sources show visible paths where mechanized vehicles have traversed the marsh.

The use of larvicides and pupacides for the purpose of mosquito management are not likely to directly affect native mammal populations of the Refuge. Adverse effects on mammals from Bti, methoprene, and Agnique (monomolecular film) are not expected (see Appendix K3 and K4 in the Mosquito Plan [USFWS 2012]) when applied according to the label instructions. Extensive acute toxicity studies indicated that Bti is virtually innocuous to mammals (Siegel and Shadduck 1992). These studies exposed a variety of mammalian species to Bti at moderate to high doses and no pathological symptoms, disease, or mortality were observed. Methoprene is not considered toxic to mammals (see Appendix K3 and K4 in the Mosquito Plan [USFWS 2012]). Impacts to the mammalian community as a result of reduced invertebrate populations are not expected because most mammal species that inhabit wetlands of the Refuge are herbivorous (invertebrates are not a primary component of their diet). Insectivorous species such as shrews (e.g., *Sorex ornatus*) do occur in wetlands of the Refuge and reduced arthropod populations may impact food availability for these species.

The use of pyrethrin pesticides will also be permitted on the Refuge under conditions identified in Threat Level 5 of the Plan (Table 3). Oral exposure of pyrethrins could occur through consumption of plants or plant parts that have been sprayed (aerial application). A terrestrial exposure model showed no acute or chronic risks to mammal or bird species (USEPA 2006).

Reptiles and Amphibians

Mosquito monitoring and surveillance, mosquito control through application of pesticides, and tidal wetland restoration could disturb reptiles and amphibians. Reptiles are known to occur within both tidal and seasonal wetland areas of the Refuge. Pesticide effects on reptiles and amphibians may occur through reductions in insects that serve as a food source (Hoffman et. al. 2008), through direct individual effects from pesticide application or from trampling of individuals or habitat (e.g., access via ARGOs). These include the federally threatened California tiger salamander (*Ambystoma californiense*) found in the vernal pool habitats of the Refuge. Birds are often used as a surrogate for effects on reptiles and fish as a surrogate for amphibians (see effects in Birds section previously, Hoffman et al. 2008). Direct chronic effects have been found for the San Francisco garter snake from application of labeled rates of permethrin (synthetic pyrethroid, Hoffman et al. 2008). This species does not occur on the Refuge, however these finding suggest other reptiles may incur direct chronic effects. Limitations on vehicle access and during sensitive times of the year will help reduce impacts to reptiles and amphibians.

Fisheries

Mosquito monitoring and surveillance activities are not expected to adversely affect fish because these activities do not occur within open subtidal waters of the Refuge (e.g., sloughs, channels, open bay), and are not expected to adversely affect water quality (e.g., turbidity, dissolved oxygen). Negative effects on fish populations are not expected from proposed larvicides and pupacides (see Appendix K3 and K4 in the Mosquito Management Plan [USFWS 2012]). Bti is practically non-toxic to fish (Appendix K5 in the Mosquito Plan [USFWS 2012]). However, the application of adulticides has the potential to adversely affect fish populations. Pyrethrins are considered highly toxic to fish and invertebrates (see Appendix K4 and K7 in the Mosquito Plan [USFWS 2012], USEPA 2006). Central California coast steelhead (*Oncorhynchus mykiss*) and North American green sturgeon (*Acipenser medirostris*) are special status fish that have the potential to occur on the Refuge.

The frequency of conditions that would require use of adulticides on the Refuge has been rare over the past few decades. No requests for adulticide use have been made over the past several years. This pattern suggests that future use of adulticides on the Refuge would be rare. Application would only occur in swales and would not be applied to channels, sloughs, or other open water areas. If application of adulticide were to occur, the low frequency and relatively limited extent of application is not likely to cause significant adverse effects to fish and invertebrate populations.

Invertebrates
Monitoring and surveillance activities are not expected to adversely affect invertebrate populations. Chemical treatment of mosquito populations on the Refuge has the potential to adversely affect invertebrates. The effect on local populations of invertebrate species over time with periodic and continued use of Bti is unknown but potential for negative effects is a possibility (see Appendix K3 and K4 in the Mosquito Management Plan [USFWS 2012]). Host range and effect on non-target organisms indicates that Bti is relatively specific to the Nematocera suborder of Diptera, in particular filter-feed mosquitoes (Culicidae) and blackflies (Simuliidae) (Glare and O'Callaghan 1998). Bti is pathogenic to some species of midges (Chironomidae) and Tipulidae, although to a lesser extent than mosquitoes and biting flies and is not reported to affect a large number of other invertebrate species (Glare and O'Callaghan 1998). Bti concentration may be important with regard to effects on nontarget organisms. Of particular concern is the potential for Bti to kill midge larvae (family Chironomidae). Chironomid (non-biting midge) larvae are often the most abundant aquatic insect in wetland environments and form a significant portion of the food base for other wildlife (Batzer et al. 1993; Cooper and Anderson 1996; Cox et al. 1998). Reduced invertebrate populations as a result of food web effects (e.g., reduction of nematoceran Diptera) have been shown in studies of Bti (Hershey et al. 1998).

Because methoprene is a juvenile hormone (JH) mimic and all insects produce JH, concerns about potential adverse effects on non-target aquatic insects when this pesticide is used for mosquito control (see Appendix K3 and K4 in the Mosquito Plan [USFWS 2012]). As with Bti, concerns include potential negative impacts on chironomid larvae due to their importance in food webs. As with any pesticide, toxicity is a factor of dose plus exposure. At mosquito control application rates, methoprene is present in the water at very small concentrations (4-10 ppb, initially). With regard to exposure, chironomid larvae occur primarily in the benthos, either within the sediments and/or within cases constructed of silk and detritus. Thus, differences may exist with regard to exposure to methoprene between chironomid and mosquito larvae, the latter occurring primarily in the water column. The published literature on the effects of methoprene to chironomids is not as extensive as that for Bti. However, evidence is found for potential toxicity to chironomid and other aquatic invertebrates from methoprene treatments. In summary, evidence exists for significant adverse non-target effects from methoprene even when applied at mosquito control rates.

Monomolecular films are potentially lethal to any aquatic insect that lives on the water surface and requires periodic contact with the air-water interface to obtain oxygen (USFWS 2005). The film interferes with larval orientation at the air-water interface and/or increases wetting tracheal structures, thus suffocating the organism. As the film spreads over the water surface, larvae tend to concentrate, which may increase mortality from crowding stress (Dale and Hulsman 1990).

Pyrethrins are known to cause acute toxicological effects to benthic invertebrates at rates used for mosquito abatement (USEPA 2006). Because pyrethrins are broad-spectrum insecticides, they are potentially lethal to most insects. All adulticides are very highly toxic to aquatic invertebrates in

concentrations as low as one part per billion (Milam et al. 2000). Because most adulticides can be applied over or near water when used for mosquito control, risks to aquatic invertebrates from direct deposition and runoff of the pesticides exist.

Public Review and Comment:
Public review and comments were solicited in conjunction with distribution of the Draft CCP/EA for Don Edwards San Francisco Bay NWR, released in May 2012. Many comments were made directly in regard to the Mosquito Management Plan and relevant to this CD. Comments relevant to this CD included the assertion that mosquito management is a refuge management activity that is conducted by a Service-authorized agent to fulfill one or more purposes of a refuge, and therefore should not be considered a use. The term "use" refers to any activity on a National Wildlife Refuge that is not a management activity conducted by refuge personnel for the purpose of conservation of fish and wildlife resources. It does not imply an extractive activity. Because we do not conduct mosquito management operations ourselves, but allow it when necessary through agreements with mosquito control agencies, we believe mosquito management must be considered a use. The remaining comments and response regarding mosquito management are contained in Appendix O of the CCP.

Determination (Check One Below):

_____ Use is Not Compatible

___X___ Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

General Stipulations

- The MADs will be required to minimize the use of pesticides (e.g., choosing less toxic materials, using smaller quantities of more toxic chemicals, conducting fewer applications) and continually investigate formulations and compounds that are least damaging to fish and wildlife (including invertebrate) populations.
- Each MAD will be required to review the past year's Pesticide Use Proposals and submit any changes in the pesticides or formulations of pesticides that they expect to use in the upcoming year. This information will be made available at or before the time of the annual meeting.
- New products will not be applied without prior Refuge approval.
- Mosquito control will be authorized on a biennial basis by a SUP. The SUP conditions will stipulate that all mosquito control work will be carried out under the guidance of pre-approved PUPs.
- Pesticides will be applied according to pesticide label instructions and per habitat type.
- Aerial mosquito control application is encouraged over ground-based application methods.
- Aerial mosquito control applications will avoid low level flight over water to access or exit the Refuge as possible, thus minimizing bird disturbance.
- Application of larvicides and pupacides will be discouraged during high tide events in order to avoid impacts to tidal marsh species.
- Unless permitted by the Refuge Manager, pesticide application should not occur within 100 feet of major natural sloughs and channels that can disperse into navigable waterways and open water.

- Application of pesticides will be informed by monitoring of mosquito vector populations and surveillance indicating location of disease prevalence.
- MADs will adapt methods to reduce ecological risk to the environment (e.g., boom height, droplet size, application rate) as new information on ecological risk and avoidance measures are identified by appropriate regulatory agencies.
- To reduce the spread of non-native invasive plants all construction equipment, vehicles and personnel gear will be cleaned of seeds, soil or plant material before arriving on site.
- Oil and other hazardous material spill contingency plans must be implemented.
- Marsh vegetation is to be hand mowed and removed down to the bare ground before dredging occurs to prevent harm to the salt marsh harvest mouse.
- Areas of marsh vegetation that are submerged in water do not need to be mowed before dredging occurs.
- Before excavation occurs, crews must walk ahead of the equipment and haze mice out of vegetation.
- When clearing vegetation from an area, begin mowing from the center of the area to be cleared and work toward the edges to avoid trapping mice in remaining patches of vegetation.
- Mowed vegetation should be cleared from the area and stockpiled for later re-use if possible.
- A final report on activities will be provided by MADs by the end of the treatment year. MADs will provide dates of mosquito sampling and treatment, mapped locations and methods of sampling/treatment sites, species of mosquito and their population indices/frequencies.

Motor Vehicle Operation:

- Mechanized vehicles will only be allowed on levees and existing roads unless approved by the Refuge Manager.
- Techniques for approved ARGO operations are such that limit impact, including: slow speeds; slow, several point turns; and using existing levees or upland to travel through sites when possible.
- Access along tidal channels and sloughs is restricted in order to reduce impacts to vegetation used as habitat by wildlife (e.g., nesting and escape habitat).
- MADs are required to attend Refuge-approved training on measures to avoid impacts to wetland wildlife and in identification of sensitive species.
- Aerial pesticide (larvicide or pupacide) application is encouraged over ground-based application methods in areas with endangered species.
- Boat access to Corkscrew Slough, Calaveras Point and Mowry Slough will be limited to the center channel during the harbor seal pupping season, March 15-June 15 to prevent flushing of pups from their mothers.

Endangered Species Habitat:

- Inspections and treatments will be primarily performed on foot, when possible.
- Aerial pesticide (larvicide or pupacide) application is encouraged over ground-based application methods in areas with endangered species.
- Access (via foot or mechanized vehicle) to tidal marsh and muted tidal marsh for the purpose of mosquito management would not be allowed access from February 1 to July 15 in areas that are inhabited by California clapper rails without authorization of the Refuge Manager.

- Access (via foot or mechanized vehicle) to seasonal pond habitats for the purpose of mosquito management would not be allowed access from March 1 to September 15 in areas used by nesting snowy plovers without authorization of the Refuge Manager.
- Trucks and ARGOs would be restricted to established roads and berms in vernal pools areas. Only small, all-terrain vehicles will be permitted near vernal pools. Refuge staff will advise MAD staff on areas appropriate for motor vehicles. Only trained staff will be allowed to access vernal pools on foot in order to limit impacts to dispersing California tiger salamanders.
- MAD staff will avoid driving and stepping on Contra Costa goldfields. Refuge staff will provide a map of known Contra Costa goldfield sites and MAD staff will avoid driving in these areas during Contra Costa goldfield germination (coincides with vernal pool draw down) and blooming period.

Use of Pyrethrins:

- Use of adulticides must meet the following criteria: (1) when mosquito-borne disease incidence has been documented on the Refuge or within flight range of vector mosquito species present on the Refuge; (2) when any adult vector mosquito thresholds (varies by district) are exceeded on the Refuge; and (3) when there are no practical and effective alternatives to reduce a mosquito-borne, disease-based health threat.
- Adulticides must be approved for use by the Service's National IPM Coordinator.
- The application of pyrethrums must be limited to reduce impacts to habitat and wildlife (i.e., during the time period when there is a mosquito-borne virus detected on or in mosquito flight range of the Refuge, or high risk to public health was documented), but sufficient to ensure effective mosquito control.
- The application of pyrethrums should occur at an ultra-low volume (according to pesticide label instructions and per habitat type).
- If beneficial, the MAD should conduct simultaneous application of larvicides with the adulticide application to prevent future adult outbreaks.
- Application would only occur during low tides to avoid impacts to fish that may move into the tidal marsh plain during high tides.
- The application of pyrethrums should occur only where monitoring and surveillance data justify its use (e.g., incidence of mosquito-borne disease, exceedance of tolerance limits for adult mosquitoes).
- Refuge staff and visitors must be notified prior to adulticide treatments. Information about treatment scheduling, location, and type of pesticide must be posted by the MADs in areas where treatments would occur when those areas could be accessible to Refuge staff or the public.
- The application of pyrethrins should occur only in specific, discrete areas where monitoring data justify its use.

Justification:

Mosquitoes are a natural component of tidal wetlands but pose a significant potential threat to human and/or wildlife health. This potential threat is especially significant where Refuge wetlands are within the known mosquito flight ranges of urbanized areas. The arbovirus labeled WNV has been of particular concern across the United States and in the San Francisco Bay region and mosquito species known to occur on the Refuge have been shown to transmit WNV and other diseases that affect humans and/or wildlife.

Measures to control mosquitoes in wetlands of the Bay Area have a long history that dates back to the early 1900s when the first mosquito district was formed in Marin County, California. The association between mosquitoes and certain vector-borne diseases is also well known (e.g., WNV). Historic measures for reducing mosquitoes includes draining or filling wetlands, but today a suite of other measures are now in place and include the placement and maintenance of mosquito ditches, tidal circulation enhancement and wetland restoration and application of biological and chemical controls. Today, the staff of both the Refuge and the MADs that operate in San Francisco Bay advocate for an integrated approach to mosquito management that includes a range of tools to improve habitat conditions for estuarine wildlife while reducing threats to public health from mosquito species capable of transmitting disease to humans.

With the continued existence of WNV and the potential for spread of other mosquito-borne disease, pressure is increasing to manage mosquito populations that occur on lands of the NWRS, especially in urban areas such as the San Francisco Bay region. There was one reported human case of WNV in Santa Clara County in 2011. The last reported human case of WNV in Alameda County was 2010. There were no humans cases of WNV reported in San Mateo County from available state reports (2007 to present). (http://www.westnile.ca.gov, accessed September 26, 2011)

A "Draft Mosquito and Mosquito-Borne Disease Management Policy" was published by the Service in October 2007, but has not yet been finalized. The Service's "Interim Guidance for Mosquito Management on National Wildlife Refuges" finalized in April 2005, provides guidance for mosquito management that is currently conducted on national wildlife refuges. The interim guidance provides a standard process for refuges to follow and criteria to consider when making decisions regarding management of mosquitoes and mosquito-borne disease. Mosquito control management plans and documentation of management actions on refuges are necessary to protect both threatened and endangered plants, fish, and wildlife and to ensure the health and welfare of surrounding human populations. This use is in compliance with the Interim Guidance. The stipulations ensure that the proposed use is compatible and would not materially interfere with or detract from fulfilling the refuge purposes and the Refuge System mission.

Mandatory Re-evaluation Dates (Provide Month and Year)

_____ Mandatory 15-year Reevaluation Date (for priority public uses)

___X___ Mandatory 10-year Reevaluation Date (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (Check One Below)

_____ Categorical Exclusion

___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)	9/24/12 (Date)
Refuge Manager:	(Signature)	9/26/12 (Date)
Project Leader Approval:	(Signature)	9-26-2012 (Date)
Concurrence Refuge Supervisor:	Dave Linehan (Signature)	9/26/2012 (Date)
Assistant Regional Director, Refuges:	Margaret J. Kolar (Signature)	10/1/2012 (Date)

Compatibility Determination for Wildlife Observation & Photography
Don Edwards San Francisco Bay NWR

Use: Wildlife Observation and Photography

Refuge Name: Don Edwards San Francisco Bay National Wildlife Refuge, Alameda, Santa Clara and San Mateo Counties, California.

Establishing and Acquisition Authorities:
86 Stat. 399, dated June 30, 1972

An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes (16 U.S.C. 667b)

Endangered Species Act of 1973 (16 U.S.C. 1534)

Fish and Wildlife Act of 1956 (16 U.S.C. 742f)

Refuge Purpose(s):
"... for the preservation and enhancement of highly significant wildlife habitat ... for the protection of migratory waterfowl and other wildlife, including species known to be threatened with extinction, and to provide an opportunity for wildlife-oriented recreation and nature study ..." (86 Stat. 399, dated June 30, 1972).

"... particular value in carrying out the national migratory bird management program" 16 U.S.C. 667b (An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes).

"... 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).

"... 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).

National Wildlife Refuge System Mission: The mission of the National Wildlife Refuge 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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-668ee]).

Description of Use: This compatibility determination is done as a review of the existing compatibility determination (1994) for selected outdoor recreation activities that include bicycling, hiking, jogging, walking, wildlife photography, and wildlife observation. It is also done in concert with the Don Edwards San Francisco Bay NWR Comprehensive Conservation Plan. This compatibility determination replaces the previous 1994 compatibility determination for selected outdoor recreation activities.

Wildlife observation and photography are two of six public uses (the other uses are hunting, fishing, environmental education, and interpretation) given priority on refuges as defined by Executive Order 12996 and the National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57).

Currently, wildlife observation and photography is permitted on foot (e.g., walking, hiking, and jogging) and bicycling on designated trails. The navigable and open waters of the Refuge are also open to boats. The Refuge has over 30 miles of trails (generally hard-packed gravel surface or paved) in the cities of Fremont, San Jose, East Palo Alto, Mountain View, Menlo Park, Sunnyvale, and Redwood City open during posted Refuge hours (which vary seasonally and by location). All motorized vehicles are prohibited on Refuge trails in order to protect ecologically sensitive areas. Bicycling is permitted on all roads and trails except the LaRiviere Marsh Trail. Information is posted on outdoor kiosks or available from staff. Additional wildlife viewing facilities will be constructed as funding is acquired. A raised boardwalk will be constructed at the Faber-Laumeister site to enhance the existing trail area, which is currently a hard-packed gravel surface. A small percentage of Refuge trails are designated as a part of the Bay Trail[1] or Bay Trail spur. Participating landowners of the Bay Trail set regulations for individual trail segments. Marshlands Road (Fremont) and the Moffett Bay Trail connector (Alviso) provide biking opportunities that are well used.

Under the comprehensive conservation plan, at least one universally-accessible photo blind will be constructed to facilitate wildlife photography and a wildlife photography permit system will be created to improve access for wildlife photography (e.g., expanded hours, additional site access).

In addition to guided activities, the Refuge supports wildlife observation through a variety of self-guided activities. Maps and trail guides are available at interpretive kiosks, which are located near Refuge parking lots and trails, and at visitor facilities in Fremont and Alviso. A bird list is provided free of charge via printed brochure and by internet download. A variety of items are available for loan that aid in self-guided wildlife observation. These include: Children's Discovery Packs, Family Birding Packs, adult birding kits, and binoculars. All are available for the public to borrow free of charge. A remote camera system will also be investigated for installation in a location that can provide virtual wildlife observation (e.g., colonial bird rookery, harbor seal pupping area, etc.).

Many area organizations use the Refuge trails to conduct field trips for the purpose of wildlife observation and wildlife photography. Three chapters of the Audubon Society conduct their annual Christmas bird counts and breeding bird surveys at the Refuge. Ohlone Audubon covers the Alameda County area. Santa Clara Audubon covers the Alviso area. Sequoia Audubon covers Bair Island.

Availability of Resources:
Funding and staffing exists to manage the existing opportunities for wildlife observation and photography on the Refuge. Additional staff and Service funding will be necessary to expand the wildlife observation and photography activities as prescribed in the CCP and as described in the following table. A visitor services information assistant and interpretive park ranger (position

[1] The Bay Trail is a planned recreational corridor that, when complete, will encircle San Francisco and San Pablo Bays with a continuous 500-mile network of bicycling and hiking trails.

shared with other programs) will be needed to conduct and enhance the additional guided and self-guided opportunities. An additional maintenance worker (position shared with other programs) will be needed to maintain and install new public use infrastructure. Replacement of signage, installation of additional signage and other outreach materials, improvements to the Tidelands Trail, construction of a boardwalk at the Faber-Laumeister site, installation of additional wildlife viewing facilities, installation of a photography blind, and a remote camera system will be needed to facilitate wildlife observation and photography. Grants and other funding sources will be sought as well.

Item	One-Time Cost	Annual Costs
Interpretive Park Ranger (0.5, GS-0025-9)		$39,500
Visitor Services Information Assistant (GS-0025-4/5)		$46,500
Maintenance Worker (0.25, WG-4749-6/7/8)		$16,250
Update old or outdated interpretive materials- information sheets and interpretive panels		$2,000
Improve Tidelands Trail Boardwalk (water bars)	$20,000	
Construct boardwalk at Faber-Laumeister site	$400,000	
Construct wildlife viewing facilities		$100,000
Remote camera system	$50,000	
Photography blind	$2,000	
TOTAL	**$472,000**	**$164,750**

Anticipated Impacts:
Wildlife observation and photography will have positive benefits to the local community and visitors. Wildlife observation and photography provide opportunities to improve understanding and stewardship of habitat and wildlife resources. The uses will encourage connections between people and the outdoors, with the ultimate intent of protecting and conserving these natural resources.

Habitat
Wildlife observation and photography may result in minor disturbance to habitat such as trampling of vegetation, soil erosion, and soil compaction. Wildlife observation and photography is generally only allowed on designated levees and trails that have little to no vegetation since they are hard-packed gravel. Trails function as habitat and conduits for movement of plant species, including non-native, invasive plants (Dale and Weaver 1974). Refuge visitors provide a potential mechanism for non-native seed dispersion. Boaters conducting wildlife observation or photography also have the potential to crush vegetation if they exit their boats in areas that are not designated launch sites.

The photo permit system for wildlife photography may result in trampling of vegetation or dispersal of non-native seeds by allowing a limited number of individuals into areas closed to the public. These individuals could trample vegetation if they should wander off-trail. The number of

individuals in non-public areas is expected to be low (less than 12 people at a time in different areas of the Refuge). Access for this type of photography will be restricted with rules and further limited during sensitive breeding periods. Vehicular traffic associated with trail maintenance and Refuge management activities may introduce and spread non-native species onto the Refuge. Creation of additional infrastructure (e.g., wildlife viewing facilities, photography blinds) as well as infrastructure improvements could also result in displacement of habitat. However, such loss is expected to be minor based on avoidance, minimization, and other best management building practices.

Wildlife
Large numbers of waterfowl, shorebirds, fish and other wildlife species use the Refuge for feeding, resting and in some cases, breeding. Several species, listed under the Federal Endangered Species Act as Threatened or Endangered, are present on the Refuge: vernal pool tadpole shrimp (*Lepidurus packardi*), steelhead (*Oncorhynchus mykiss*), California tiger salamander (*Ambystoma californiense*), California clapper rail (*Rallus longirostris obsoletus*), California least tern (*Sterna antillarum browni*), western snowy plover (*Charadrius alexandrinus nivosus*), salt marsh harvest mouse (*Reithrodontomys r. raviventris*), and Contra Costa goldfield (*Lasthenia conjugens*).

Wildlife observation and photography may result in wildlife disturbance, eliciting responses including: 1) avoidance, 2) habituation, and 3) attraction (Knight and Cole 1991).
Immediate responses by wildlife to recreational activity can range from behavioral changes including nest abandonment or change in food habits, physiological changes such as elevated heart rates due to flight, or even death (Knight and Cole 1991). The long term effects are more difficult to assess but may include altered behavior, vigor, productivity or death of individuals; altered population abundance, distribution, or demographics; and altered community species composition and interactions.

Avoidance response may depend on a number of factors including the type, distance, movement pattern, speed, and duration of the disturbance, as well as the time of day, time of year, weather; and the animal's access to food and cover, energy demands, and reproductive status (Knight and Cole 1991; Gabrielsen and Smith 1995). Human activities along wildlife observation trails can reduce foraging or even cause migratory birds to avoid foraging habitats adjacent to the trails (Klein 1993), especially when actions involve close proximity and/or fast-moving human activities (Burger 1981). Rapid movement by joggers is more disturbing to wildlife than slower moving hikers (Bennett and Zuelke 1999). However, joggers tend to spend less time in a particular area than pedestrians and are less likely to directly approach or otherwise disturb wildlife. Bicycling is not anticipated to disturb wildlife more than other public access, such as hiking, because riders are restricted to designated trails therefore making their movements more predictable for wildlife.

Activities along trails tend to displace wildlife and can cause localized reduction in species richness and abundance (Riffell et al. 1996). In addition, nest predation tends to increase near more frequently utilized areas for songbirds (Miller et al. 1998), raptors (Glinski 1976), colonial nesting species (Buckley and Buckley 1976), and waterfowl (Boyle and Samson 1985). Knight and Cole (1991) suggest that sound may elicit a much milder response from wildlife if animals are visually buffered from the disturbance.

Boating to facilitate wildlife observation and photography may result in disturbance. A 2008 study of the behavioral response of harbor seals to boaters at Bair Island found that seal vigilance

increased as boats passed the haul-out, and as boats came closer to the seals. Though within ten minutes of the disappearance of the boats, the seals relaxed. During 70 percent of the boating events, seals did not flush, remaining at the haul-out. When flushing did occur, the seals almost always recovered within the large haul-out area. However, total seal numbers observed during days with multiple boats were lower than observed on days without boating activity (Fox 2008)

Wildlife observation and photography may also result in habituation by wildlife. Habituation is defined as a form of learning in which individuals stop responding to stimuli that carry no reinforcing consequences for the individuals that are exposed to them (Alcock 1993). A key factor for determining how wildlife would respond to disturbance is predictability. Often, when a use is predictable -- following a trail or boardwalk or at a viewing deck – wildlife will accept human presence (Oberbillig 2000). Gabrielsen and Smith (1995) suggest that most animals seem to have a greater defense response to humans moving unpredictably in the terrain than to humans following a distinct path. Wildlife may also be attracted to human presence. For example, wildlife may be converted to "beggars" lured by handouts (Knight and Temple 1995), and scavengers are attracted to road kills (Rosen and Lowe 1994).

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). 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 and the tendency of causal photographers with low-power lenses to get much closer to their subjects than other activities would require (Dobb 1998). This usually results in increased disturbance to wildlife and habitat, including trampling of vegetation as mentioned previously. Despite access to non-public areas, wildlife photographers are not expected to significantly impact wildlife because there will be restrictions on the number of individuals allowed access, rules on responsible wildlife watching, and prohibited access during sensitive breeding periods. Further, photography blinds will further lessen photographers' impacts on wildlife and their habitat by reducing the frequency of unauthorized off-trail use, thus reducing the amount of vegetation trampled and the time spent in close proximity to the wildlife they are trying to photograph.

The activities associated with this use are not expected to significantly impact the ability of the Refuge to protect wildlife, diverse tidal marsh, seasonal wetland habitats and adjacent transitional uplands critical to the needs of migratory birds and listed species. The Refuge is already open to public access and also provides habitat for waterfowl, waterbirds, shorebirds and terns. Regulatory signage should also reduce disturbance to wildlife and damage to sensitive habitat areas. Increasing public awareness is also expected to reduce the frequency and degree of adverse impacts resulting from this use. Outreach and education is critical for making visitors aware that their actions can have negative impacts on wildlife, and will increase the likelihood that visitors will abide by restrictions on their actions. For example, Klein (1993) demonstrated that visitors who spoke with refuge staff or volunteers were less likely to disturb birds.

Potential Conflicts between User Groups

Shared-use trails attract a variety of user groups who often have conflicting needs. People with disabilities may be particularly affected if they do not have the ability to quickly detect or react to hazards or sudden changes in the environment.

Bicycles using the same trail as pedestrians may present a safety hazard to visitors. If the number

of trail users increases as predicted, the potential for accidents or user group conflicts may also increase. However, the proposed trails meet Federal Highway Administration standards for shared use path design (Federal Highway Administration 2001) and should be able to accommodate increased use. Although user groups are not physically separated, the trails provide sufficient tread width, grade (essentially flat), viewing distance, clearance, and a firm and stable surface for safe, shared use by pedestrians and joggers, as well as bicycle riders traveling at a safe speed.

Measures to reduce potential conflicts between user groups would include providing information at the trailhead, Visitor's Center, EEC, and in the Refuge's brochure that clearly indicates permitted users and rules of conduct. Providing signs that clearly indicate which users have the right of way would help mitigate conflict (Federal Highway Administration 2001). Trail etiquette signing would clearly state that bicycles should give an audible warning before passing other trail users.

Potential conflict with other public use such as hunting, and interpretation will be minimized by using trail head signs and other media to inform the various users about current public uses.

Public Review and Comment:
Public review and comments were solicited in conjunction with distribution of the Draft CCP/EA for Don Edwards San Francisco Bay NWR, released in May 2012. One commenter requested that further analysis on boating impacts in the CD. Information on boating impacts was added to the "Anticipated Impacts" section.

Determination:

_____ Use is Not Compatible

___X___ Use is Compatible with Stipulations

The following stipulations are required to ensure compatibility:

- Staff, brochures, and signage and other informational material such as websites will inform visitors of proper etiquette for wildlife observation and photography (including methods for proper bicycling).

- Collection of plants, animals, and other specimens, debris, or artifacts by visitors is strictly prohibited.

- Maintenance and construction activities related to Refuge roads, trails, and other visitor infrastructure would occur during specific periods of the year to avoid disturbance or impacts to birds during breeding season.

- Infrastructure to facilitate these public uses will be designed to minimize impacts to wildlife though proper location, design and building material.

- Most public uses will be confined to trail surfaces and the public will not be allowed to enter adjacent habitat or closed areas.

- No bicycling is permitted on La Riviere Marsh Trail.

- No motorized vehicles or skateboards are permitted on Refuge trails.

- Dog walking is prohibited on the Refuge except on the Refuge's Tidelands Trail. This trail is closely monitored by Refuge staff and volunteers due to its proximity to Refuge staff offices. Dogs will be permitted on this trail only if they are on a six-foot or shorter leash and are under the direct control of the dog walker. The dog walker must pick up and properly dispose of their dog's waste. Monitoring will include user estimates, compliance with regulations, impact on wildlife and conflicts between other user groups and dog walkers. If impacts to wildlife or their habitats are identified that cannot be effectively mitigated, dog walking may be prohibited on this trail as well.

- Wildlife photography will be permitted in areas closed to the public under a Special Use Permit. There will be restrictions on number of individuals, rules on responsible wildlife watching, and prohibited access during sensitive breeding periods.

- Buffers will be maintained around existing trails and viewing platforms to protect nesting and roosting birds. Buffers will be included in the design of any new viewing platforms, boardwalks, or other relevant infrastructure.

- Refuge law enforcement will ensure compliance with regulations and area closures, and will discourage vandalism and off trail activity.

- Several stipulations would minimize the potential for impacts from non-native species invasion. First, public uses would be restricted to level surfaces, which would reduce spread of non-native seed from the levees and boardwalks onto the Refuge. Second, invasive plants that germinate on the levee top and sides would be treated with herbicide. Third, monitoring and surveillance of invasive species would increase, reducing the potential for new invasive species to become established on the trail and spread into the Refuge.

- Potential conflict with other public use such as waterfowl hunting, environmental education, and interpretation activities will be minimized by using trail head signs and other media to inform the various users about current public uses; if necessary, activities will be separated in time and place.

- Trails, platforms, blinds and other wildlife observation and photography facilities will be subject to seasonal closures during bird breeding season (April – August) if deemed necessary, based on the species needs and the results of adaptive management studies.

- Trails will only be open for wildlife observation and photography during posted Refuge hours (generally daylight hours).

- No organized races will be permitted on Refuge trails.

Justification: Wildlife observation and wildlife photography are Priority Public Uses as defined by the NWRS Administration Act of 1966, as amended by the NWRS Improvement Act of 1997

(Public Law 105-57), and if compatible, are to receive enhanced consideration over other general public uses. These uses are supportive of the Refuge's purposes and the mission of the NWRS. Wildlife observation and photography would provide an excellent forum for allowing public access and increasing public understanding and appreciation of Refuge resources. The Refuge is one of the few areas in the urban South San Francisco Bay to be able to offer these uses. It is one of the only locations with access to former commercial salt ponds and the open bay that is managed for wildlife and can offer these wildlife oriented activities in these unique habitats.

Potential for wildlife disturbance is expected to be minimal. Restricting the disturbance to an established trail with appropriate set-back distances (buffers) would increase predictability of public use patterns on the Refuge, allowing wildlife to habituate to non-threatening activities. Consolidating compatible recreational activities to designated trails, located at the edge of the Refuge habitat boundary, reduces habitat fragmentation, thereby maintaining a core "sanctuary area" of the Refuge for more sensitive species.

The stipulations outlined above are expected to minimize potential impacts relative to wildlife/human interactions. In particular, the adaptive management studies will determine the exact nature of the public use impacts on the Refuge's wildlife and allow Refuge managers to adjust public use to further minimize wildlife impacts or discontinue those activities that are unacceptable. The proposed activities will not materially interfere or detract from the fulfillment of the NWRS Mission or the purposes of the Refuge.

Mandatory Reevaluation Date (provide month and year):

____X____ Mandatory 15-Year Reevaluation Date (for priority public uses)

_____ Mandatory 10-Year Reevaluation Date (for all uses other than priority public uses)

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

Conducted with Comprehensive Conservation Plan

_____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) 9/24/12 (Date)

Refuge Manager: _____ (Signature) 9/26/12 (Date)

Acting Project Leader Approval: _____ (Signature) 9-26-2012 (Date)

Concurrence
Refuge Supervisor _____ (Signature) 9/26/2012 (Date)

Assistant Regional Director, Refuges _____ (Signature) 10/1/2012 Date)

Compatibility Determination for Wildlife Observation and Photography

Compatibility Determination for Environmental Education and Interpretation

Don Edwards San Francisco Bay National Wildlife Refuge

Use: Environmental Education and Interpretation

Station Name: Don Edwards San Francisco Bay National Wildlife Refuge, Alameda, Santa Clara and San Mateo Counties, California

Date Established: June 30, 1972

Establishing and Acquisition Authorities:
86 Stat. 399, dated June 30, 1972

An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes (16 U.S.C. 667b)

Endangered Species Act of 1973 (16 U.S.C. 1534)

Fish and Wildlife Act of 1956 (16 U.S.C. 742f)

Refuge Purpose(s):
"... for the preservation and enhancement of highly significant wildlife habitat ... for the protection of migratory waterfowl and other wildlife, including species known to be threatened with extinction, and to provide an opportunity for wildlife-oriented recreation and nature study ..." (86 Stat. 399, dated June 30, 1972).

"... particular value in carrying out the national migratory bird management program" 16 U.S.C. 667b (An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes).

"... 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).

"... 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).

National Wildlife Refuge System Mission: The mission of the National Wildlife Refuge System (NWRS) 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" (NWRS Administration Act of 1966, as amended [16 U.S.C. 668dd-668ee]).

Description of Use: This compatibility determination is done in concert with the Don Edwards San Francisco Bay NWR Comprehensive Conservation Plan. Environmental education and interpretation are two of six public uses (the other uses are hunting, fishing, wildlife observation,

and photography) given priority on refuges as defined by Executive Order 12996 and the National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57).

Environmental Education
The Refuge was established to provide opportunities for "nature study". Because environmental education is part of the Refuge purposes, it is a high priority for the Refuge. To this end, the Environmental Education Center (EEC) was built in 1979 to facilitate environmental education. The Environmental Education Program serves over 10,000 students annually, providing supporting materials for other educators along with curriculum-based field trips and classroom presentations. Known for developing high quality, innovative instructional models and programmatic materials, the Refuge is a leader in the environmental education field and also provides trainings and resources for other educators in the U.S. Fish and Wildlife Service (Service) and the national environmental education community.

The majority of field trips and educational programs take place at the headquarters site in Fremont (hereafter referred as headquarters) and the EEC, which is located in Alviso. As prescribed in the comprehensive conservation plan (CCP), the EEC will be remodeled to accommodate additional programs as well as meet LEED certification requirements. School districts and students from all over the Bay Area participate in field trip programs. Additional programs occur on the Faber-Laumeister sub-unit of the Refuge in East Palo Alto. Several funding partnerships allow us to provide a variety of educational programs. Some of the partners include the City of San Jose, Santa Clara Valley Urban Runoff Pollution Prevention Program, and San Francisco Bay Wildlife Society. To facilitate environmental education in the future, a LEED-certified visitor services complex will be constructed at headquarters, as prescribed in the CCP.

Some of the many environmental education programs taking place or planned for the future as prescribed in the CCP at the Refuge are described below:

<u>Wetland Round-up</u>
Wetland Round-up is an educator-led field trip program designed for grades K-6. It is the oldest and largest environmental education program on the Refuge. Conducted both at the EEC and the headquarters, this program brings schoolchildren out to the Refuge to learn about tidal marsh, endangered species, native wildlife, and the importance of their habitat.

All activities are correlated to State of California Education Standards. Teachers are required to attend a teacher orientation once every 2 years. It is recommended that parents also attend training. Parents lead the hands-on activities by using a "Do, Read, Ask" teaching script. The program is offered 3-4 times per week October-December and March-May. The Salt Marsh Manual, an educators' guide, is provided to teachers to help plan their field trip. The Salt Marsh Manual presents all the activity scripts, pre- and post-visit activities, background information, guidance on planning the field trip, and other resources. Educator training and environmental education resources will be improved for use by partners and educators.

To support this program, the Refuge provides a video lending library for teachers. The Salt Marsh Manual will be translated to Spanish. Additional partners will be sought to host this program (e.g., Girl Scouts).

Slow the Flow

The *Slow the Flow* program seeks to inform participants about water pollution and consumption habits as they relate to habitat protection and endangered species conservation. This program connects the *Slow the Flow* messages to visitors and students through classroom presentations, field trips, interpretive programs, and outreach events (e.g., Bird Fest, Spooky Slough). The field trip program covers 5th grade through college, an age group not covered by Wetland Round-up. This program provides over 5,000 visitor experiences per year. Under the CCP, the Refuge staff plan to increase capacity for joint Water Pollution Control Plant/EEC tours and improve the *Slow the Flow* curriculum.

Restoration Education

The restoration education program is a service learning program (a combination of community service and classroom curriculum) which focuses on habitat restoration. Each year, over 300 students from a local high school participate in wetland studies and service learning at the headquarters. The Habitat Heroes Summer Camp program also includes restoration education at the headquarters.

In Alviso, local elementary school, middle school, and college students have participated in service learning programs since 2006, and in 2010 a restoration education field trip program was piloted for elementary and college-aged students. This program is continually being modified and improved. We will develop and expand the audience for this program to neighboring communities over the life of the CCP. Habitat restoration programs will be developed for Warm Springs, Mayhew's Landing, Alviso, Fremont, and East Palo Alto.

The restoration education program also serves non-school based audiences. The restoration education program in Alviso utilizes a Native Plant Demonstration Garden. The garden is used by the EEC staff to teach children and adults about planting techniques and native plant species that can be used to provide habitat for a variety of wildlife in their home garden. Education programs about native plants and gardening with native plants are offered quarterly.

A different approach to restoration education has been used on the Faber-Laumeister sub-unit of the Refuge located in East Palo Alto. A summer employment program for local high school students was started in 2010, using Youth Conservation Corps funding, to engage young people in habitat restoration education. In 2010, we also started providing service learning opportunities for school clubs and after school programs in East Palo Alto and vicinity. These opportunities will be expanded to include school field trips.

Summer Camp Programs

The Refuge hosts two free summer day camps for youth: Marsh-In Summer Day Camp and Habitat Heroes Camp. Together, these camps provide opportunities for children in 1st-12th grade to learn more about the Refuge, ecology, and conservation. The program is tiered so that youth continue to benefit from the experience as they grow.

The Marsh-In Summer Day Camp, established in 1980 and held at the EEC, is designed for grades 1-6. For one week, campers participate in hands-on activities such as crafts, games, and nature walks, designed to connect children to nature and to teach about wildlife, plants, habitats, and natural resource conservation. On the last night of camp, campers in grades 4-6 spend the night under the stars at the EEC.

The Habitat Heroes camp at headquarters began in 2007 and is designed for grades 7-12. Each year through the Habitat Heroes program, a dozen teens develop leadership and team-building skills by participating in trust and problem solving activities. Most of the participants are former Marsh-In Summer Day Camp attendees. Service projects are included throughout the week. In addition, the teens pledge future service to the Refuge and practice their new skills as junior counselors at the Marsh-In Summer Day Camp. Habitat Heroes introduces a new generation of leaders to our refuge and develops them as dedicated stewards. Many past participants in the Habitat Heroes program continue to volunteer at the Marsh-In Summer Day Camp and also at other Refuge events to provide opportunities for others to learn about conservation and the Refuge. The Habitat Heroes Program will be expanded to include enrichment activities throughout the year.

Climate change

The environmental education program will be expanded to include a climate change curriculum and the effects of climate change on Refuge resources. The future LEED-certified visitor service complex and EEC will be used as demonstration tools to encourage others to implement LEED features.

Scout Programs

Programs tailored to meet badge requirements for the Girl Scouts and Boy Scouts of America are offered at the EEC and at the headquarters. Activities are presented intermittently depending upon the expertise and availability of EEC staff. At the EEC, Webelos, Junior Girl Scout Badge, and Brownie Eco-Explorer patch programs are offered. At the headquarters site, Webelos programs are offered. Discovery Packs for self-guided activities will be redesigned to improve the Program.

Santa Clara Valley Urban Runoff Pollution Prevention Program

The Santa Clara Valley Urban Runoff Pollution Prevention Program provides grant funding for a full-time interpretive specialist and a stipend for a part-time intern to administer the *Watershed Watchers* program at the EEC. The program presents a range of interpretive programs. All programs revolve around a common theme: Our Role in Preventing Urban Runoff Pollution. Scout packs and troops, Lyceum groups, after-school child care centers, universities, and senior centers all participated in tours of the wetlands at the Refuge. Through discussions and activities, participants learned about the Refuge's unique habitats, the diverse life dependent on these habitats, and the protection of wildlife through prevention of urban runoff pollution from storm drains. This program hosts several popular special events at the Refuge including the South Bay Bird Festival, Shark Day, and Spooky Slough. The Refuge relies directly on this funding and staffing to keep the EEC open on Saturdays.

Interpretation:

The Refuge provides an extensive interpretive program that offers guided programs, self-guided opportunities, and special annual events. The CCP calls for the EEC to be remodeled to provide better interpretive exhibits. The CCP also identifies that a visitor services complex will be constructed at the headquarters to house interpretive exhibits and activities.

Guided Programs

Refuge staff and volunteers offer over 200 guided interpretive programs annually. The majority of programs are given at the headquarters and the EEC, though programs are regularly offered at other Refuge and partner sites. These programs are conducted on the Refuge at the following

locations: Ravenswood sub-unit, Stevens Creek East Trailhead, and the Dumbarton Bridge fishing pier.

Programs cover a variety of natural and cultural history topics. A sample of the topics presented includes: bird watching, historical use of local marshlands, wetlands restoration, salt marsh ecology, nature photography, native plants and animals, star gazing, and pollution prevention. Conducted programs include walks and hikes, bike and van tours, fishing clinics, planting parties, habitat restoration clean-up events, photography and sketching workshops, festivals and special events. Under the CCP, the interpretive programs will be updated with at least two new interpretive opportunities annually, such as outdoor recreation-based activities (e.g., yoga program, bicycling tours). A water-based guided program such as canoe or kayak tours will be researched and offered as feasible. The CCP calls for interpretation to be expanded at the Warm Springs sub-unit with at least four tours during the vernal pool flowering season and interpretive materials (e.g., panels and information sheets). Outdated or old interpretive materials such as panels and information sheets will be replaced. The EEC will also be updated to provide visitor contact or information services on the weekends.

Tours are provided for specific program areas including the South Bay Salt Pond Restoration Project (SBSPRP), Watershed Watchers, and garden tours. Private interpretive programs are also offered through special request. Audubon chapters, scout troops, community groups, senior centers, teachers' associations, and college classes are just a few groups which take advantage of this opportunity.

The interpretive program for the SBSPRP focuses on wetlands restoration and wildlife. Elements of the interpretive program for the SBSPRP include guided public programs, development of interpretive media and displays, and creation of a docent program. Guided public programs are offered once per week at a minimum and often include birding classes, van and bicycle tours of the managed ponds, hikes, and talks. Van tours of the SBSPRP allow visitors with lower mobility get out into the pond landscape. Private tours and programs for special groups, such as university classes and media outlets, are also conducted by reservation.

Garden tours of the EEC's habitat gardens and introductions to chemical-free gardening techniques are also conducted. The annual Native Plant Nursery Open House during National Wildlife Refuge Week offers techniques on how to garden with native plants for wildlife.

Self-Guided Interpretive Opportunities

The Refuge provides visitors a range of self-guided opportunities to help them connect with Refuge resources. Interpretative displays and other information signs in Alviso are presented in English and Spanish. Another self-guided interpretive program using Refuge-designated geocaches helps to promote connections between the Refuge and people through current technology.

Old or outdated interpretive signs on the Refuge are being and will continue to be updated over the life of the CCP to help facilitate self-guided walks. Over 30 new signs have been created and installed since 2009. They are found along the Tidelands trail (Fremont), the Marsh View, New Chicago Marsh, Mallard Slough and Moffet Bay Trail trails (Alviso) and the SF2 trail (Ravenswood). The Tidelands Trail in Fremont is registered as a National Recreation Trail in the National Trails System and a spur of the San Francisco Bay Trail. Two new audio tours will also be created to facilitate a future self-guided auto tour route at the headquarters. A nature exploration area will be developed at the headquarters to promote the Service's "Children in

Nature" Initiative and the NWRS Vision.

New interpretive exhibits at the Visitor Contact Station (VCS) (2010) and the EEC (2010-11) also provide opportunities for self-guided discovery of refuge resources. The VCS exhibits introduce the visitor to the San Francisco Bay NWR Complex (including the Don Edwards National Wildlife Refuge), refuge wildlife, and wetlands restoration efforts. The EEC exhibits illustrates and interprets five periods of human history along the Bay shoreline.

A Refuge program uses staff-designated geocache sites in appropriate areas of the Refuge to facilitate interpretive opportunities. Participants use a Global Positioning System (GPS) receiver or other navigational techniques to hide and seek containers (called "geocaches" or "caches") anywhere in the world. Although traditional geocaching is prohibited on Refuge lands, an alternate program has been made available to gadget lovers. The Refuge has placed coordinates or "caches" in compatible locations with information about the Refuge in order to connect people with nature through current technology. This activity encourages the public to explore various parts of the Refuge in the South and East Bay and learn more about Refuge objectives.

Special Events
Special events are also held on the Refuge as vehicles for interpretation. Currently special events are described below. Ten, on-site, annual special events will be held annually within the life of the CCP. Currently, these include the following:

Earth Day
The annual Earth Day Clean-Up takes place at the Ravenswood Unit in Menlo Park. Staff and volunteers lead participants on the trail picking up trash. Working alongside staff gives participants a unique perspective on management issues and wildlife that they might not otherwise receive.

Endangered Species Poster Contest/Endangered Species Day
The Endangered Species Poster Contest has been in existence for 28 years and is co-sponsored by the San Francisco Bay Wildlife Society. The contest is open to schools with grades K-6 in Newark, Union City, Fremont, and East Palo Alto.

South Bay Bird Fest
The South Bay Bird Fest is hosted by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) at the EEC to celebrate International Migratory Bird Day. The Santa Clara Valley Audubon Society, San Francisco Bay Bird Observatory, and San Francisco Bay Wildlife Society collaborate with Refuge staff and SCVURPPP staff to hold this very popular interpretive event. In 2010, over 300 participants took part in its bird walks, migratory songbird gardening workshops, and live bird show.

Coastal Clean-Up Day
The Refuge hosts a Coastal Cleanup in Fremont each September in coordination with the Alameda County Coast Cleanup Commission. In 2010, well over 150 volunteers participated in the cleanup along Shoreline Trail.

National Wildlife Refuge Week
The Refuge hosts a range of onsite activities and events in celebration of National Wildlife Refuge Week. The Connections to Pier Fishing event and a native plant sale are annual offerings. In

addition, each year a new event is offered to help encourage participation from returning visitors. Events have ranged from Open Houses to drawing and photography demonstrations to competitive games and always focus on refuge objectives, wildlife, natural history, and/or conservation.

Availability of Resources:
Funding and staffing is available to manage the existing environmental education and interpretation for the Refuge. Additional staff and Service funding will be necessary to expand the environmental education and interpretation programs as prescribed in the CCP as described in the following table. A visitor services information assistant and interpretive park ranger (position shared with other programs) will be needed to conduct and enhance the additional guided and self-guided opportunities. Two additional environmental education specialists, one with bilingual background, will be needed for the expanded environmental education program. An additional maintenance worker (position shared with other programs) will be needed to maintain and install new public use infrastructure. A visitor center complex at the headquarters, update of the EEC, replacement of interpretive materials, and materials for conducting new programs will be needed to expand environmental education and interpretation. Construction of a nature exploration area will encourage children to explore the outdoors and support the Service's Children in Nature initiative. Grants and other funding sources will be sought as well.

Item	One-Time Cost	Annual Costs
Visitor Services Information Assistant (GS-0025-4/5)		$46,500
Interpretive Park Ranger (0.5, GS-0025-9)		$39,500
Bilingual Environmental Education Specialist (GS-1701-9)		$79,000
Environmental Education Specialist* (GS-1701-9)		$79,000
Maintenance Worker (0.25, WG-4749-6/7/8)		$16,250
Visitor Center Complex	$7,000,000	
New interpretive programs		$200
10 special events		$1,000
Update old or outdated interpretive materials		$2,000
Update EEC	$3,500,000	
Climate change/LEED curriculum	$10,000	$500
New teacher and student resources	$5,000	$1,000
New training materials for educators	$5,000	$1,000
Additional Science Nights	$1,000	$500
Additional Restoration Education program sites	$10,000	$3,000
Watershed study and water conservation education program	$10,000	$5,000
Contract for Spanish translation	$15,000	$1,000
Additional Habitat Heroes program		$300
4 Discovery packs	$500	$300

Nature exploration area	$85,000	$2,000
Summer Camp		$900
TOTAL	**$14,641,500**	**$278,950**

*This position would be needed if grant funding was eliminated for the Slow the Flow Integrated Field Trip Program and Santa Clara Valley Urban Runoff Pollution Program.

Anticipated Impacts:

Habitat

Environmental education and interpretation activities may result in minor disturbance to habitat such as trampling of vegetation, soil erosion, and soil compaction. Refuge visitors also provide a potential mechanism for non-native seed dispersion. Trails function as conduits for movement of plant species, including non-native, invasive plants (Dale and Weaver 1974). Vehicular traffic associated with trail maintenance and Refuge management activities may introduce and spread non-native species onto the Refuge. Creation of additional infrastructure (e.g., wildlife viewing facilities, interpretive panels) as well as infrastructure improvements would also result in impacts to wildlife habitats or displacement of wildlife species. However, this construction is expected to be minor given the size of the Refuge and by avoiding or minimizing intrusion into sensitive wildlife habitat. Also, all these activities take place primarily on the Refuge's trail system or designated public use areas which have little to no vegetation since they are hard-packed dirt. Also, guided programs would be supervised by Refuge staff, volunteers, or partners. Information on reducing impacts to habitat would be provided via website, visitor center, and staff to visitors enjoying self-guided interpretation opportunities.

Wildlife

Trail based environmental education and interpretation events can cause immediate responses by wildlife. These can range from behavioral changes including nest abandonment or change in food habits, physiological changes such as elevated heart rates due to flight, or even death (Knight and Cole 1991). The long term effects are more difficult to assess but may include altered behavior, vigor, productivity or death of individuals; altered population abundance, distribution, or demographics; and altered community species composition and interactions. According to Knight and Cole (1991), there are three wildlife responses to human disturbance: 1) avoidance; 2) habituation; and 3) attraction.

The magnitude of the avoidance response may depend on a number of factors including the type, distance, movement pattern, speed, and duration of the disturbance, as well as the time of day, time of year, weather; and the animal's access to food and cover, energy demands, and reproductive status (Knight and Cole 1991; Gabrielsen and Smith 1995). Knight and Cole (1991) suggest that sound may elicit a much milder response from wildlife if animals are visually buffered from the disturbance.

Habituation is defined as a form of learning in which individuals stop responding to stimuli that carry no reinforcing consequences for the individuals that are exposed to them (Alcock 1993). A key factor for determining how wildlife would respond to disturbance is predictability. Often, when a use is predictable -- following a trail or boardwalk or at a viewing deck – wildlife will accept human presence (Oberbillig 2000). Gabrielsen and Smith (1995) suggest that most animals seem to have a greater defense response to humans moving unpredictably in the terrain than to humans following a distinct path.

Results of local studies indicate that non-motorized trail use, on raised levees, tangential to tidal

mudflat habitat does not have a significant overall effect on the numbers, species richness, or behavior of foraging shorebirds. At the Shoreline site, waterbird abundance and species richness were higher near trail sites than at control sites (Trulio and Sokale 2007). However, the results of this study are not applicable to other waterbird guilds, especially waterfowl.

Environmental education and interpretive programs also 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 Refuge's 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 the public 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 will be limited; (2) students and teachers will be instructed in etiquette while on the Refuge 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; and (4) activity areas will located away from sensitive wildlife habitat.

Overall, increased visitation resulting from the environmental education and interpretation program may impact sensitive species and their habitats. However, these effects would be monitored and managed to ensure that impacts to sensitive species and their habitats do not reach significant levels.

Shared-use trails attract a variety of user groups who often have conflicting needs. People with disabilities may be particularly affected by trail conflicts if they do not have the ability to quickly detect or react to hazards or sudden changes in the environment. Measures to reduce potential conflicts between user groups would include providing information at the trailhead, Visitor Center, and in the Refuge's brochures that clearly indicates permitted users and rules of conduct. Providing signs that clearly indicate which users have the right of way would help reduce conflict (Federal Highway Administration 2001). Potential conflict with other public uses such as waterfowl hunting, wildlife observation, and photography will be minimized by using trail head signs and other media to inform the various users about current public uses.

Public Review and Comment:
Public review and comments were solicited in conjunction with distribution of the Draft CCP/EA for Don Edwards San Francisco Bay NWR, released in May 2012. No comments were made directly in regard to this compatibility determination.

Determination:

_____ Use is Not Compatible

___X___ Use is Compatible with Stipulations

The following stipulations are required to ensure compatibility:

- Maintenance of trails and construction of new proposed viewing platforms, boardwalks, and environmental education and interpretation facilities (e.g. visitor center and updated EEC) would occur during specific periods of the year to avoid disturbance or impacts to birds during breeding season;

- The proposed viewing platforms, boardwalks, and environmental education and interpretation facilities (e.g. visitor center and updated EEC) will be designed to minimize impacts to wildlife though proper location, design and building material;

- Raised platforms will be constructed to view wildlife allowing for a superior wildlife viewing experience while reducing disturbance levels to wildlife and habitat by concentrating visitors in one location;

- Environmental education and interpretation will be confined generally to trail surfaces and the public will not be allowed to enter adjacent habitat or closed areas;

- Buffers will be maintained around trails and viewing platforms to protect nesting and roosting birds;

- Information will be provided at trailheads, at the VCS and EEC, in refuge publications and flyers, on kiosks, and through interpretative programs about permitted uses, rules of conduct, and the effects of human impacts on habitat and wildlife resources. The Refuge will explain how wildlife lives and how the visiting public can avoid negative impacts to wildlife;

- Periodic law enforcement will ensure compliance with regulations and area closures, and will discourage vandalism and off-trail activity;

- Potential impacts from the public spreading non-native seeds would be minimized by: (1) restricting public uses to level surfaces, which would tend to prevent the transportation of non-native seed from the levees and boardwalks into other habitats, such as wetlands, through wind and water; (2) invasive plants that germinate on the levee top and sides would be treated with herbicide; and (3) monitoring and surveillance of invasive species would increase, reducing the potential for new invasive species to become established on the trail

and spread into other locations such as into adjacent wetland habitats; and

- Potential conflict with other public use such as hunting, wildlife observation, photography will be minimized by using trail head signs and other media to inform the various users about current public uses; activities such as hunting are also located in areas closed to other public uses and occur during specified days thus reducing potential conflicts between uses.

Justification: Environmental education, and interpretation are priority general public uses as defined by Executive Order 12996 and the NWRS Administration Act of 1966, as amended by the NWRS Improvement Act of 1997 (Public Law 105-57), and when compatible, are to receive enhanced consideration over other general public uses. These uses are supportive of the Refuge's purposes and the mission of the NWRS. One of this Refuge's purposes is to provide opportunities for "nature study" and over the years since Refuge establishment has evolved to become one of the most robust environmental education and interpretative programs in the National Wildlife Refuge System. Environmental education and interpretation provide public access to the Refuge that increases understanding and often support of Refuge purposes and the wildlife resources found there, while focusing visitors to certain locations thus limiting impacts.

The Refuge is one of the few areas in the urban South San Francisco Bay to be able to offer these uses. In the urban South Bay, the Refuge is the only location with former commercial salt ponds that are managed for wildlife. Therefore, there are no areas off the Refuge that can offer these wildlife oriented activities in this unique habitat.

Potential for wildlife disturbance is minimized by restricting the disturbance to established trails with appropriate set-back distances (buffers) thus increasing predictability of public use patterns on the Refuge, allowing wildlife to habituate to non-threatening activities. Moreover, consolidating environmental education, interpretation and other compatible recreational activities to designated trails, located at the edge of the Refuge habitat boundary, reduces habitat fragmentation, thereby maintaining a core "sanctuary area" of the Refuge for more sensitive species.

The stipulations outlined above should minimize potential impacts relative to wildlife/human interactions. In particular, the adaptive management studies will determine the exact nature of the public use impacts on the Refuge's wildlife and allow Refuge managers to adjust public use to further minimize wildlife impacts or discontinue those activities that are unacceptable. The proposed activities will not materially interfere or detract from the fulfillment of the NWRS Mission or the purposes of the Refuge.

Mandatory Reevaluation Date (provide month and year):

____X____ Mandatory 15-Year Reevaluation Date (for priority public uses)

_____ Mandatory 10-Year Reevaluation Date (for all uses other than priority public uses)

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

Conducted with Comprehensive Conservation Plan

_____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)	9/24/12 (Date)
Refuge Manager:	(Signature)	9/26/12 (Date)
Acting Project Leader Approval:	(Signature)	9-26-2012 (Date)
Concurrence Refuge Supervisor	(Signature)	9/26/2012 (Date)
Assistant Regional Director, Refuges	(Signature)	10/1/2012 Date)

Compatibility Determination for Environmental Education and Interpretation

Compatibility Determination for Waterfowl Hunting
Don Edwards San Francisco Bay NWR

Use: Waterfowl Hunting

Station Name: Don Edwards San Francisco Bay National Wildlife Refuge, Alameda, Santa Clara and San Mateo Counties, California

Date Established: June 30, 1972

Establishing and Acquisition Authorities:
86 Stat. 399, dated June 30, 1972

An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes (16 U.S.C. 667b)

Endangered Species Act of 1973 (16 U.S.C. 1534)

Fish and Wildlife Act of 1956 (16 U.S.C. 742f)

Refuge Purpose(s):
"... for the preservation and enhancement of highly significant wildlife habitat ... for the protection of migratory waterfowl and other wildlife, including species known to be threatened with extinction, and to provide an opportunity for wildlife-oriented recreation and nature study ..." (86 Stat. 399, dated June 30, 1972).

"... particular value in carrying out the national migratory bird management program" 16 U.S.C. 667b (An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes).

"... 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).

"... 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).

National Wildlife Refuge System Mission: The mission of the National Wildlife Refuge 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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-668ee]).

Description of Use: This compatibility determination is done as a review of the existing compatibility determination (1994) for waterfowl hunting, and in concert with the Don Edwards San Francisco Bay NWR Comprehensive Conservation Plan. This compatibility determination replaces the previous 1994 compatibility determination for waterfowl hunting.

Hunting is one of six public uses (the other uses are fishing, wildlife observation, photography, environmental education, and interpretation) given priority on refuges as defined by Executive Order 12996 and the National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57).

Waterfowl hunting is a common and accepted recreational activity on many units of the National Wildlife Refuge System. Opportunities to hunt waterfowl in South San Francisco Bay outside the Refuge are limited. The nearest areas open to hunting have been the State and Federal lands (San Pablo Bay National Wildlife Refuges) in the North San Francisco Bay (1.5 hour drive) with more extensive hunting opportunities in the Sacramento – San Joaquin Delta and the Central Valley (2.5 to 5 hour drive).

The Master Plan developed for the refuge in 1974 states: "Waterfowl hunting is a traditional sport on San Francisco Bay and a substantial amount of waterfowl hunting still occurs within the area to be acquired for the Refuge. Under existing policy and legal authority this activity may continue in the future as long as harvestable populations exist and hunting remains compatible with Refuge objectives". Some of the waterfowl hunting that occurred in the South Bay was through leases with Cargill, Inc. on commercial salt production ponds. These leased ponds allowed a limited segment of the public to participate in this outdoor activity prior to refuge establishment. After establishment, regulated hunting was continued on certain areas of the refuge. Under the existing Refuge Hunt Plan first developed in 1982 and amended in 2004, approximately 10,280 acres (34 percent) of this 30,000-acre Refuge is open to waterfowl hunting leaving 19,720 acres as sanctuary (66 percent). Habitats available for waterfowl hunting include former commercial salt evaporation ponds, tidal sloughs and tidal marshes.

This compatibility determination is done as a review of existing compatibility determinations for hunting and in concert with the Don Edwards San Francisco Bay NWR CCP. No new physical changes to the hunt program are prescribed under this compatibility determination. This compatibility determination combines and replaces all previous versions for hunting, described as follows.

The majority of the tidal areas on the Refuge are leased from the State of California. The existing lease from California State Lands Commission (SLC) encourages waterfowl hunting "unless it is determined after consultation with the State of California Department of Fish and Game that the area be closed because of the public safety, for waterfowl resource protection, or for administrative purposes." This lease language is based upon the historic "Public Trust" doctrine, which requires that State-owned tidelands remain open to "commerce, navigation and fisheries." Courts have ruled that the Public Trust also includes the right to hunt. The existing lease requirement with SLC (since 1980) is consistent with the National Wildlife Refuge System Improvement Act of 1997, which considers hunting a "priority public use", when found compatible with the mission of the National Wildlife Refuge System and the purposes for which the Refuge was established.

The hunt season is set by the California Department of Fish & Game and generally occurs from mid-October to late January. The hunting program is regulated by both the California

Department of Fish and Game and the Refuge. Information on hunting regulations can be found at: http://www.dfg.ca.gov/ and http://www.fws.gov/desfbay/Hunt/Hunt_Information.htm. All Refuge hunting areas are boat-access only, except for Ravenswood and Ponds A5-A8. Figure 1 identifies areas within the Refuge that are open to hunting.

The Refuge has three hunter check-in stations. They are located at Ponds A3W, A2E, and A5. Using data derived from these stations, it is estimated that there are over 2,000 hunter visits annually on the southernmost hunting areas within the Refuge (Table 1).

Table 7. Hunt Information for Alviso Area

Year	# Hunters	# Ducks	# Ducks per Hunter	# Geese	# Geese per Hunter	Total Birds	Total Birds per Hunter
2005	1028	2261	2.2	41	.04	2302	2.2
2006	1665	3304	2.0	35	.02	3339	2.0
2007	2464	7231	2.9	88	.04	7319	3.0
2008	1960	2180	1.1	46	.02	2226	1.1
2009	1126	2549	2.3	40	.04	2589	2.3
2010	1789	2557	1.4	24	.01	2581	1.44

In addition to the state determined rules and regulations, the Refuge specific rules are:

1. Hunting is allowed three days a week (Wednesdays, Saturdays and Sundays) on the following ponds: AB1, A2E, AB2, A3N, A3W, A5, A7 and A8. In addition to State Hunting Licenses, hunters of these ponds need a Refuge Special Use Permit. Ponds A1, A2W, A6, A9,A10,A11, A12, A13, A14, A15, A16,A20, A21, A22, A23, R3, R4, R5, RSF-2 and RS5 are closed to waterfowl hunting to serve as wildlife sanctuaries, protect endangered species, and reduce conflict with adjacent landowners. All blinds are located at least 150 yards from any public trail or dwelling.

2. Access to Ponds AB1 and A2E is from the Crittenden Lane Trailhead in Mountain View. Access to Pond A3W is from the Carl Road Trailhead in Sunnyvale. Access to Ponds A3N and AB2 is by boat from the other ponds. Hunting is only allowed from existing hunting blinds for these 5 ponds.

3. Access to Ponds A5, A7, and A8 is by foot/ bicycle from the Gold Street Gate in Alviso. In these three ponds hunting is restricted to existing hunting blinds, hunting from boat, and walking on pond levees.

4. During the two weekends before opening of the hunt season, hunters may bring a boat into Ponds AB1, A2E, AB2, A3N, A3W, A5, A7 and A8 to be used to access the hunting blinds and moor it at a designated site if they have a valid Refuge Special Use Permit. Hunters are allowed to leave their boat in the ponds during the season and remove them within two weeks following close of the hunt season. Permitted boats are as follows: non- motorized, electric motors, and two or four-stroke gasoline motors. Once the season opens, hunters are only allowed in hunt areas on hunt days (no scouting trips will be allowed).

5. Hunters may maintain an existing blind if they have a valid Refuge Special Use Permit, but the blind will be open for general use on a first-come, first-served basis. We prohibit pit blinds or digging into the levees.

6. Hunters may enter closed areas of the refuge to retrieve downed birds, provided they leave all weapons in a legal hunting area (unless a crippled bird is downed in closed area, a weapon is allowed to dispatch wounded birds). The Refuge encourages the use of retriever dogs. They must keep the dog(s) under control at all times. These dogs must be in a vehicle or on a leash until they are on the ponds as a part of the hunt or on the levees (Ponds A5, A7, A8, and Ravenswood Ponds only) as a part of the hunt.

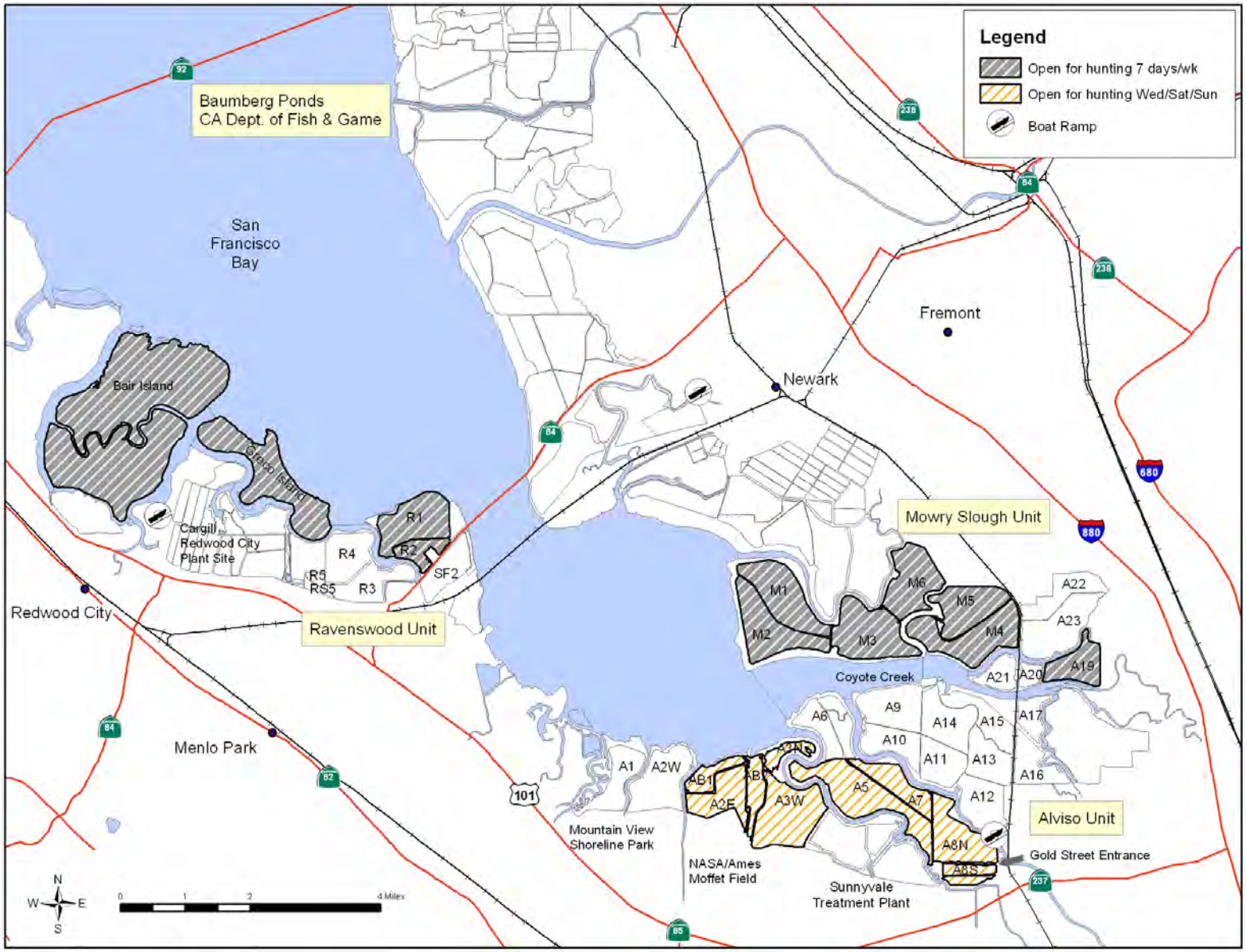
7. Dog handlers must have a hunt license and must be out only during the hunting season. No dog training activities are allowed.

8. Hunting in the Ravenswood Unit and Mowry Unit ponds is allowed seven days per week during the hunt season with a Refuge Special Use Permit. The Ravenswood ponds are accessible by foot or bicycle, and shooting is allowed from the levee only. The Mowry Unit is assessable only by boat, and hunting is allowed from a boat inside the ponds. There is no self-check in box for these two areas.

9. Other hunting areas do not require a Special Use Permit from the Refuge. These areas include Bair Island, Greco Island and the open bay. Access to these areas is only by boat, and hunting is allowed only from a boat; no land access is permitted unless to retrieve downed birds. Hunting is not allowed from outside a boat when on Refuge lands. Bair Island, Greco Island and the open Bay are open to hunting seven days a week.

10. At the end of the regular hunt season, the State usually opens the next weekend following the close of the season for junior hunters. All junior hunters must be under the age of 16 at the beginning of the license year, and accompanied by an adult (adults are not permitted to hunt during junior hunt days). The Refuge participates in the Junior Hunt Program if offered by the State.

Figure 1. Refuge Hunt Areas



Availability of Resources: Existing staff are adequate to offer the hunt program to the public. Approximately 1,250 staff days is required to monitor and conduct the Program. This includes opening all the ponds two weekends before the opening of hunt season and two weekends after the closing of the season to allow hunters to place and retrieve small boats in the ponds and maintain blinds under Refuge Special Use Permits. Staffing activities also includes law enforcement, sign posting, graveling entrance roads, responding to public inquiries and issuance of Special Use Permits. There is sufficient staffing to enforce regulations by Refuge law enforcement officers.

When possible, the California Waterfowl Association and local hunters partner with Refuge staff to hold organized work parties to assist with blind and boat dock maintenance at the ponds before each hunting season. However, additional funding is needed for maintenance of the hunt program infrastructure and outreach. An annual waterfowl hunt fee program would be developed in order to fund these maintenance needs (e.g., provide improvements to hunt blinds, hunt access, and outreach and education materials).

Anticipated Impacts:
Direct effects of hunting include mortality, wounding, and disturbance (De Long 2002). Hunting can alter behavior (e.g., 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). Boating activities (e.g., for fishing, hunting) can also displace waterfowl from feeding grounds and increase energetic costs associated with flight (Korschgen and Dahlgren 1992). In California, the numbers of northern pintails on Sacramento National Wildlife 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 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).

Potential impacts to wildlife may also occur through the use of boating to facilitate hunting. Both motorized and non-motorized boating can alter wildlife behavior. Though motorized boats generally have a greater effect on wildlife, even non-motorized boat use can alter distribution, reduce use of particular habitats by waterfowl and other birds, alter feeding behavior and nutritional status, and cause premature departure from areas (Knight and Cole 1995). However, compared to motorboats, canoes and kayaks appear to have less disturbance effects on most wildlife species (DeLong 2002). Disturbance to birds in general is reduced when boats travel at or below the five mile per hour speed limit.

Individual animals may be disturbed by human contact to varying degrees. Studies have shown that birds can be impacted by human activities 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 are observed to be more sensitive than resident species to disturbance (Klein 1989).

Impacts can be reduced by the presence of adjacent sanctuary areas where hunting does not occur and where 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 Refuge.

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 National Wildlife 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 wigeons, 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 results 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.

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 refuge 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 is encouraged in all areas open to waterfowl hunting. These dogs will be required to be under control at all times. Law enforcement officers will enforce regulations requiring owners to maintain control over their dogs while on the Refuge. 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.

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 Refuge 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 will not negatively affect waterfowl populations. To assure that waterfowl populations are sustainable, the California Fish and Game Commission, in consultation with the CDFG, will continue to annually review the population censuses to establish season lengths and harvest levels within the guidelines developed by the

Service based on annual overall waterfowl population estimates. The areas closed to various hunting activities were designed to provide adequate sanctuaries for wildlife.

Hunters also may trespass into sensitive habitats. Hunting beyond the open bay waters or navigable sloughs in non-designated sites, into the interior of the marsh or other restricted areas would result in disturbance to endangered species such as the salt marsh harvest mouse (*Reithrodontomys raviventris raviventris*) and California clapper rail (*Rallus longirostris*), as well as shorebirds, wading birds, and songbirds. The Service will protect these habitats and resources with signage and hunting brochures to increase hunter awareness. Restrictions will be enforced through law enforcement field checks. In addition, unauthorized human access in fragile tidal marsh habitat could cause trampling creating a lower quality marsh and creating trails for mammalian predators. Hunting in tidal areas is restricted to boats only, retrieval dogs may be used in boat only areas and may cause disturbance to wildlife. Hunters must have command of dogs at all time.

The Service believes that there will be minimal conflicts between hunters and the other wildlife-dependent recreational uses. The hunted tidal areas have minimal conflict because of estimated low hunt participation numbers and limited interaction between the users. While the open bay is open to hunting, these areas are not known to be frequented by visitors for wildlife observation and photography. The majority of the Refuge ponds open to hunting are not open to other recreational users therefore, there is no conflict among user groups. Ponds AB1, AB2, A2E and A3W are open to hunting and are visible from the Moffett Bay Trail, one of the more popular public use trails on the Refuge. Signs are posted by Refuge staff to advise trail users about hunting activity in the vicinity. Refuge staff has received few complaints about the hunting program along this trail, thus indicating low user conflicts.

Therefore, some wildlife disturbance will occur during the hunting seasons. Proper zoning, timing and other regulation will continue to be utilized to minimize negative impacts to wildlife populations using the Refuge. Harvesting these species, or any other hunted species, would not result in a substantial decrease in biological diversity on the Refuge.

Public Review and Comment:
Public review and comments were solicited in conjunction with distribution of the Draft CCP/EA for Don Edwards San Francisco Bay NWR, released in May 2012. Comments were made with regard to waterfowl hunting, but not directly to this compatibility determination. Comments and response to comments on waterfowl hunting are located in Appendix O of the CCP.

Determination:

_____ Use is Not Compatible

___X___ Use is Compatible with Stipulations

The following stipulations are required to ensure compatibility:

- The Refuge must maintain an effective law enforcement program to protect Refuge resources and the visiting public. Environmental education and outreach will remain a key component and priority for the Refuge. Hunting outreach brochures will be made available to the public at the Refuge offices, through Refuge law enforcement officers and other staff

and via the Refuge web site.

- The use of retrieving dogs will be permitted and encouraged in all areas open to hunting. Dogs must be under control at all times. Dogs will be required to be kept on leash, except when engaged in authorized hunting activities and under the direct voice control of a licensed hunter.
- In addition to the State-determined rules and regulations, refer to the section prior, *Description of Use*, for Refuge specific rules for hunting.
- Boats used for hunting will be limited to navigable sloughs, open waters, and specified managed ponds.
- The following areas will be closed to hunting by boat: Mallard Slough, March 1 – August 31 and Mowry Slough and Steinberger Slough, March 15 – June 15.
- Boats used for hunting must adhere to the California Boating Law. This information will be available to the public at appropriate access points on the Refuge, the headquarters visitor center, Alviso Environmental Educational Center and via the Refuge's web site.

Justification: Hunting is one of six priority public uses (the other uses are fishing, wildlife observation, photography, environmental education, and interpretation) encouraged in the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57). Hunting would allow the visiting public to enjoy, experience, and learn about the unique and rare habitats of southern San Francisco Bay region.

Waterfowl hunting is determined to be compatible, in view of the potential impacts that hunting and supporting activities (i.e. motorized and non-motorized boating, driving vehicles, bicycling, and walking on pond levees, and use of dogs) can have on our ability to achieve Refuge purposes and the mission of the National Wildlife Refuge System, because: 1) sufficient restrictions have been placed on hunting, driving, bicycling, walking, boating and use of dogs to ensure that (a) an adequate amount of sanctuary would be available to accommodate the needs of waterfowl and other wetland birds using the Refuge (i.e., no more than 40 percent open to hunting [605 FW 2]), and (b) hunting would not detract from other existing wildlife-dependent uses such as wildlife observation, photography, environmental education and interpretation 2) the hunt would be managed under the State waterfowl hunting regulations that are specifically designed to maintain healthy waterfowl populations along the Pacific Flyway of which the Refuge is a part, and 3) effective monitoring is conducted on hunter use, regulation compliance and overall impacts to waterfowl and other wildlife utilizing this information to make necessary adjusts to maintain the compatibility of the hunt program.

Although boating, driving to the ponds, use of dogs, bicycling, and walking the levees are not forms of wildlife-dependent recreation; they do in this case support a wildlife dependent use. Implementing the prescribed restrictions on boating, dogs, bicycling and walking outlined in the Stipulations section should alleviate any substantial impacts. Allowing use of private vehicles to access the ponds will increase their accessibility for those hunters will physical limitations.

An adequate amount of waterfowl sanctuary would be available to waterfowl and other water dependent wildlife. The total acreage of the Refuge which would be open to hunting is 10,280 acres (34%). On this 30,000-acre Refuge, 19,720 acres would be sanctuary (66%). Thus, it is anticipated that waterfowl and other highly mobile wildlife species would find sufficient food resources and resting places such that distribution from hunting would not be substantially impacted.

The Service's policy on Biological Integrity, Diversity, and Environmental Health requires that Refuge actions at least maintain existing levels of biological integrity, diversity and environmental health. This Hunt Program allows for waterfowl hunting on selected Refuge ponds under State harvest regulations which are designed to maintain the diversity and integrity of the flyway waterfowl population. Therefore, it would at least maintain existing levels as required in the policy.

Mandatory Reevaluation Date (provide month and year):

____X____ Mandatory 15-Year Reevaluation Date (for priority public uses)

_____ Mandatory 10-Year Reevaluation Date (for all uses other than priority public uses)

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

Conducted with Comprehensive Conservation Plan

_____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) 9/24/12 (Date)

Refuge Manager: _____ (Signature) 9/26/12 (Date)

Acting Project Leader Approval: _____ (Signature) 9-26-2012 (Date)

Concurrence
Refuge Supervisor _____ (Signature) 9/26/2012 (Date)

Assistant Regional Director, Refuges _____ (Signature) 10/1/2012 (Date)

Compatibility Determination for Recreational Boating on Don Edwards San Francisco Bay National Wildlife Refuge

Uses: Recreational Boating

Refuge Name: Don Edwards San Francisco Bay National Wildlife Refuge, Alameda, Santa Clara and San Mateo Counties, California

Establishing and Acquisition Authorities:
86 Stat. 399, dated June 30, 1972

An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes (16 U.S.C. 667b)

Endangered Species Act of 1973 (16 U.S.C. 1534)

Fish and Wildlife Act of 1956 (16 U.S.C. 742f)

Refuge Purpose(s):
"... for the preservation and enhancement of highly significant wildlife habitat ... for the protection of migratory waterfowl and other wildlife, including species known to be threatened with extinction, and to provide an opportunity for wildlife-oriented recreation and nature study ..." (86 Stat. 399, dated June 30, 1972).

"... particular value in carrying out the national migratory bird management program" 16 U.S.C. 667b (An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes).

"... 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).

"... 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).

National Wildlife Refuge System Mission: The mission of the National Wildlife Refuge 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." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd - 668ee.])

Description of Use(s): This compatibility determination is done in concert with the Don Edwards NWR Comprehensive Conservation Plan (CCP). The National Wildlife Refuge System Improvement Act of 1997 identifies fishing, hunting, wildlife observation, photography, environmental education, and interpretation as the six priority public uses on refuges. The use generally includes motorized and non-motorized boating to facilitate wildlife research, hunting, environmental education, wildlife observation, wildlife photography and fishing.

The Refuge's navigable sloughs and open waters will be open to recreational boating. The majority of these waters is leased from the State of California Lands Commission (SLC) and managed as part of the Refuge; they are extremely important waters due to existing fish and wildlife populations. While there are currently no boat launches available on the Refuge, boat access to the bay is available in Redwood City, Newark, and Alviso (See Figure 1). A canoe and kayak site (potentially near Dumbarton Bridge/fishing pier) will be explored and implemented if feasible on the Refuge, as stated in the CCP.

Boats will be permitted to enter the Refuge's navigable sloughs and open waters to facilitate the public's participation in wildlife observation, wildlife photography, environmental education, waterfowl hunting, and fishing. In the Refuge's managed ponds, boats are permitted during waterfowl season to facilitate hunting. No jet skis or other personal motorized vehicles will be permitted within the managed ponds.

Due to presence of sensitive wildlife species, no boat access will be permitted within Mowry Slough, from March 15 – June 15. Additional areas may be closed to boat access as needed. Eventual tidal marsh formation is expected to occur as managed ponds are restored to tidal action through restoration efforts such as the South Bay Salt Pond Restoration Project. As these sites become occupied by listed species, additional restrictions to public access may be necessary.

All boating opportunities will be implemented in a manner to ensure protection for listed species and migratory birds by providing law enforcement patrols, education and outreach conducted on site as well as tours and other group programs to create an environmental awareness of stewardship for wildlife and habitat of the Refuge. Public use activities will be allowed during daylight hours only.

Figure 2. Boat Launches Near Don Edwards San Francisco Bay NWR

Availability of Resources:
Additional funding and staffing is needed to encourage compatible boating activities. Staffing to develop and maintain outreach material (e.g., signage, brochures, websites, etc.) to assist in protection of wildlife and their habitats would be needed along with increased law enforcement patrols in sensitive areas of the Refuges such as Mowry Slough. Funding will be needed to construct the canoe and kayak site, as well as the related signage and outreach materials.

Item	One-Time Cost	Annual Costs
Refuge Law Enforcement (0.1 FTE)	N/A	$6,500
Outdoor Recreation Planner (0.1 FTE)	N/A	$7,600
Signage, outreach materials at launch sites to reduce disturbance	$30,000	$3,000
Canoe and kayak site on the Refuge (e.g., near Dumbarton Bridge/fishing pier), interpretive/informational signage	$20,000	$1,000
TOTAL	**$50,000**	**$18,100**

Anticipated Impacts:
Large numbers of waterfowl, shorebirds, fish and other wildlife species use the Refuge for feeding, resting and in some cases, breeding. Sensitive fish species occur within the Refuge including the green sturgeon (*Acipenser medirostris*), steelhead salmon (*Oncorhynchus mykiss*), and the Chinook salmon (*Oncorhynchus tshawytscha)*. The presence of boats should not create any long-term effects on fish and wildlife species.

Open water and tidal areas of the Refuge provide habitat for other sensitive species including the California clapper rail, California black rail, western snowy plover, and salt marsh harvest mouse. Potential impacts to these wildlife may occur through the use of boating. Individual animals may be disturbed by human contact to varying degrees. Studies have shown that birds can be impacted from human activities 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 are observed to be more sensitive than resident species to disturbance (Klein 1989).

Harbor seals may be impacted by boating. A 2008 study of the behavioral response of harbor seals to boaters at Bair Island found that seal vigilance increased as boats passed the haul-out, and as boats came closer to the seals. Within ten minutes of the disappearance of the boats, the seals relaxed. During 70% of the boating events, seals did not flush, remaining at the haul-out. When flushing did occur, the seals almost always recovered within the large haul-out area. However, total seal numbers observed during days with multiple boats were lower than observed on days without boating activity (Fox 2008).

Though motorized boats generally have a greater effect on wildlife, even non-motorized boat use can alter distribution, reduce use of particular habitats by waterfowl and other birds, alter feeding behavior and nutritional status, and cause premature departure from areas (Knight and Cole 1995). However, compared to motorboats, canoes and kayaks appear to have less disturbance effects on most wildlife species and disturbance to birds in general is reduced when boats travel at or below the 5 mile per hour speed limit (DeLong 2002).

The proposed use would not significantly impact the ability of the Refuge to protect wildlife, diverse tidal marsh, seasonal wetland habitats and adjacent transitional uplands critical to the needs of migratory birds and listed species. Many acres of the Refuge are currently open to public access including boating. While some disturbance to waterbird populations occurs, significant habitat remains available that is inaccessible or closed to public access. To reduce disturbance, speed restrictions on motorized boats within some areas will be implemented. In addition, outreach to the public will be increased to promote awareness of the importance of habitats within and around the Refuge. Environmental Education is critical for making visitors aware that their actions can have negative impacts on wildlife, and will increase the likelihood that visitors will abide by restrictions on their actions. For example, Klein (1993) demonstrated that visitors who spoke with refuge staff or volunteers were less likely to disturb birds.

Public Review and Comment:
Public review and comments were solicited in conjunction with distribution of the Draft CCP/EA for Don Edwards San Francisco Bay NWR, released in May 2012. One commenter requested that further analysis on boating impacts to harbor seals in the CD. Information on boating impacts was added to the "Anticipated Impacts" section.
Determination (Check One Below):

_____ Use is Not Compatible

___X___ Use is Compatible with Stipulations

Stipulations Necessary to Ensure Compatibility:

- Recreational boating will be limited to navigable sloughs and open waters except as allowed to facilitate waterfowl hunting in managed ponds.
- The following areas will be closed to boating: Mallard Slough, March 1 – August 31 and Mowry Slough and Steinberger Slough, March 15 – June 15.
- Boats must adhere to the California Boating Law. This information will be available to the public at appropriate access points on the Refuge, the headquarters visitor center, Alviso Environmental Educational Center and via the Refuge's web site.
- Fishing and boating brochures and signage will be developed to inform users of regulations and etiquette to reduce wildlife disturbance. A "Boating on the Refuge" brochure will be updated and made available to the public at the Refuge Office in Fremont, Alviso Environmental Education Center, and on the Refuge website. Information provided in this brochure will include no-wake speed limits, seasonal or specific area closures, and a map of trails in the adjacent sloughs.
- Increased law enforcement will be needed to ensure compliance with all state and federal regulations.
- Monitoring of habitats and species in all areas where boating occurs will take place during biological surveys. If habitat or wildlife disturbance is determined to be detrimental,

modifications to this use will be implemented to keep boat use on the Refuge compatible.

Justification:
Although boating is not considered wildlife-dependent recreation, many activities identified in the Refuge Improvement Act of 1997, particularly hunting, fishing, wildlife observation and photography) are facilitated by this use. Recreational boating would allow the visiting public to enjoy, experience, and learn about native fish, wildlife and their habitats of south San Francisco Bay.

Mandatory Re-evaluation Dates (Provide Month and Year)

_____ Mandatory 15-year Reevaluation Date (for priority public uses)

___X___ Mandatory 10-year Reevaluation Date (for all uses other than priority public uses)

NEPA Compliance (Check One Below)

_____ 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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Smith, L. and J.D. Hunt. 1995. Nature tourism: impacts and management. Pp. 203-219 in Knight, R.L; Gutzwiller, K.J. (Wildlife and recreationists: coexistence through management and research, eds.). Island Press, Washington, D.C.

Refuge Determination

Prepared by:	(Signature)	9/24/12 (Date)
Refuge Manager:	(Signature)	9/26/12 (Date)
Acting Project Leader Approval:	(Signature)	9-26-2012 (Date)
Concurrence Refuge Supervisor	(Signature)	9/26/2012 (Date)
Assistant Regional Director, Refuges	(Signature)	10/1/2012 (Date)

Compatibility Determination for Recreational Boating

Compatibility Determination for Recreational Fishing on
Don Edwards San Francisco Bay NWR

Use: Recreational Fishing

Refuge Name: Don Edwards San Francisco Bay National Wildlife Refuge, Alameda, Santa Clara and San Mateo Counties, California.

Establishing and Acquisition Authorities:
86 Stat. 399, dated June 30, 1972

An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes (16 U.S.C. 667b)

Endangered Species Act of 1973 (16 U.S.C. 1534)

Fish and Wildlife Act of 1956 (16 U.S.C. 742f)

Refuge Purpose(s):
"... for the preservation and enhancement of highly significant wildlife habitat ... for the protection of migratory waterfowl and other wildlife, including species known to be threatened with extinction, and to provide an opportunity for wildlife-oriented recreation and nature study ..." (86 Stat. 399, dated June 30, 1972).

"... particular value in carrying out the national migratory bird management program" 16 U.S.C. 667b (An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes).

"... 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).

"... 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).

National Wildlife Refuge System Mission: The mission of the National Wildlife Refuge 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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-668ee]).

Description of Use: This compatibility determination is undertaken as a review of the existing compatibility determination for recreational fishing (1994) and in concert with the Don Edwards San Francisco Bay NWR Comprehensive Conservation Plan (CCP). This compatibility determination replaces the previous 1994 compatibility determination for recreational fishing.

Fishing is one of six public uses (the other uses are hunting, wildlife observation, photography, environmental education, and interpretation) given priority on refuges as defined by Executive

Order 12996 and the National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57).

Shoreline fishing opportunities are limited on the Refuge due to the shallow geography of the Bay. This geography makes it difficult, and in most places impossible, to access waters deep enough to catch fish. Fishing is currently allowed on the Refuge from the pier at the end of Marshlands Road in Fremont, at the shoreline of the Faber-Laumeister sub-unit, at the shoreline of Coyote Creek near Coyote Creek Lagoon, and from the platform at Mallard Slough Trail. Fishing is also allowed by boat on the portions of the South Bay and sloughs within the Refuge. All fishing is regulated by the California Department of Fish and Game and information on sport fishing regulations can be found at: http://www.dfg.ca.gov/.

Portions of the South Bay's navigable sloughs and open waters are leased from the State of California Lands Commission (SLC) and managed as part of the Refuge. Under the existing lease with SLC, the Service is encouraged to allow "... waterfowl hunting and fishing … unless it is determined after consultation with the State of California Department of Fish and Game that the area be closed because of the public safety, for waterfowl resource protection, or for administrative purposes." The original lease language is based upon the historic "Public Trust" doctrine, which requires that State-owned tidelands remain open to "commerce, navigation and fisheries."

The Refuge's sloughs and open waters are extremely important angling waters due to significant fish populations and the proximity to safe road access and boat launches in Newark near the Refuge Headquarters, in Alviso and Redwood City. These facilities enable public access to the Refuge for the neighboring communities of Alameda, San Mateo, and Santa Clara counties. Fishing is an existing use on the Refuge and will continue to be allowed from boats in the open waters and navigable sloughs of southern San Francisco Bay. To protect harbor seals, boating has been prohibited on Mallard Slough from March 1 – August 31 and on Mowry Slough and Steinberger Slough from March 15 – June 15th. The Refuge's managed ponds and tidal marshes are closed to fishing.

Shoreline-based fishing is also a popular visitor use on the Refuge which will continue. The public fishing pier in Fremont is open daily except on Thanksgiving, Christmas and New Year. However, the threatened western snowy plover occasionally nests along Marshlands Road. Between April 1 and August 31, if nesting birds are found, Marshlands Road is closed to public vehicle traffic. On weekends when the closure is in effect, public access to the fishing pier is enabled via a free shuttle service. As a designated "Public Fishing Pier," no fishing license is needed at this location. Access to the fishing sites on Coyote Creek at Coyote Creek Lagoon and Faber-Laumeister is provided by trails.

Major fish species caught include rays, leopard sharks, sand sharks, white sturgeon, striped bass, and shiner surfperch. Based on annual reports over the last several years, there are an estimated 3,700 fishing visits a year on the Refuge. Most anglers conduct catch-and-release fishing. Because of contaminants such as heavy metals in the Bay, an Environmental Health Hazard Assessment advises anglers to limit the amount of Bay fish that is eaten. Warning signs at the Dumbarton Fishing Pier and at Coyote Creek Lagoon explain the hazards in Korean, Spanish, Cambodian, Chinese, Vietnamese, and English.

Every year during National Wildlife Refuge Week, a special event is hosted on the Refuge to introduce the public to fishing. Bait and tackle for up to 50 people are provided allowing each

participant to learn how to use a fishing rod along with the safety and ethics of fishing and what they can do to protect San Francisco Bay.

Access for fishing on the Refuge will be expanded to provide additional shoreline opportunities. Materials such as brochures and wayside exhibits for hunting and fishing programs that convey Refuge messages would be developed or updated. A small fishing platform at Coyote Creek and Faber-Laumeister would be designed and installed. Shoreline fishing access to Alviso Slough (near Pond A9) would be implemented if determined feasible. The Marshlands Road fishing pier would be updated, including renovating the fish cleaning station.

Availability of Resources: Additional funds for construction of the new fishing platforms at Coyote Creek and Faber-Laumeister, updating the existing fishing pier and establishing the shoreline fishing opportunity on Alviso Slough near Pond A9 will be necessary. Funding for updated fishing and boating brochures will also be required. These funds would be sought though the existing National Wildlife Refuge appropriations. Grants and other funding sources will also be sought. Additional Refuge law enforcement and maintenance staff funding is needed for existing and proposed expanded fishing opportunities.

Item	One-Time Cost	Annual Costs
Fishing platform at Faber-Laumeister	$300,000	$1,000
Fishing platform at Coyote Creek	$300,000	$1,000
Fishing access at Alviso Slough near A9	$35,000	$1,000
Update fishing pier, fish cleaning stations, interpretive panels, etc.	$200,000	$2,000
Fishing and boating brochures, signage	$20,000	$2,000
Maintenance Staff (0.1 FTE)	N/A	$6,500
Refuge Law Enforcement (0.1 FTE)	N/A	$6,500
TOTAL	**$855,000**	**$20,000**

Anticipated Impacts:
The proposed use would not adversely impact sensitive fish species in the South Bay because of State fishing regulations would be enforced. In the South Bay, two species (Distinct Population Segments [DPS]) of fish are listed under the federal Endangered Species Act: Central California Coast steelhead DPS (*Oncorhynchuse mykiss*) and the North American green sturgeon southern DPS (*Acipenser medirostris*). Fishermen will be required to adhere to all California Fish and Game regulations. These regulations are designed to protect these and other sensitive species from impacts due to fishing.

Fishing will be limited to sloughs, open water, and designated facilities. Potential impacts to wildlife may occur through the use of boating to facilitate fishing. Individual animals may be disturbed by human contact to varying degrees. Studies have shown that birds can be impacted by human activities 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 are observed to be more sensitive than resident species to disturbance (Klein 1989).

Both motorized and non-motorized boating can alter wildlife behavior. Though motorized boats generally have a greater effect on wildlife, even non-motorized boat use can alter distribution, reduce use of particular habitats by waterfowl and other birds, alter feeding behavior and nutritional status, and cause premature departure from areas (Knight and Cole 1995). However, compared to motorboats, canoes and kayaks appear to have less disturbance effects on most wildlife species (DeLong 2002) and disturbance to birds in general is reduced when boats travel at or below the 5 mile per hour speed limit.

Boating, including that associated with fishing, can disturb sensitive species during nesting season. This is particularly true in areas were boat traffic in the narrow Mallard Slough. Boating can negatively affect harbor seals (*Phoca vitulina*) during their sensitive pupping season. To prevent negative effects from boating, the following existing area closures are in effect: Mallard Slough, March 1 – August 31 and on Mowry Slough and Steinberger Slough, March 15 – June 15. The Refuge's managed ponds are also closed to fishing due to the limited potential to catch recreational fish and high potential to disturb large concentrations of birds using these ponds.

Discarded fishing line and other fishing litter can entangle migratory birds and other wildlife and cause injury or death (Thompson 1969, Gregory 1991).

Construction of new fishing facilities, signage, other associated infrastructure as well as the renovation of the fishing pier will result in loss of habitat and temporary disturbance to wildlife. Localized dust and noise will be created from construction operations, but should have negligible air quality impacts. The facilities, signage, and other associated infrastructure will be placed in sparsely vegetated (non-sensitive) areas near established or designated public trails to minimize loss of vegetation. Total construction footprint for new fishing infrastructure is expected to be less than 0.5 acre. In the long-term, use of the new fishing facilities will reduce existing impacts to the shoreline and vegetation that result from uncontrolled trampling of these areas by fishermen. The facilities will be small (accommodating no more than 20 people at a time) and installed in locations that avoid sensitive wildlife habitat. Additional signage would be installed to encourage visitors to limit their disturbance to wildlife and properly dispose of litter.

Overall, the proposed use of fishing is not expected to impact the ability of the Refuge to protect diverse tidal marsh, seasonal wetland habitats and adjacent transitional uplands critical to the needs of migratory birds and endangered species. Signage will be used to identify closed areas and deter entry into sensitive wildlife habitat and restrictions will be enforced.

Public Review and Comment:
Public review and comments were solicited in conjunction with distribution of the Draft CCP/EA for Don Edwards San Francisco Bay NWR, released in May 2012. One commenter requested that further analysis on boating impacts to habitat, such as increased fishing debris. Fishing debris, such as discarded fishing line, was mentioned in the "Anticipated Impacts" section.

Determination:

_____ Use is Not Compatible

___X___ Use is Compatible with Stipulations

The following stipulations are required to ensure compatibility:

- Fishing and boating brochures and signage will be developed to inform users of regulations and etiquette to reduce wildlife disturbance.
- Boats engaging in fishing must adhere to the California Boating Law. This information will be available to the public at appropriate access points on the Refuge, the headquarters visitor center, Alviso Environmental Educational Center and via the Refuge's web site.
- Fishing and boating brochures, and signage will be developed to inform users of regulations and etiquette to reduce wildlife disturbance. A "Boating on the Refuge" brochure will be updated and made available to the public at the Refuge Office in Fremont, Alviso Environmental Education Center, and on the Refuge website. Information provided in this brochure will include no-wake speed limits, seasonal or specific area closures, and a map of trails in the adjacent sloughs.
- The following areas will be closed to boating and fishing: Mallard Slough, March 1 – August 31 and Mowry Slough and Steinberger Slough, March 15 – June 15.
- When endangered or threatened nesting birds are found on or nearby, Marshlands Road will be closed to public vehicle traffic, April 1- August 31.
- Monitoring of habitat in all areas where fishing occurs will take place during biological surveys for other species. If habitat or wildlife disturbance is determined to be detrimental, modifications to this use will be made to assure fishing on the Refuge is compatible.
- Increased law enforcement will be needed to ensure compliance with all state and federal regulations.

Justification: The National Wildlife Improvement Act of 1997 (Pub. L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. Where these uses have been determined compatible, they are to receive enhanced consideration over other uses in planning and management.

These uses have been determined compatible because fishing will not materially interfere with or detract from unit purposes. Fishing would allow the visiting public to enjoy, experience, and learn about native fish and plants in these unique and rare habitats of the South Bay. Concerns about protecting rare native plants and animals, and the overall integrity of the marsh ecosystem, require that fishing opportunities be limited to the open waters, navigable sloughs, and fishing facilities of the Refuge at this time.

Mandatory Reevaluation Date (provide month and year):

___X___ Mandatory 15-Year Reevaluation Date (for priority public uses)

_____ Mandatory 10-Year Reevaluation Date (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 Cited:

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Refuge Determination

Prepared by: _____ (Signature) 9/24/12 (Date)

Refuge Manager: _____ (Signature) 9/26/12 (Date)

Acting Project Leader Approval: _____ (Signature) 9-26-2012 (Date)

Concurrence Refuge Supervisor _____ (Signature) 9-26-2012 (Date)

Assistant Regional Director, Refuges _____ (Signature) 10/1/2012 (Date)

Compatibility Determination for Recreational Fishing

Appendix D. Refuge Plant List

Family	Scientific name	Common name	Native/Non-Native
Aceraceae	*Acer negundo var. californicum*	California box elder	Native
Aizoaceae	*Mesembryanthemum crystallinum*	crystalline iceplant	non-native
Aizoaceae	*Mesembryanthemum nodiflorum*	slenderleaf iceplant	non-native
Aizoaceae	*Tetragonia tetragonioides*	New Zealand spinach	non-native
Amaranthaceae	*Amaranthus spp.*	amaranthus spp.	non-native
Anacardiaceae	*Rhus integrifolia*	lemonade berry	native
Anacardiaceae	*Schinus molle*	Peruvian peppertree	non-native
Anacardiaceae	*Toxicodendron diversilobum*	Pacific poison oak	native
Apiaceae	*Anthriscus caucalis*	Bur chervil	non-native
Apiaceae	*Apium graveolens var. dulce*	Wild celery	non-native
Apiaceae	*Conium maculatum*	poison hemlock	non-native
Apiaceae	*Eryngium aristulatum*	coyote thistle	native
Apiaceae	*Foeniculum vulgare*	fennel	non-native
Apiaceae	*Lomatium caruifolium*	caraway-leaved lomatium	native
Apiaceae	*Lomatium utriculatum*	common lomatium	native
Apiaceae	*Sanicula bipinnatifida*	purple sanicle	native
Apocynaceae	*Vinca major*	periwinkle	non-native
Araceae	*Zantedeschia aethiopica*	calla lily	non-native
Araceae	*Arum italicum*	Italian lords and ladies	non-native
Araliaceae	*Hedera helix*	English ivy	non-native
Arecaceae	*Washingtonia robusta*	Mexican fan palm	non-native
Arecaceae	*Phoenix canariensis*	Canary Island date palm	non-native
Asteraceae	*Delairea odorata*	Cape ivy	non-native
Asteraceae	*Achillea millefolium*	yarrow	Native
Asteraceae	*Acroptilon repens*	Russian knapweed	non-native
Asteraceae	*Ambrosia psilostachya*	western ragweed	Native
Asteraceae	*Anaphalis margaritacea*	pearly everlasting	native
Asteraceae	*Anthemis cotula*	stinking chamomile	non-native
Asteraceae	*Artemisia douglasiana*	mugwort	Native
Asteraceae	*Artemisia californica*	California sagebrush	native
Asteraceae	*Baccharis douglasii*	salt marsh baccharis	Native
Asteraceae	*Baccharis pilularis*	coyote brush	native
Asteraceae	*Calendula arvensis*	field marigold	non-native
Asteraceae	*Carduus pycnocephalus*	Italian thistle	non-native
Asteraceae	*Carduus tenuiflorus*	Slender-flowered thistle	non-native
Asteraceae	*Centaurea calcitrapa*	purple starthistle	non-native
Asteraceae	*Centaurea maculosa*	spotted knapweed	non-native
Asteraceae	*Centaurea melitensis*	tocolote	non-native
Asteraceae	*Centaurea solstitialis*	yellow starthistle	non-native
Asteraceae	*Centromadia pungens ssp. pungens*	common tarweed	native
Asteraceae	*Chamomilla suaveolens*	pineapple weed	non-native

Family	Scientific name	Common name	Native/Non-Native
Asteraceae	*Cirsium vulgare*	bull thistle	non-native
Asteraceae	*Cotula australis*	Australian waterbuttons	non-native
Asteraceae	*Cotula coronopifolia*	brass buttons	non-native
Asteraceae	*Dittrichia graveolens*	stinkwort	non-native
Asteraceae	*Encelia farinosa*	brittle bush	native
Asteraceae	*Eriophyllum confertiflorum*	golden yarrow	Native
Asteraceae	*Eriophyllum lanatum*	wooly sunflower	Native
Asteraceae	*Eriophyllum staechadifolium*	lizard tail	native
Asteraceae	*Euthamia occidentalis*	western goldenrod	Native
Asteraceae	*Gnaphalium luteo-album*	everlasting cudweed	non-native
Asteraceae	*Grindelia stricta*	gum plant	native
Asteraceae	*Hemizonia congesta*	Hayfield tarweed	native
Asteraceae	*Hemizonia pungens*	Common tarweed	native
Asteraceae	*Hypochaeris glabra*	smooth cat's ear	non-native
Asteraceae	*Hypochaeris radicata*	rough cat's ear	non-native
Asteraceae	*Jaumea carnosa*	jaumea	native
Asteraceae	*Lactuca saligna*	willow-leaf lettuce	non-native
Asteraceae	*Lactuca serriola*	prickly lettuce	non-native
Asteraceae	*Lasthenia conjugens*	Contra Costa goldfields	native (fed endangered, CNPS 1B.1)
Asteraceae	*Lasthenia glaberrima*	smooth goldfields	native
Asteraceae	*Lasthenia glabrata*	yellowray goldfields	native
Asteraceae	*Layia platyglossa*	tidy tips	Native
Asteraceae	*Madia sativa*	coast tarweed	Native
Asteraceae	*Picris echioides*	bristly oxtongue	non-native
Asteraceae	*Psilocarphus brevissimus*	woolly marbles	native
Asteraceae	*Psilocarphus oregonus*	Oregon woolly-marbles	native
Asteraceae	*Senecio vulgaris*	common groundsel	non-native
Asteraceae	*Silybum marianum*	blessed milkthistle	non-native
Asteraceae	*Sonchus asper*	spiny sowthistle	non-native
Asteraceae	*Sonchus oleraceus*	common sow thistle	non-native
Asteraceae	*Symphyotrichum chilense*	Pacific aster	Native
Asteraceae	*Taraxacum officinale*	dandelion	non-native
Asteraceae	*Tragopogon porrifolius*	purple salsify	non-native
Asteraceae	*Xanthium spinosum*	spiny cockleburr	non-native
Boraginaceae	*Amsinckia menziesii var. intermedia*	fiddleneck	native
Boraginaceae	*Heliotropium curassavicum*	seaside heliotrope	native
Boraginaceae	*Myosotis latifolia*	forget-me-not	non-native
Boraginaceae	*Myosotis sylvatica*	woodland forget-me-not	non-native
Boraginaceae	*Plagiobothrys bracteatus*	bracted popcornflower	native
Boraginaceae	*Plagiobothrys humistratus*	dwarf popcornflower	native
Boraginaceae	*Plagiobothrys stipitatus var. micranthus*	Stalked popcornflower	native

Family	Scientific name	Common name	Native/Non-Native
Boraginaceae	*Plagiobothrys leptocladus*	alkali popcornflower	native
Brassicaceae	*Brassica nigra*	black mustard	non-native
Brassicaceae	*Brassica rapa*	field mustard	non-native
Brassicaceae	*Capsella bursa-pastoris*	shepherd's purse	non-native
Brassicaceae	*Cardamine hirsuta*	hairy bittercress	non-native
Brassicaceae	*Cardaria draba*	hoary cress	non-native
Brassicaceae	*Hirschfeldia incana*	short podded mustard	non-native
Brassicaceae	*Lepidium latifolium*	perennial pepperweed	non-native
Brassicaceae	*Lepidium oxycarpum*	forked pepperweed	native
Brassicaceae	*Raphanus sativus*	radish	non-native
Brassicaceae	*Sibara virginica*	common rock cress	native
Brassicaceae	*Sinapis arvensis*	charlock mustard	non-native
Brassicaceae	*Sisymbrium orientale*	oriental mustard	non-native
Callitrichaceae	*Callitriche marginata*	California water starwort	native
Campanulaceae	*Downingia pulchella*	flatface downingia	native
Caprifoliaceae	*Lonicera hispidula var. vacillans*	California honeysuckle	native
Caprifoliaceae	*Sambucus nigra ssp. Cerulea*	blue elderberry	Native
Caprifoliaceae	*Symphoricarpos albus var. laevigatus*	Snowberry	native
Caryophyllaceae	*Cerastium arvense*	field chickweed	native
Caryophyllaceae	*Cerastium glomeratum*	mouse-ear chickweed	non-native
Caryophyllaceae	*Spergularia macrotheca*	sticky sandspurry	native
Caryophyllaceae	*Spergularia marina*	salt sandspurry	native
Caryophyllaceae	*Stellaria media*	common chickweed	non-native
Chenopodiaceae	*Atriplex depressa*	brittlescale	native (rare) CNPS 1B.2
Chenopodiaceae	*Atriplex fruticulosa*	ball saltbush	native
Chenopodiaceae	*Atriplex hortensis*	garden orache	non-native
Chenopodiaceae	*Atriplex patula*	fat hen	native
Chenopodiaceae	*Atriplex semibaccata*	Australian saltbush	non-native
Chenopodiaceae	*Atriplex triangularis*	spearscale	native
Chenopodiaceae	*Bassia hyssopifolia*	five horn bassia	non-native
Chenopodiaceae	*Beta vulgaris*	common beet	non-native
Chenopodiaceae	*Chenopodium album*	lamb's quarters	non-native
Chenopodiaceae	*Salicornia europaea*	glasswort	native
Chenopodiaceae	*Salicornia virginica*	salt marsh pickleweed	native
Chenopodiaceae	*Salsola soda*	opposite-leaf Russian thistle	non-native
Chenopodiaceae	*Salsola tragus*	Russian thistle	non-native
Chenopodiaceae	*Suaeda californica*	California sea-blite	native (fed endangered, CNPS 1B.1)
Chenopodiaceae	*Suaeda moquinii*	bush seep-weed	native
Chenopodiaceae	*Salicornia subterminalis*	Parish's pickleweed	native
Convolvulaceae	*Convolvulus arvensis*	field bindweed	non-native
Convolvulaceae	*Cressa truxillensis*	alkali weed	native

Family	Scientific name	Common name	Native/Non-Native
Cornaceae	*Cornus sericea*	American dogwood	native
Crassulaceae	*Crassula aquatica*	water pygmy-weed	native
Crassulaceae	*Crassula connata*	sand pygmy-weed	native
Cuscutaceae	*Cuscuta salina*	salt marsh dodder	native
Cyperaceae	*Carex praegracilis*	field sedge	Native
Cyperaceae	*Eleocharis acicularis var. acicularis*	needle spikerush	native
Cyperaceae	*Eleocharis macrostachya*	pale spikerush	native
Cyperaceae	*Schoenoplectus acutus var. occidentalis*	tule	Native
Cyperaceae	*Bolboschoenus robustus*	alkali bulrush	Native
Cyperaceae	*Schoenoplectus californicus*	California Bulrush	native
Cyperaceae	*Bolboschoenus maritimus*	maritime tule	native
Dipsacaceae	*Dipsacus sativus*	Fuller's teasel	non-native
Ericaeae	*Arctostaphylos spp.*	manzanita	native
Euphorbiaceae	*Croton setigerus*	dove weed	native
Euphorbiaceae	*Euphorbia esula*	leafy spurge	non-native
Euphorbiaceae	*Euphorbia helioscopia*	madwoman's milk	non-native
Euphorbiaceae	*Euphorbia oblongata*	eggleaf spurge	non-native
Euphorbiaceae	*Euphorbia peplus*	petty spurge	non-native
Euphorbiaceae	*Chamaesyce prostrata*	prostrate spurge	non-native
Fabaceae	*Acacia baileyana*	Cootamundra wattle	non-native
Fabaceae	*Acacia dealbata*	silver wattle	non-native
Fabaceae	*Acacia longifolia*	golden wattle	non-native
Fabaceae	*Acacia melanoxylon*	black acacia	non-native
Fabaceae	*Acacia retinodes*	everblooming acacia	non-native
Fabaceae	*Astragalus tener*	alkali milk vetch	native
Fabaceae	*Genista monspessulana*	french broom	non-native
Fabaceae	*Lotus corniculatus*	bird’s-foot trefoil	non-native
Fabaceae	*Lotus purshianus*	lotus	Native
Fabaceae	*Lotus scoparius*	deerweed	native
Fabaceae	*Lupinus albifrons*	silver lupine	native
Fabaceae	*Lupinus bicolor*	lupine	native
Fabaceae	*Lupinus succulentus*	arroyo lupine	Native
Fabaceae	*Medicago polymorpha*	California burclover	non-native
Fabaceae	*Melilotus indicus*	annual yellow sweetclover	non-native
Fabaceae	*Melilotus officinalis*	yellow sweetclover	non-native
Fabaceae	*Trifolium barbigerum*	bearded clover	native
Fabaceae	*Trifolium depauperatum var. amplectens*	pale sack clover	native
Fabaceae	*Trifolium depauperatum var. depauperatum*	dwarf sack clover	native
Fabaceae	*Trifolium depauperatum var. hydrophilum*	water sack clover	native (rare) CNPS 1B.2
Fabaceae	*Trifolium fucatum*	bull clover	native
Fabaceae	*Trifolium hirtum*	rose clover	non-native

Family	Scientific name	Common name	Native/Non-Native
Fabaceae	*Trifolium incarnatum*	crimson clover	non-native
Fabaceae	*Trifolium variegatum*	variegated clover	native
Fabaceae	*Trifolium willdenovii*	tomcat clover	Native
Fabaceae	*Vicia sativa*	spring vetch	non-native
Fabaceae	*Vicia sativa ssp. sativa*	common vetch	non-native
Fabaceae	*Vicia villosa*	hairy vetch	non-native
Fagaceae	*Quercus agrifolia*	coast live oak	native
Fagaceae	*Quercus douglasii*	blue oak	Native
Frankeniaceae	*Frankenia salina*	Alkali heath	native
Garryaceae	*Garrya elliptica*	coast silk-tassel bush	native
Geraniaceae	*Erodium botrys*	broad-leaf filaree	non-native
Geraniaceae	*Erodium cicutarium*	redstem filaree	non-native
Geraniaceae	*Erodium moschatum*	whitestem filaree	non-native
Geraniaceae	*Geranium carolinianum*	Carolina geranium	native
Geraniaceae	*Geranium dissectum*	cutleaf geranium	non-native
Geraniaceae	*Geranium molle*	crane's bill geranium	non-native
Grossulariaceae	*Ribes sanguineum*	red-flowering currant	native
Grossulariaceae	*Ribes speciosum*	fuschia-flowered gooseberry	native
Hippocastanaceae	*Aesculus californica*	California buckeye	native
Hydrophyllaceae	*Phacelia ciliata*	Great Valley phacelia	native
Iridaceae	*Sisyrinchium bellum*	Blue-eyed grass	native
Iridaceae	*Sisyrinchium californicum*	golden-eyed grass	native
Isoetaceae	*Isoetes sp.*	quillwort	native
Juncaceae	*Juncus ambiguus*	seaside toad rush	native
Juncaceae	*Juncus balticus*	Baltic rush	native
Juncaceae	*Juncus kelloggii*	kellogg dwarf rush	native
Juncaginaceae	*Lilaea scilloides*	flowering-quillwort	native
Lamiaceae	*Lamium amplexicaule*	henbit	non-native
Lamiaceae	*Marrubium vulgare*	white horehound	non-native
Lamiaceae	*Salvia mellifera*	black sage	native
Lamiaceae	*Salvia spathacea*	hummingbird Sage	native
Lamiaceae	*Stachys ajugoides*	hedge nettle	native
Liliaceae	*Agave deserti*	desert agave	native
Liliaceae	*Brodiaea elegans*	harvest brodiaea	native
Liliaceae	*Brodiaea terrestris ssp. terrestris*	dwarf brodiaea	native
Liliaceae	*Chlorogalum pomeridianum*	soap plant	native
Liliaceae	*Dichelostemma capitatum*	blue dicks	native
Liliaceae	*Muilla maritima*	common muilla	native
Lythraceae	*Lythrum hyssopifolium*	Hyssop's loosestrife	non-native
Malvaceae	*Malacothamnus fremontii*	Fremont mallow	native
Malvaceae	*Malva neglecta*	common mallow	non-native

Family	Scientific name	Common name	Native/Non-Native
Malvaceae	*Malva nicaeensis*	bull mallow	non-native
Malvaceae	*Malva Parviflora*	cheeseweed mallow	non-native
Malvaceae	*Malvella leprosa*	alkali mallow	native
Marsiliaceae	*Pilularia americana*	pillwort	native
Moraceae	*Ficus carica*	edible fig	non-native
Myoporaceae	*Myoporum laetum*	myoporum	non-native
Myrtaceae	*Eucalyptus camaldulensis*	red gum	non-native
Myrtaceae	*Eucalyptus globulus*	Tasmanian blue gum	non-native
Myrtaceae	*Eucalyptus polyanthemos*	silver dollar gum	non-native
Myrtaceae	*Eucalyptus rudis*	western Australian floodedgum	non-native
Oleaceae	*Olea europaea*	olive	non-native
Onagraceae	*Camissonia subacaulis*	long-leaved suncup	native
Onagraceae	*Epilobium brachycarpum*	willow herb	native
Onagraceae	*Epilobium canum*	California fuchsia	native
Onagraceae	*Epilobium ciliatum*	fringed willowherb	native
Onagraceae	*Epilobium cleistogamum*	cleistogamus boisduvalia	
Onagraceae	*Epilobium minutum*	desert willow herb	native
Onagraceae	*Camissonia ovata*	sun cup	native
Onagraceae	*Oenothera elata ssp. hookeri*	Hooker's evening primrose	Native
Oxalidaceae	*Oxalis pes-caprae*	bermuda buttercup	non-native
Papaveraceae	*Dicentra formosa*	Western bleeding heart	native
Papaveraceae	*Eschscholzia californica*	California poppy	native
Papaveraceae	*Fumaria officinalis*	fumitory	non-native
Plantaginaceae	*Plantago coronopus*	cutleaf plantain	non-native
Plantaginaceae	*Plantago elongata*	annual coast plantago	native
Plantaginaceae	*Plantago erecta*	California plantain	native
Plantaginaceae	*Plantago lanceolata*	english plantain	non-native
Platanaceae	*Platanus racemosa*	westernsycamore	native
Plumbaginaceae	*Limonium californicum*	California sea lavender	native
Plumbaginaceae	*Limonium ramosissimum*	Algerian sea lavendar	non-native
Plumbaginaceae	*Plumbago auriculata*	Cape leadwort	non-native
Poaceae	*Agrostis exarata**	spike bentrgrass	Native
Poaceae	*Alopecurus saccatus*	Pacific foxtail	native
Poaceae	*Arundo donax*	giant reed	non-native
Poaceae	*Avena barbata*	slender wild oat	non-native
Poaceae	*Avena fatua*	wild oat	non-native
Poaceae	*Bromus carinatus var. carinatus*	California brome	native
Poaceae	*Bromus catharticus*	rescue grass	non-native
Poaceae	*Bromus hordeaceus*	soft brome	non-native
Poaceae	*Bromus madritensis ssp. Rubens*	red brome	non-native
Poaceae	*Bromus tectorum*	downy brome	non-native

Family	Scientific name	Common name	Native/Non-Native
Poaceae	*Cortaderia selloana*	pampasgrass	non-native
Poaceae	*Crypsis schoenoides*	swamp pricklegrass	non-native
Poaceae	*Cynodon dactylon*	bermudagrass	non-native
Poaceae	*Dactylis glomerata*	orchard grass	non-native
Poaceae	*Danthonia californica*	California oatgrass	Native
Poaceae	*Deschampsia cespitosa*	tufted hairgrass	Native
Poaceae	*Distichlis spicata*	saltgrass	native
Poaceae	*Elytrigia spp.*	tall wheatgrass	non-native
Poaceae	*Elymus glaucus*	blue wildrye	Native
Poaceae	*Festuca arundinacea*	tall fescue	non-native
Poaceae	*Festuca idahoensis*	Idaho fescue	Native
Poaceae	*Festuca rubra*	red fescue	Native
Poaceae	*Hordeum brachyantherum*	meadow barley	native
Poaceae	*Hordeum depressum*	low barley	native
Poaceae	*Hordeum marinum ssp. gussoneanum*	Mediterranean barley	non-native
Poaceae	*Hordeum murinum ssp. leporinum*	mouse barley	non-native
Poaceae	*Koeleria macrantha*	june grass	Native
Poaceae	*Koeleria phleoides*	annual junegrass	non-native
Poaceae	*Leymus triticoides*	creeping wild rye	native
Poaceae	*Lolium multiflorum*	Italian ryegrass	non-native
Poaceae	*Lolium perenne*	perennial rye grass	non-native
Poaceae	*Nassella pulchra*	purple needlegrass	native
Poaceae	*Parapholis incurva*	sickle grass	non-native
Poaceae	*Pennisetum clandestinum*	kikuyugrass	non-native
Poaceae	*Pennisetum setaceum*	crimson fountaingrass	non-native
Poaceae	*Phalaris aquatica*	harding grass	non-native
Poaceae	*Phragmites australis*	common reed	non-native
Poaceae	*Piptatherum miliaceum*	smilo grass	non-native
Poaceae	*Pleuropogon californicus*	semaphore grass	native
Poaceae	*Poa annua*	snnual bluegrass	non-native
Poaceae	*Poa pratensis*	Kentucky bluegrass	non-native
Poaceae	*Poa secunda ssp. secunda*	one-sided bluegrass	native
Poaceae	*Polypogon monspeliensis*	rabbitfoot grass	non-native
Poaceae	*Puccinellia maritima*	seaside alkaligrass	non-native
Poaceae	*Puccinellia simplex*	California alkaligrass	native
Poaceae	*Spartina alterniflora hybrids*	spartina hybrids	non-native
Poaceae	*Spartina foliosa*	California cord grass	native
Poaceae	*Vulpia bromoides*	European foxtail fescue	non-native
Poaceae	*Vulpia microstachys*	small fescue	Native
Poaceae	*Vulpia myuros*	rat-tail fescue	non-native
Poaceae	*Bromus diandrus*	ripgut brome	non-native

Family	Scientific name	Common name	Native/Non-Native
Polemoniacea	*Navarretia prostrata*	prostrate navarettia	native (rare)CNPS 1B.1
Polemoniacea	*Navarretia squarrosa*	skunkweed	Native
Polygonacae	*Rumex acetosella*	sheep sorrel	non-native
Polygonacae	*Rumex crispus*	curly dock	non-native
Polygonacae	*Rumex pulcher*	fiddle dock	non-native
Polygonaceae	*Eriogonum nudum*	naked buckwheat	Native
Polygonaceae	*Eriogonum spp.*	buckwheat species	native
Portulacaceae	*Claytonia perfoliata*	miner's lettuce	native
Portulacaceae	*Montia fontana*	water chickweed	native
Portulacaceae	*Portulaca oleracea*	common purslane	non-native
Primulaceae	*Anagallis arvensis*	scarlet pimpernel	non-native
Ranunculaceae	*Aquilegia eximia*	VanHoutte's columbine	native
Ranunculaceae	*Myosurus minimus*	common mousetail	native
Ranunculaceae	*Myosurus sessilis*	tiny mousetail	native
Ranunculaceae	*Ranunculus californicus*	Califonria buttercup	native
Rhamnaceae	*Ceanothus foliosus*	wavyleaf ceanothus	native
Rhamnaceae	*Ceanothus gloriosus*	glory mat	native
Rhamnaceae	*Ceanothus griseus*	Carmel ceanothus	native
Rhamnaceae	*Ceanothus thyrsiflorus*	blueblossom	native
Rhamnaceae	*Rhamnus californica*	California coffeeberry	native
Rosaceae	*Heteromeles arbutifolia*	toyon	native
Rosaceae	*Prunus ilicifolia*	holly-leaf cherry	native
Rosaceae	*Rosa californica*	California wild rose	native
Rosaceae	*Rubus armeniacus*	Himalayan blackberry	non-native
Rosaceae	*Rubus ursinus*	California blackberry	native
Rubiaceae	*Galium aparine*	common bedstraw	native
Salicaceae	*Salix lasiolepis*	arroyo willow	native
Scrophulariaceae	*Antirrhinum vexillo sp.*	foothillpenstemon	native
Scrophulariaceae	*Castilleja densiflora*	dense flower owl's clover	native
Scrophulariaceae	*Kickxia elatine*	sharp point fluvellin	non-native
Scrophulariaceae	*Limosella acaulis*	broad-leaved mudwort	native
Scrophulariaceae	*Mimulus aurantiacus*	sticky monkey flower	native
Scrophulariaceae	*Mimulus cardinalis*	scarlet monkeyflower	native
Scrophulariaceae	*Mimulus puniceus*	red bush monkeyflower	native
Scrophulariaceae	*Scrophularia californica*	bee plant	native
Scrophulariaceae	*Veronica anagallis-aquatica*	water speedwell	non-native
Scrophulariaceae	*Veronica peregrina ssp. xalapensis*	purslane speedwell	native
Scrophulariaceae	*Castilleja ambigua*	johnny-nip	native
Solanaceae	*Nicotiana acuminata var. multiflora*	many flower tobacco	non-native
Solanaceae	*Nicotiana glauca*	tree tobacco	non-native
Solanaceae	*Solanum nigrum*	black nightshade	non-native

Family	Scientific name	Common name	Native/Non-Native
Solanaceae	*Solanum rostratum*	buffalobur	non-native
Tamaricaceae	*Tamarix parviflora*	tamarisk	non-native
Typhaceae	*Typha latifolia*	cattail	non-native
Urticaceae	*Urtica urens*	dwarf nettle	non-native
Valerianaceae	*Centranthus ruber*	red valerian	non-native
Zygophyllaceae	*Tribulus terrestris*	puncturevine	non-native
Liliaceae	*Yucca*	Spanish banner	native

Appendix E. Refuge Species List

Don Edwards San Francisco Bay National Wildlife Refuge Birds List

Common Name	Scientific Name	Federal	State	Occurrence	Classification
Greater White-fronted Goose	*Anser albifrons*				native
Snow Goose	*Chen hyperborea*				native
Ross's Goose	*Chen rossii*				native
Canada Goose	*Branta canadensis*			nests locally	native
Cackling Goose	*Branta hutchinsii*				native
Brant	*Branta bernicla*		SSC		native
Tundra Swan	*Cygnus columbianus*				native
Gadwall	*Anas strepera*			nests locally	native
Eurasian Wigeon	*Anas penelope*				native
American Wigeon	*Anas americana*				native
Mallard	*Anas platyrhynchos*			nests locally	native
Blue-winged Teal	*Anas discors*				native
Cinnamon Teal	*Anas cyanoptera*			nests locally	native
Northern Shoveler	*Anas clypeata*			nests locally	native
Northern Pintail	*Anas acuta*			nests locally	native
Green-winged Teal	*Anas crecca*				native
Canvasback	*Aythya valisineria*			nests locally	native
Redhead	*Aythya americana*		SSC		native
Ring-necked Duck	*Aythya collaris*				native
Tufted Duck	*Aythya fuligula*				non-native
Greater Scaup	*Aythya marila*				native
Lesser Scaup	*Aythya affinis*			nests locally	native
Surf Scoter	*Melanitta perspicillata*				native
White-winged Scoter	*Melanitta fusca*				native
Black Scoter	*Melanitta nigra*				native
Long-tailed Duck	*Clangula hyemalis*				native
Bufflehead	*Bucephala albeola*				native
Common Goldeneye	*Bucephala clangula*				native
Barrow's Goldeneye	*Bucephala islandica*				native
Hooded Merganser	*Lophodytes cucullata*				native
Common Merganser	*Mergus merganser*				native
Red-breasted Merganser	*Mergus serrator*				native
Ruddy Duck	*Oxyura jamaicensis*			nests locally	native
California Quail	*Callipepla californica*				native
Ring-necked Pheasant	*Phasianus colchicus*			nests locally	non-native
Red-throated Loon	*Gavia stellata*				native
Pacific Loon	*Gavia pacifica*				native
Common Loon	*Gavia immer*				native
Pied-billed Grebe	*Podilymbus podiceps*			nests locally	native
Horned Grebe	*Podiceps auritus*				native
Red-necked Grebe	*Podiceps grisegena*				native
Eared Grebe	*Podiceps nigricollis*			nests locally	native

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Don Edwards San Francisco Bay National Wildlife Refuge Birds List

Common Name	Scientific Name	Federal	State	Occurrence	Classification
Western Grebe	*Aechmophorus occidentalis*				native
Clark's Grebe	*Aechmophorus clarkii*			nests locally	native
American White Pelican	*Pelecanus erythrorhynchos*		SSC		native
Brown Pelican	*Pelecanus occidentalis*				native
Brandt's Cormorant	*Phalacrocorax penicillatus*				native
Double-crested Cormorant	*Phalacrocorax auritus*			nests locally	native
Pelagic Cormorant	*Phalacrocorax pelagicus*				native
American Bittern	*Botaurus lentiginosus*				native
Least Bittern	*Ixobrychus exilis*		SSC		native
Great Blue Heron	*Ardea herodias*			nests locally	native
Great Egret	*Ardea alba*			nests locally	native
Snowy Egret	*Egretta thula*			nests locally	native
Little Blue Heron	*Egretta caerulea*				native
Cattle Egret	*Bubulcus ibis*			nests locally	native
Green Heron	*Butorides virescens*				native
Black-crowned Night-Heron	*Nycticorax nycticorax*			nests locally	native
White-faced Ibis	*Plegadis chihi*				native
Turkey Vulture	*Cathartes aura*				native
Osprey	*Pandion haliaetus*			nests locally	native
White-tailed Kite	*Elanus coeruleus*		SP	nests locally	native
Bald Eagle	*Haliaeetus leucocephalus*		E		native
Northern Harrier	*Circus cyaneus*		SSC	nests locally	native
Sharp-shinned Hawk	*Accipiter striatus*				native
Cooper's Hawk	*Accipiter cooperii*				native
Red-shouldered Hawk	*Buteo lineatus*				native
Red-tailed Hawk	*Buteo jamaicensis*			nests locally	native
Ferruginous Hawk	*Buteo regalis*				native
Rough-legged Hawk	*Buteo lagopus*				native
Golden Eagle	*Aquila chrysaetos*		SP		native
American Kestrel	*Falco sparverius*			nests locally	native
Merlin	*Falco columbarius*				native
Peregrine Falcon	*Falco peregrinus*			nests locally	native
Prairie Falcon	*Falco mexicanus*				native
California Black Rail	*Laterallus jamaicensis coturniculus*		T		native
California Clapper rail	*Rallus longirostris obsoletus*	E	E	nests locally	native
Virginia Rail	*Rallus limicola*				native
Sora	*Porzana carolina*				native
Common Moorhen	*Gallinula chloropus*			nests locally	native
American Coot	*Fulica americana*			nests locally	native
Sandhill Crane	*Grus canadensis*				native
Black-bellied Plover	*Pluvialis squatarola*				native
American Golden-Plover	*Pluvialis dominica*				native

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Don Edwards San Francisco Bay National Wildlife Refuge Birds List

Common Name	Scientific Name	Federal	State	Occurrence	Classification
Pacific Golden-Plover	*Pluvialis fulva*				native
Western Snowy Plover	*Charadrius alexandrinus nivosus*	T		nests locally	native
Semipalmated Plover	*Charadrius semipalmata*				native
Killdeer	*Charadrius vociferus*			nests locally	native
Black-necked Stilt	*Himantopus mexicanus*			nests locally	native
American Avocet	*Recurvirostra americana*			nests locally	native
Greater Yellowlegs	*Tringa melanoleuca*				native
Lesser Yellowlegs	*Tringa flavipes*				native
Willet	*Catoptrophorus semipalmatus*				native
Wandering Tattler	*Heteroscelus incanus*				native
Spotted Sandpiper	*Actitis macularia*				native
Whimbrel	*Numenius phaeopus*				native
Long-billed Curlew	*Numenius americanus*				native
Marbled Godwit	*Limosa fedoa*				native
Ruddy Turnstone	*Arenaria interpres*				native
Black Turnstone	*Arenaria melanocephala*				native
Red Knot	*Calidris canutus*				native
Sanderling	*Calidris alba*				native
Semipalmated Sandpiper	*Calidris pusilla*				native
Western Sandpiper	*Calidris mauri*				native
Least Sandpiper	*Calidris minutilla*				native
Baird's Sandpiper	*Calidris bairdii*				native
Pectoral Sandpiper	*Calidris melanotos*				native
Dunlin	*Calidris alpina*				native
Stilt Sandpiper	*Calidris himantopus*				native
Ruff	*Philomachus pugnax*				native
Short-billed Dowitcher	*Limnodromus griseus*				native
Long-billed Dowitcher	*Limnodromus scolopaceus*				native
Wilson's Snipe	*Gallinago delicata*				native
Wilson's Phalarope	*Phalaropus tricolor*				native
Red-necked Phalarope	*Phalaropus lobatus*				native
Red Phalarope	*Phalaropus fulicaria*				native
Parasitic Jaeger	*Stercorarius parasiticus*				native
Franklin's Gull	*Larus pipixcan*				native
Bonaparte's Gull	*Larus Philadelphia*				native
Heermann's Gull	*Larus heermanni*				native
Mew Gull	*Larus canus*				native
Ring-billed Gull	*Larus delawarensis*				native
California Gull	*Larus californicus*			nests locally	native
Herring Gull	*Larus argentatus*				native
Thayer's Gull	*Larus thayeri*				native
Western Gull	*Larus occidentalis*			nests locally	native

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Don Edwards San Francisco Bay National Wildlife Refuge Birds List

Common Name	Scientific Name	Federal	State	Occurrence	Classification
Glaucous-winged Gull	*Larus glaucescens*				native
Glaucous Gull	*Larus hyperboreus*				native
Sabine's Gull	*Xena sabini*				native
Caspian Tern	*Sterna caspia*			nests locally	native
Elegant Tern	*Sterna elegans*				native
Common Tern	*Sterna hirundo*				native
Forster's Tern	*Sterna forsteri*			nests locally	native
California Least Tern	*Sterna antillarum browni*	E	E		native
Black Tern	*Chlidonias niger*				native
Black Skimmer	*Rynchops niger*		SSC	nests locally	native
Common Murre	*Uria aalge*				native
Rock Dove	*Columba livia*				non-native
Mourning Dove	*Zenaida macroura*			nests locally	native
Barn Owl	*Tyto alba*			nests locally	native
Great Horned Owl	*Bubo virginianus*				native
Burrowing Owl	*Athene cunicularia*		SSC	nests locally	native
Short-eared Owl	*Asio flammeus*		SSC	nests locally	native
Vaux's Swift	*Chaetura vauxi*		SSC		native
White-throated Swift	*Aeronautes saxatalis*				native
Anna's Hummingbird	*Calypte anna*			nests locally	native
Rufous Hummingbird	*Selasphorus rufus*				native
Allen's Hummingbird	*Selasphorus sasin*				native
Belted Kingfisher	*Ceryle alcyon*				native
Red-breasted Sapsucker	*Sphyrapicus ruber*				native
Nuttall's Woodpecker	*Picoides nuttallii*				native
Downy Woodpecker	*Picoides pubescens*				native
Northern Flicker	*Colaptes auratus*				native
Western Wood-Pewee	*Contopus sordidulus*				native
Willow Flycatcher	*Empidonax traillii*				native
Pacific-slope Flycatcher	*Empidonax difficilis*				native
Black Phoebe	*Sayornis nigricans*			nests locally	native
Say's Phoebe	*Sayornis saya*				native
Ash-throated Flycatcher	*Myiarchus cinerascens*				native
Western Kingbird	*Tyrannus verticalis*				native
Loggerhead Shrike	*Lanius ludovicianus*		SSC	nests locally	native
Warbling Vireo	*Vireo gilvus*				native
Western Scrub-Jay	*Aphelocoma californica*			nests locally	native
American Crow	*Corvus brachyrhynchos*				native
Common Raven	*Corvus corax*			nests locally	native
Horned Lark	*Eremophila alpestris*			nests locally	native
Purple Martin	*Progne subis*				native
Tree Swallow	*Tachycineta bicolor*			nests locally	native

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Don Edwards San Francisco Bay National Wildlife Refuge Birds List

Common Name	Scientific Name	Federal	State	Occurrence	Classification
Violet-green Swallow	*Tachycineta thalassina*				native
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*				native
Bank Swallow	*Riparia riparia*		T		native
Cliff Swallow	*Petrochelidon pyrrhonota*			nests locally	native
Barn Swallow	*Hirundo rustica*			nests locally	native
Chestnut-backed Chickadee	*Poecile rufescens*				native
Bushtit	*Psaltriparus minimus*			nests locally	native
Rock Wren	*Salpinctes obsoletus*				native
Bewick's Wren	*Thryomanes bewickii*			nests locally	native
House Wren	*Troglodytes aedon*				native
Marsh Wren	*Cistothorus palustris*			nests locally	native
Golden-crowned Kinglet	*Regulus satrapa*				native
Ruby-crowned Kinglet	*Regulus calendula*				native
Blue-gray Gnatcatcher	*Polioptila caerulea*				native
Swainson's Thrush	*Catharus ustulatus*				native
Hermit Thrush	*Catharus guttatus*				native
American Robin	*Turdus migratorius*				native
Varied Thrush	*Ixoreus naevius*				native
Northern Mockingbird	*Mimus polyglottos*			nests locally	native
Sage Thrasher	*Oreoscoptes montanus*				native
European Starling	*Sturnus vulgaris*				non-native
American Pipit	*Anthus rubescens*				native
Cedar Waxwing	*Bombycilla cedrorum*				native
Orange-crowned Warbler	*Vermivora celata*				native
Nashville Warbler	*Vermivora ruficapilla*				native
Yellow Warbler	*Dendroica petechia*		SSC		native
Yellow-rumped Warbler	*Dendroica coronata*				native
Townsend's Warbler	*Dendroica townsendi*				native
Palm Warbler	*Dendroica palmarum*				native
Blackpoll Warbler	*Dendroica striata*				native
Northern Waterthrush	*Seiurus noveboracensis*				native
San Francisco common yellowthroat	*Geothlypis trichas sinuosa*		SSC	nests locally	native
Wilson's Warbler	*Wilsonia pusilla*				native
Western Tanager	*Piranga ludoviciana*				native
Spotted Towhee	*Pipilo maculatus*				native
California Towhee	*Pipilo crissalis*			nests locally	native
Bryant's savannah sparrow	*Passerculus sandwichensis alaudinus*		SSC	nests locally	native
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*				native
Fox Sparrow	*Passerella iliaca*				native
Alameda song sparrow	*Melospiza melodia pusillula*		SSC	nests locally	native
Lincoln's Sparrow	*Melospiza lincolnii*				native
Swamp Sparrow	*Melospiza georgiana*				native

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Don Edwards San Francisco Bay National Wildlife Refuge Birds List

Common Name	Scientific Name	Federal	State	Occurrence	Classification
White-throated Sparrow	*Zonotrichia leucophrys*				native
White-crowned Sparrow	*Zonotrichia atricapilla*				native
Golden-crowned Sparrow	*Zonotrichia atricapilla*				native
Dark-eyed Junco	*Junco hyemalis*				native
Black-headed Grosbeak	*Pheucticus melanocephalus*				native
Lazuli Bunting	*Passerina amoena*				native
Red-winged Blackbird	*Agelaius phoeniceus*			nests locally	native
Tricolored Blackbird	*Agelaius tricolor*		SSC		native
Western Meadowlark	*Sturnella neglecta*			nests locally	native
Brewer's Blackbird	*Euphagus cyanocephalus*				native
Brown-headed Cowbird	*Molothrus ater*				native
Hooded Oriole	*Icterus cucullatus*				native
Bullock's Oriole	*Icterus bullockii*			nests locally	native
House Finch	*Carpodacus mexicanus*			nests locally	native
Lesser Goldfinch	*Carduelis psaltria*				native
American Goldfinch	*Carduelis tristis*			nests locally	native
House Sparrow	*Passer domesticus*			nests locally	non-native
Brown Booby	*Sula leucogaster*			accidental	native
Magnificent Frigatebird	*Fregata magnificens*			accidental	native
Glossy Ibis	*Plegadis falcinellus*			accidental	native
Wild Turkey	*Meleagris gallopavo*				native
Black Oystercatcher	*Haematopus bachmani*			accidental	native
Solitary Sandpiper	*Tringa solitaria*			accidental	native
Hudsonian Godwit	*Limosa haemastica*			accidental	native
Bar-tailed Godwit	*Limosa lapponica*			accidental	native
Surfbird	*Aphriza virgata*			accidental	native
Little Stint	*Calidris minuta*			accidental	native
Sharp-tailed Sandpiper	*Calidris acuminata*			accidental	native
Curlew Sandpiper	*Calidris ferruginea*			accidental	native
Buff-breasted Sandpiper	*Tryngites subruficollis*			accidental	native
Little Gull	*Larus minutus*			accidental	native
Black-headed Gull	*Larus ridibundus*			accidental	native
Lesser Black-backed Gull	*Larus fuscus*			accidental	native
Slaty-backed Gull	*Larus schistisagus*			accidental	native
Arctic Tern	*Sterna paradisaea*			accidental	native
Ancient Murrelet	*Synthliboramphus antiquus*			accidental	native
Pigeon Guillemot	*Cepphus columba*			accidental	native
Band-tailed Pigeon	*Columba fasciata*				native
Chimney Swift	*Chaetura pelagica*			accidental	native
Black-chinned Hummingbird	*Archilochus alexandri*			accidental	native
Least Flycatcher	*Empidonax minimus*			accidental	native
Dusky Flycatcher	*Empidonax oberholseri*			accidental	native

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Don Edwards San Francisco Bay National Wildlife Refuge Birds List

Common Name	Scientific Name	Federal	State	Occurrence	Classification
Hammond's Flycatcher	*Empidonax hammondii*			accidental	native
Tropical Kingbird	*Tyrannus melancholicus*			accidental	native
Cassin's Kingbird	*Tyrannus vociferans*			accidental	native
Hutton's Vireo	*Vireo huttoni*			accidental	native
Cassin's Vireo	*Vireo cassinii*			accidental	native
White Wagtail	*Motacilla alba*			accidental	native
American Redstart	*Setophaga ruticilla*			accidental	native
Magnolia Warbler	*Dendroica magnolia*			accidental	native
Yellow-breasted Chat	*Icteria virens*		SSC	accidental	native
Sage Sparrow	*Amphispiza belli*			accidental	native
Chipping Sparrow	*Spizella passerina*			accidental	native
Clay-colored Sparrow	*Spizella pallida*			accidental	native
Brewer's Sparrow	*Spizella breweri*			accidental	native
Vesper Sparrow	*Pooecetes gramineus*			accidental	native
Lark Sparrow	*Chondestes grammacus*			accidental	native
Chestnut-collared Longspur	*Calcarius ornatus*			accidental	native
Pine Siskin	*Spinus pinus*			accidental	native

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Don Edwards San Francisco Bay National Wildlife Refuge Mammal List

Common Name	Scientific Name	Federal	State	Occurrence	Classification
Virginia opossum	*Didelphis virginianus*			upland	non-native
salt marsh wandering shrew	*Sorex vagrans halicoetes*			marsh	native
Yuma myotis	*Myotis yumanensis*			all habitats	native
Western red bats	*Lasirurs blossevillii*			all habitats	native
Hoary bats	*Lasiurus cinereus*			all habitats	native
Mexican free-tailed bat	*Tadarida brasiliensis*			all habitats	native
Raccoon	*Procyon lotor*			all habitats	native
Common muskrat	*Ondatra zibethicus*			all habitats	native
Long-tailed weasel	*Mustela frenata*			all habitats	native
Striped skunk	*Mephitis mephitis*			all habitats	native
western spotted skunk	*Spilogale gracilis*			all habitats	native
Gray fox	*Urocyon cinereoargenteus*			all habitats	native
Red fox	*Vulpes vulpes*			all habitats	non-native
Mountain lion	*Felis concolor*		FP	all habitats	native
Pacific harbor seal	*Phoca vitulina richardsi*			tidal sloughs	native
California ground squirrel	*Spermophilus beecheyi*			upland	native
Botta's pocket gopher	*Thomomys bottae*			upland	native
Western harvest mouse	*Reithrodontomys megalotis*			all habitats	native
Salt marsh harvest mouse	*Reithrodontomys raviventris raviventris*	E	E	marsh	native
House mouse	*Mus musculus*			all habitats	non-native
Deer mouse	*Peromyscus maniculatus*			all habitats	native
California vole	*Microtus californicus*			all habitats	native
Norway rat	*Rattus norvegicus*			all habitats	non-native
Black rat	*Rattus rattus*			all habitats	non-native
Brush rabbit	*Sylvilagus bachmani*			upland	native
Audubon's cottontail	*Sylvilagus audubonii*			upland	native
Black-tailed jackrabbit	*Lepus californicus*			upland	native

E: Endangered; FP: Fully Protected

Don Edwards San Francisco Bay National Wildlife Refuge Amphibian and Reptile List

Common Name	Scientific Name	Federal	State	Occurrence	Classification
California tiger salamander	*Ambystoma californiense*	T	E	Known	native
Arboreal salamander	*Aneides lugubris*			Possible	native
California slender salamander	*Batrachoseps attenuatus*			Possible	native
Pacific tree frog	*Pseudacris regilla*			Known	native
Western fence lizard	*Sceloporus occidentalis*			Known	native
Western skink	*Eumeces skiltonianus*			Possible	native
Southern alligator lizard	*Elgaria multicarinata*			Known	native
Gopher snake	*Pituophis melanoleuca*			Known	native
Common garter snake	*Thamnophis sirtalis*			Known	native
Western terrestrial garter snake	*Thamnophis elegans*			Known	native
Western rattlesnakes	*Crotalus oreganus*			Known	native
Western pond turtle	*Clemmys marmorata*		SC	Known	native

T: Threatened; E: Endangered; SC: Species of Concern

Don Edwards San Francisco Bay National Wildlife Refuge Fish List

Common Name	Scientific Name	Federal	State	Occurrence	Classification
Leopard shark	*Triakis semifasciata*			present in tidal waters and ponds	native
Soupfin shark	*Galeorhinus galeus*			present in tidal waters	native
Brown smoothhound	*Mustelus henlei*			present in tidal waters and ponds	native
Big skate	*Raja binoculata*			present in tidal waters	native
Spiny dogfish	*Squalus acanthias*			present in tidal waters	native
California skate	*Raja inornata*			present in tidal waters	native
Bat ray	*Myliobatis californica*			present in tidal waters and ponds	native
Green sturgeon	*Acipenser medirostris*	T		present in tidal waters	native
American shad	*Alosa sapidissima*			present in tidal waters	non-native
Pacific herring	*Clupea pallasii*			present in tidal waters	native
Threadfin shad	*Dorosma petenense*			present in tidal waters	non-native
Pacific sardine	*Sardinops sagax*			present in tidal waters	native
Northern anchovy	*Engraulis mordax*			present in tidal waters and ponds	native
Chinook salmon	*Oncorhynchus tshawytscha*	E	E	present in tidal waters	native
Steelhead (Central California Coast DPS)	*Oncorhynchus mykiss*	T		present in tidal waters	native
Longfin smelt	*Spirinchus thaleichthys*		T	present in tidal waters	native
Common carp	*Cyprinus carpio*			present in tidal waters	non-native
Sacramento sucker	*Catostomus occidentalis occidentalis*			present in tidal waters	native
Pacific whiting (hake)	*Merluccius productus*			present in tidal waters	native
Plainfin midshipman	*Porichthys notatus*			present in tidal waters	native
Rainwater killifish	*Lucania parva*			present in tidal waters and ponds	non-native
Topsmelt	*Atherinops affinis*			present in tidal waters and ponds	native
Mississippi silversides	*Menidia audens*			present in tidal waters and ponds	non-native
Jacksmelt	*Atherinopsis californiensis*			present in tidal waters	native
Threespine sticklebacks	*Gasterosteus aculeatus*			present in tidal waters and ponds	native
Bay pipefish	*Syngnathus leptorhynchus*			present in tidal waters and ponds	native
Brown rockfish	*Sebastes auriculatus*			present in tidal waters	native
Bocaccio	*Sebastes paucispinis*			rare in tidal waters	non-native
Calico rockfish	*Sebastes dalli*			rare in tidal waters	native
Kelp greenling	*Hexagrammos decagrammus*			present in tidal waters	native
Lingcod	*Ophiodon elongatus*			present in tidal waters	native
Prickly sculpin	*Cottus asper*			present in tidal waters and ponds	native
Pacific staghorn sculpin	*Leptocottus armatus*			present in tidal waters and ponds	native
Cabezon	*Scorpaenichthys marmoratus*			rare in tidal waters	non-native
Striped bass	*Morone saxatilis*			present in tidal waters and ponds	non-native
Jackmackerel	*Trachurus symmetricus*			present in tidal waters	native
White croaker	*Genyonemus lineatus*			present in tidal waters	native
Shiner surfperch	*Cymatogaster aggregata*			present in tidal waters and ponds	native
Barred surfperch	*Amphistichus argenteus*			present in tidal waters and ponds	native
Yellowfin goby	*Acanthogobius flavimanus*			present in tidal waters and ponds	non-native
Arrow goby	*Clevelandia ios*			present in tidal waters	native
Longjaw mudsucker	*Gillichthys mirabilis*			present in tidal waters and ponds	native
Cheekspot goby	*Ilypnus gilberti*			present in tidal waters	native
Bay goby	*Lepidogobius lepidus*			present in tidal waters	native
Chameleon goby	*Tridentiger trigonocephalus*			present in tidal waters and ponds	non-native

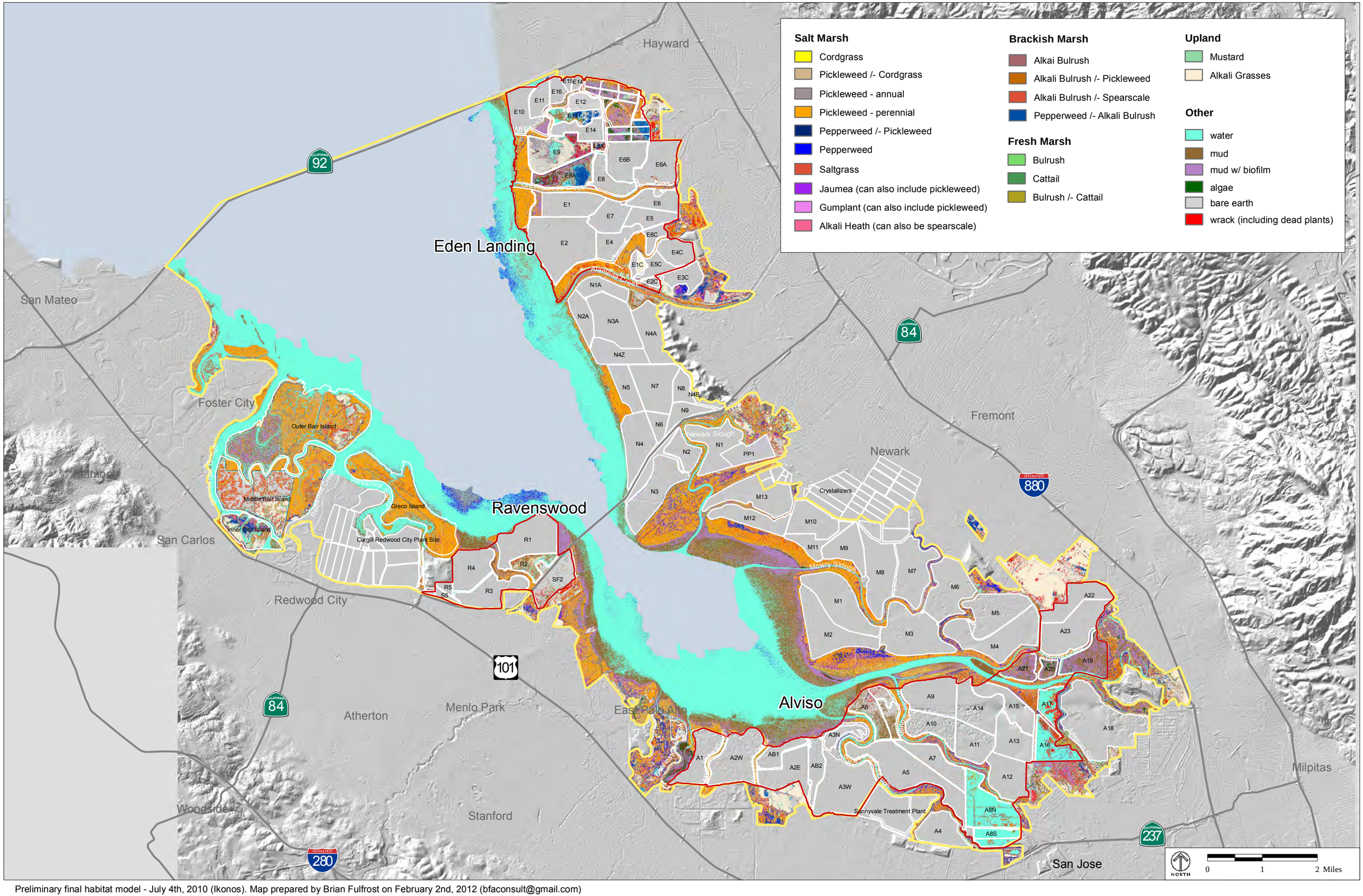
T: Threatened; E: Endangered

Don Edwards San Francisco Bay National Wildlife Refuge Fish List

Shimofuri goby	*Tridentiger bifasciatus*			present in tidal waters and ponds	non-native
Shokahaze goby	*Tridentiger barbatus*			present in tidal waters and ponds	non-native
Pacific sanddab	*Citharichthys sordidus*			present in tidal waters	native
Speckled sanddab	*Citharichthys stigmaeus*			present in tidal waters and ponds	native
California halibut	*Paralichthys californicus*			present in tidal waters	native
Rex sole	*Glyptocephalus zachirus*			rare in tidal waters	native
Diamond turbot	*Hypsopsetta guttulata*			present in tidal waters and ponds	native
English sole	*Parophrys vetulus*			present in tidal waters	native
Starry flounder	*Platichthys stellatus*			present in tidal waters	native
Curlfin sole	*Pleuronichthys decurrens*			present in tidal waters	native
Sand sole	*Psettichthys melanostictus*			present in tidal waters	native

T: Threatened; E: Endangered

Appendix F. Vegetation Map



Preliminary final habitat model - July 4th, 2010 (Ikonos). Map prepared by Brian Fulfrost on February 2nd, 2012 (bfaconsult@gmail.com)

Appendix G. Avian Use of Salt-Production and Wildlife-Managed Ponds in the South Bay

Avian use of salt-production and wildlife-managed ponds in the South Bay

Adapted from: N. D. Athearn, J.Y. Takekawa, J.D. Bluso-Demers, J.M. Shinn, L. A. Brand, C.W. Robinson-Nilsen, and C.M. Strong. 2011, in press. Monitoring Bird Distribution and Abundance to Inform Adaptive Management for Salt Pond Restoration in San Francisco Bay, California, USA. Hydrobiologia.

Seventy-six South Bay ponds were sampled monthly October 2005- May 2009. Ponds ranged in size from 12 ha to 276 ha and varied in mean annual salinity from 15 g·l-1 to 271 g·l-1. U.S. Geological Survey and San Francisco Bay Bird Observatory observers conducted counts of all species of waterbirds. Surveys were conducted during daylight hours within 3 hours of the high tide, when the largest number of waterbirds was roosting in the ponds. Identified waterbirds were separated into guilds to examine differences among generalized groups in addition to differences among key species. These groups included ducks, shorebirds, shorebirds, phalaropes (a high salinity specialist shorebird), and piscivores (fish-eating birds; Table 1), although many more species were identified that did not conform to these groups. These groups were chosen because of their high pond use, and because of their diverse foraging strategies. Several additional representative species were chosen which were typically found in high densities on ponds relative to other Bay habitats: 1) eared grebe – grebes which foraged on water column invertebrates and considered a high-salinity specialist, 2) Forster's terns – representing colonially nesting birds including American avocets, black-necked stilts, Caspian and Forster's terns that nest on islands and levees within the pond complexes, 3) California gulls - gulls that nest on islands, levees and dry ponds; now considered a nuisance species in the South Bay due to their expanding population.

Ponds were grouped according to geographic location, and whether they were salt-production ponds ("Production") or wildlife-managed ponds, and thus part of the South Bay Salt Pond Restoration Project management ("SBSPRP"; Figure 1). Takekawa et al. (2006) identified four salinity classes to classify trophic communities in ponds: brackish (0.5 – 30 g•l-1), and low salinity (31 – 80 g•l-1), mid salinity (81 – 150 g•l-1), and high salinity (>150 g•l-1). The following maps serve as a visual representation of this synthesized data set, with each guild or species map chosen for highest abundance of birds (Figures 2-8).

Table 1. Species and associated guilds counted on USGS and SFBBO surveys, October 2005 – May 2009.

Ducks

American Green-winged Teal
American Wigeon
Blue-winged Teal
Cinnamon Teal
Domestic Mallard
Eurasian Wigeon
Gadwall
Long-tailed Duck
Mallard
Northern Pintail
Northern Shoveler
Barrow's Goldeneye
Bufflehead
Canvasback
Common Goldeneye
Greater Scaup
Lesser Scaup
Redhead

Ring-necked Duck
Ruddy Duck
Surf Scoter
Tufted Duck
White-winged scoter

Shorebirds

American Avocet
Black-bellied Plover
Black Turnstone
Black-necked Stilt
Common Snipe
Golden Plover
Greater Yellowlegs
Killdeer
Long-billed Curlew
Lesser Yellowlegs
Marbled Godwit
Pacific Golden-Plover
Red Knot
Ruff
Ruddy Turnstone
Spotted Redshank
Stilt Sandpiper
Surfbird
Whimbrel
Willet
Baird's Sandpiper
Dunlin
Long-billed Dowitcher
Least Sandpiper
Pectoral Sandpiper
Sanderling
Short-billed Dowitcher
Semipalmated Plover
Semipalmated Sandpiper
Snowy Plover
Spotted Sandpiper
Western Sandpiper
Curlew Sandpiper

Phalaropes

Red Phalarope
Red-necked Phalarope
Wilson's Phalarope

Piscivores

American White Pelican
Belted Kingfisher
Brown Pelican
Clark's Grebe
Common Loon
Common Merganser
Double-crested Cormorant
Hooded Merganser
Pacific Loon
Pied-billed Grebe
Pelagic Cormorant
Red-breasted Merganser
Red-necked Grebe
Red-throated Loon
Western Grebe
Brandt's Cormorant
California Gull
Glaucous Gull
Glaucous-winged Gull
Herring Gull
Mew Gull
Ring-billed Gull
Slaty-backed Gull
Thayer's Gull
Western Gull
American Bittern
Black-crowned Night Heron
Cattle Egret
Great Blue Heron
Great Egret
Green Heron
Little Blue Heron

Snowy Egret
Arctic Tern
Black Skimmer
Black Tern
Caspian Tern
Common Tern
Elegant Tern
Forster's Tern
Least Tern

Figure 1: The seventy-six South Bay ponds were grouped according to geographic location, and whether they were salt-production ponds ("Production") or wildlife-managed ponds, and thus part of the South Bay Salt Pond Restoration Project management ("SBSPRP").

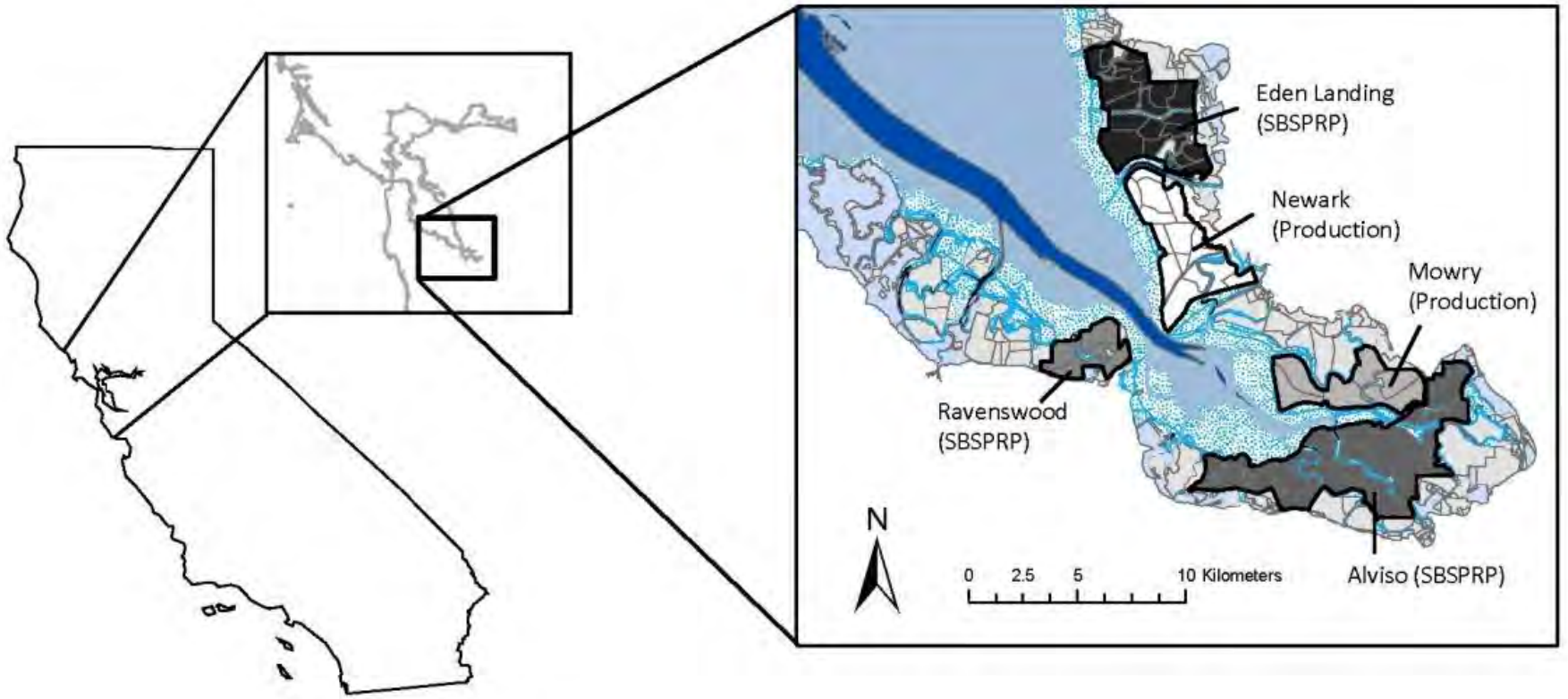


Figure 2: Average monthly abundance of ducks, winter 2006-2009.

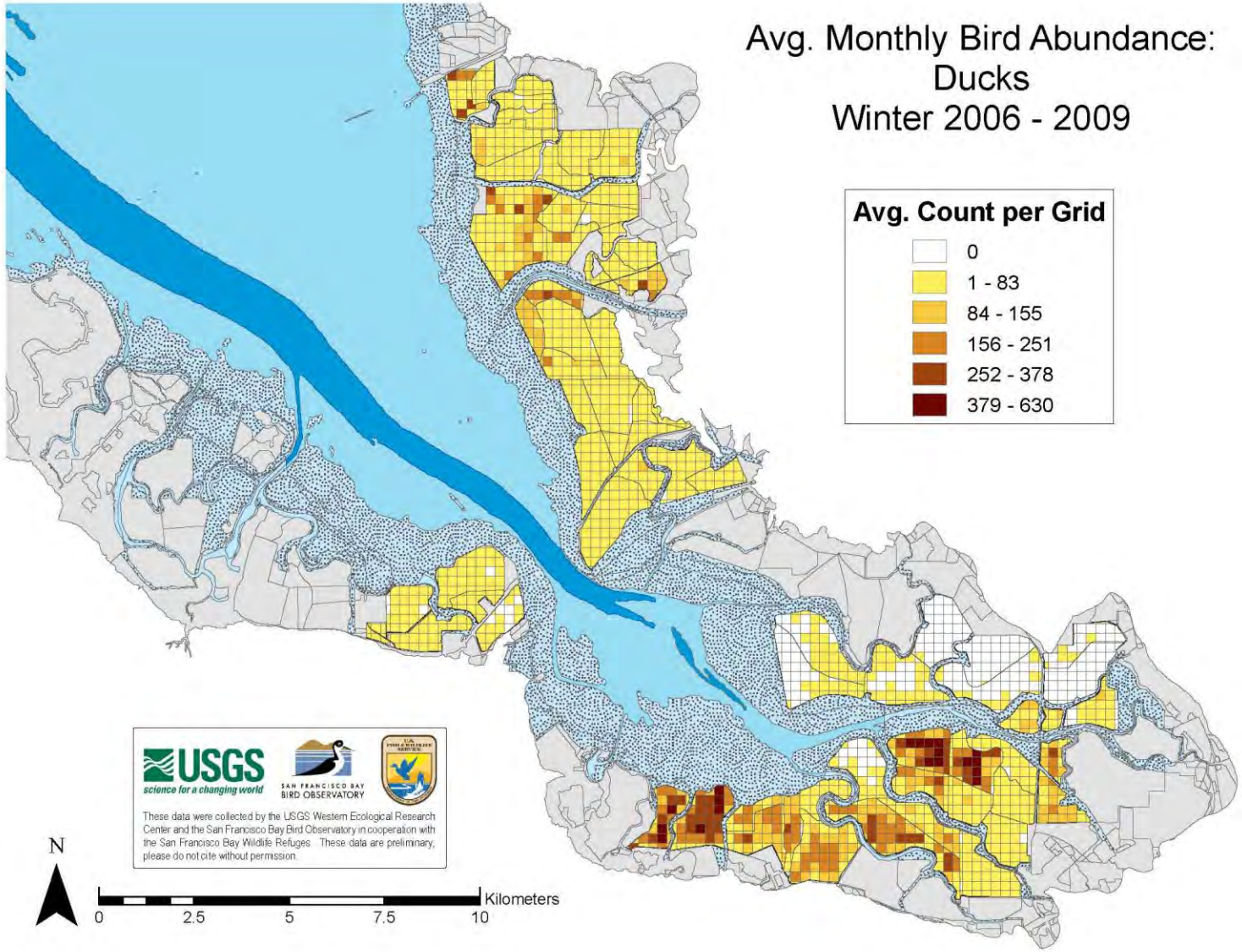


Figure 3: Average monthly abundance of shorebirds, winter 2006-2009.

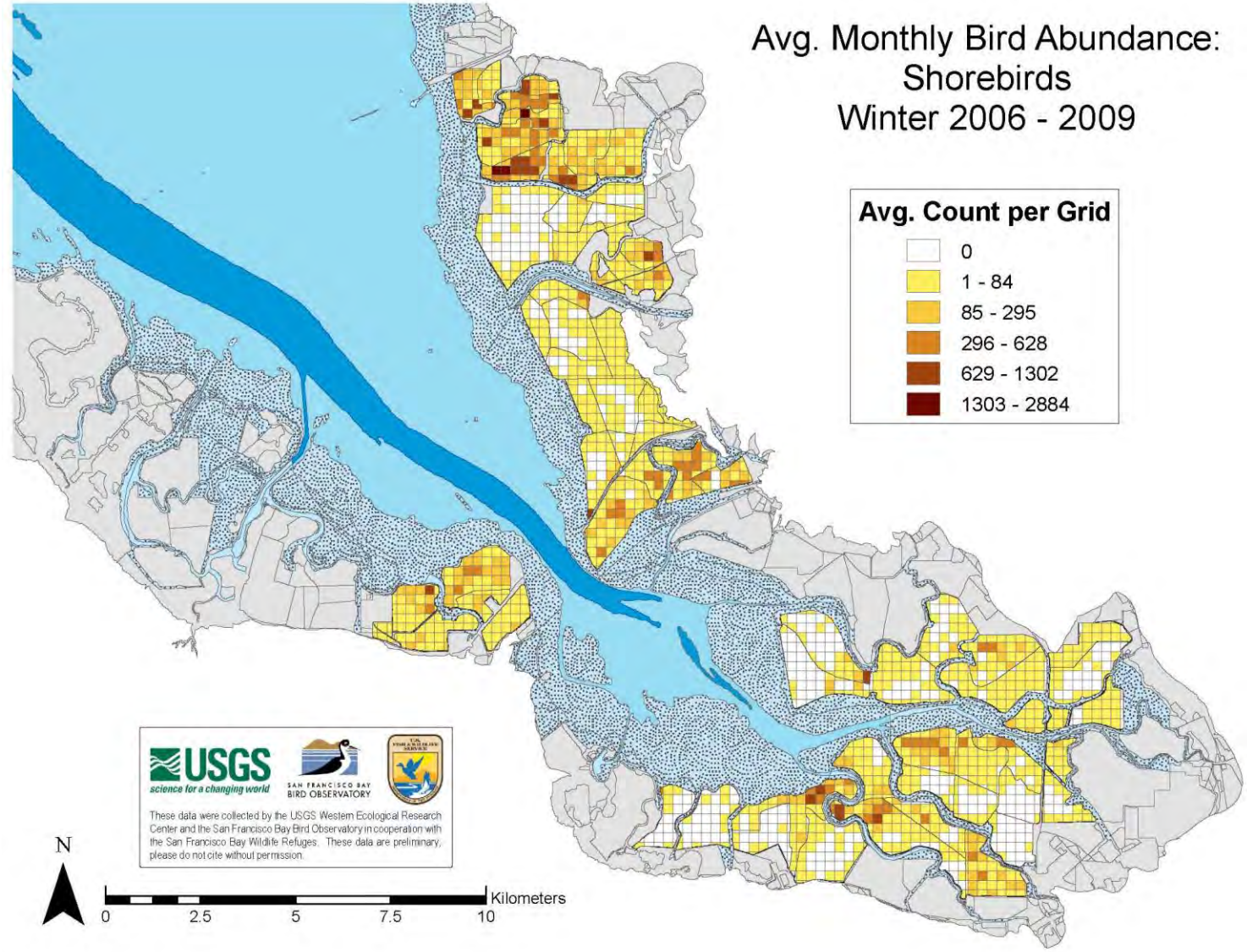


Figure 4: Average monthly abundance of phalaropes, summer 2006-2008.

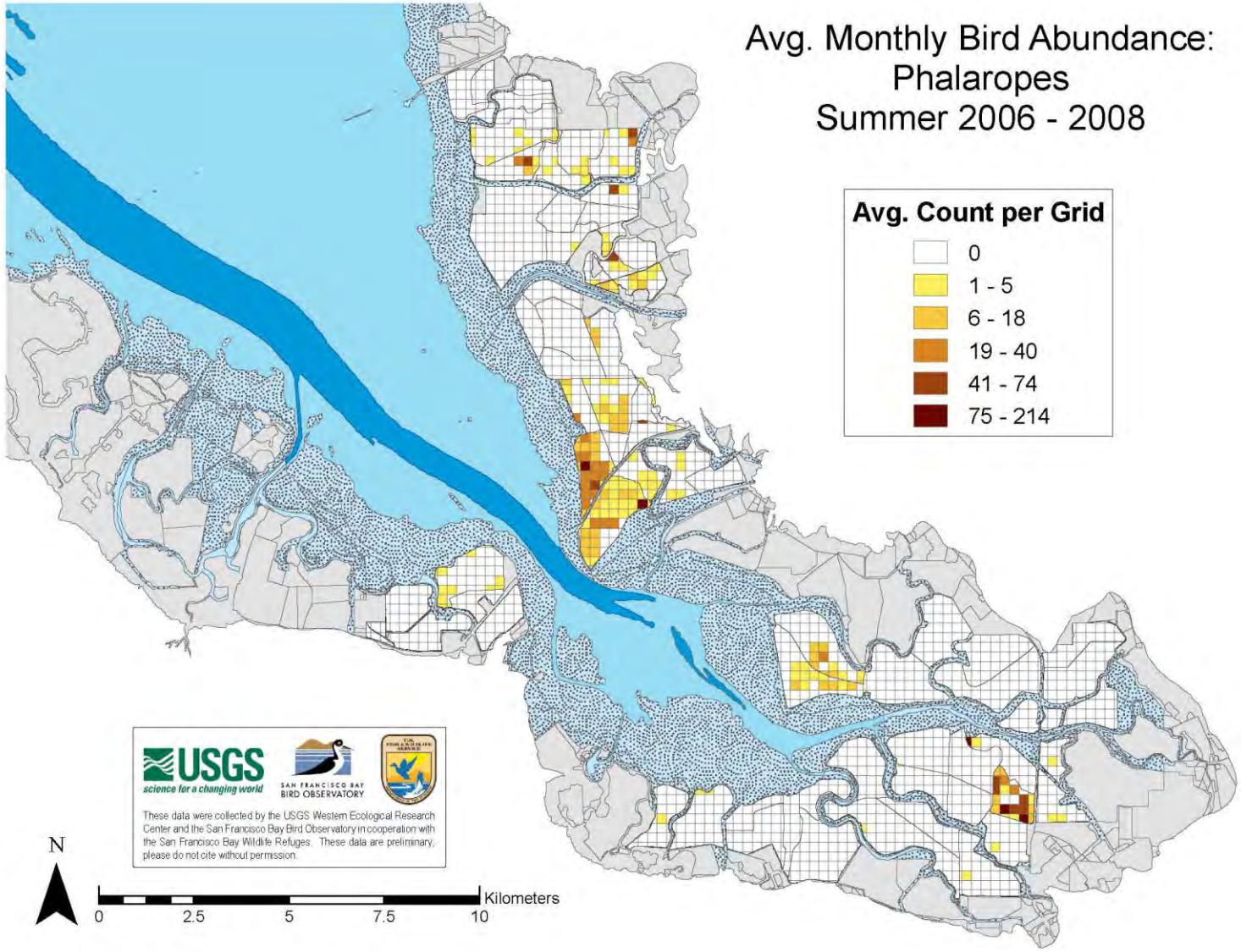


Figure 5: Average monthly abundance of piscivores, winter 2006-2009.

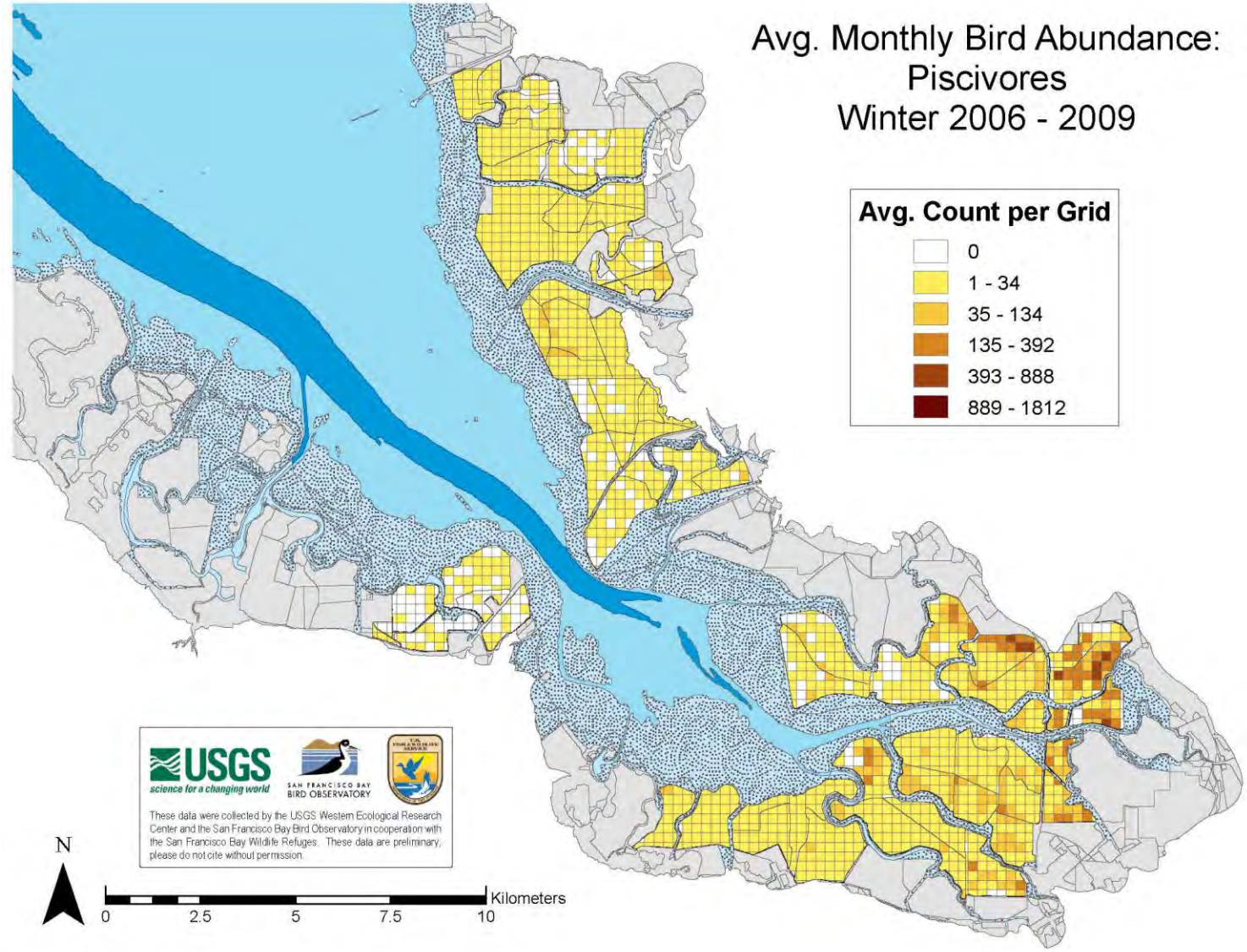


Figure 6: Average monthly abundance of eared grebe, spring 2006-2009.

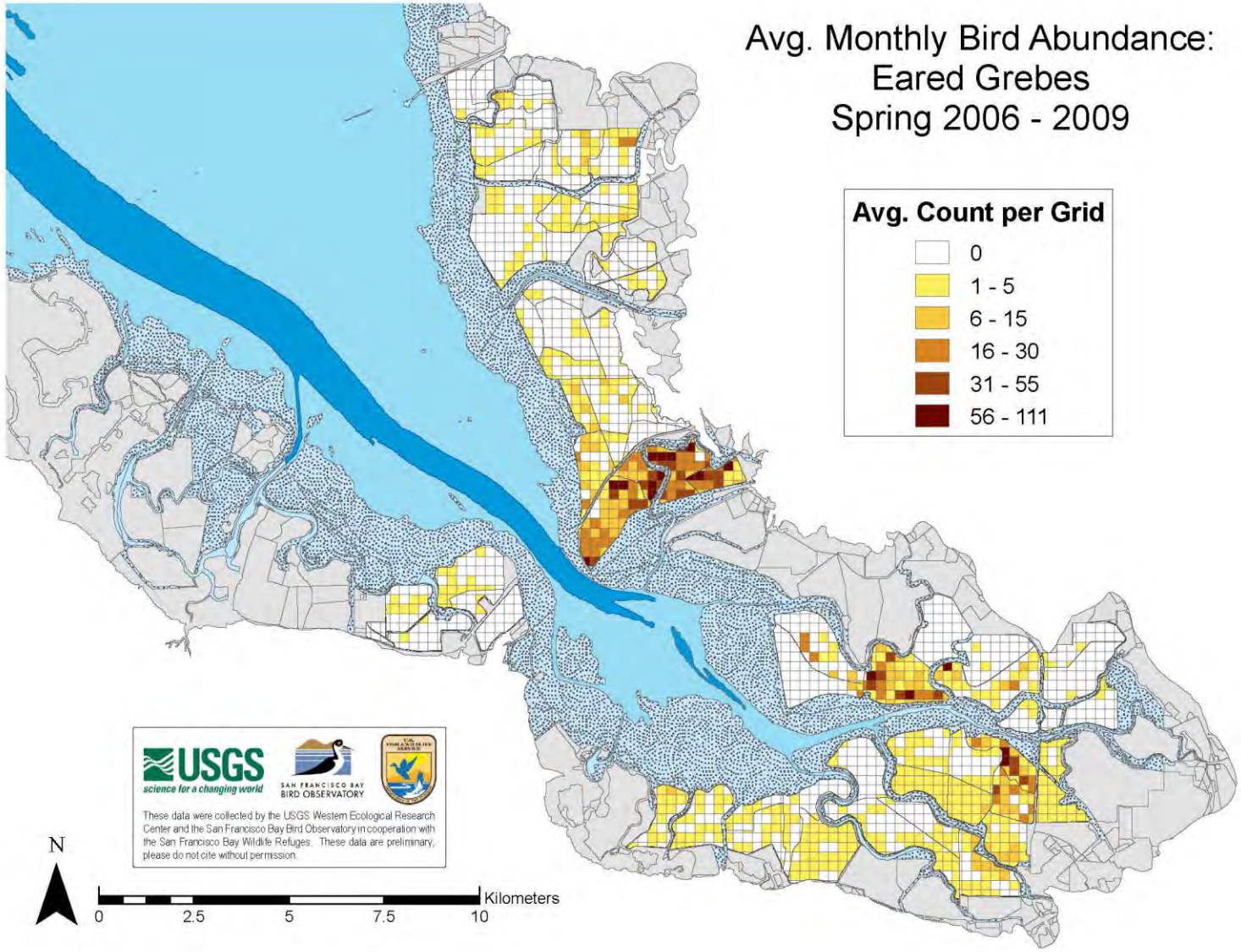


Figure 7: Average monthly abundance of Forster's tern, summer 2006-2008.

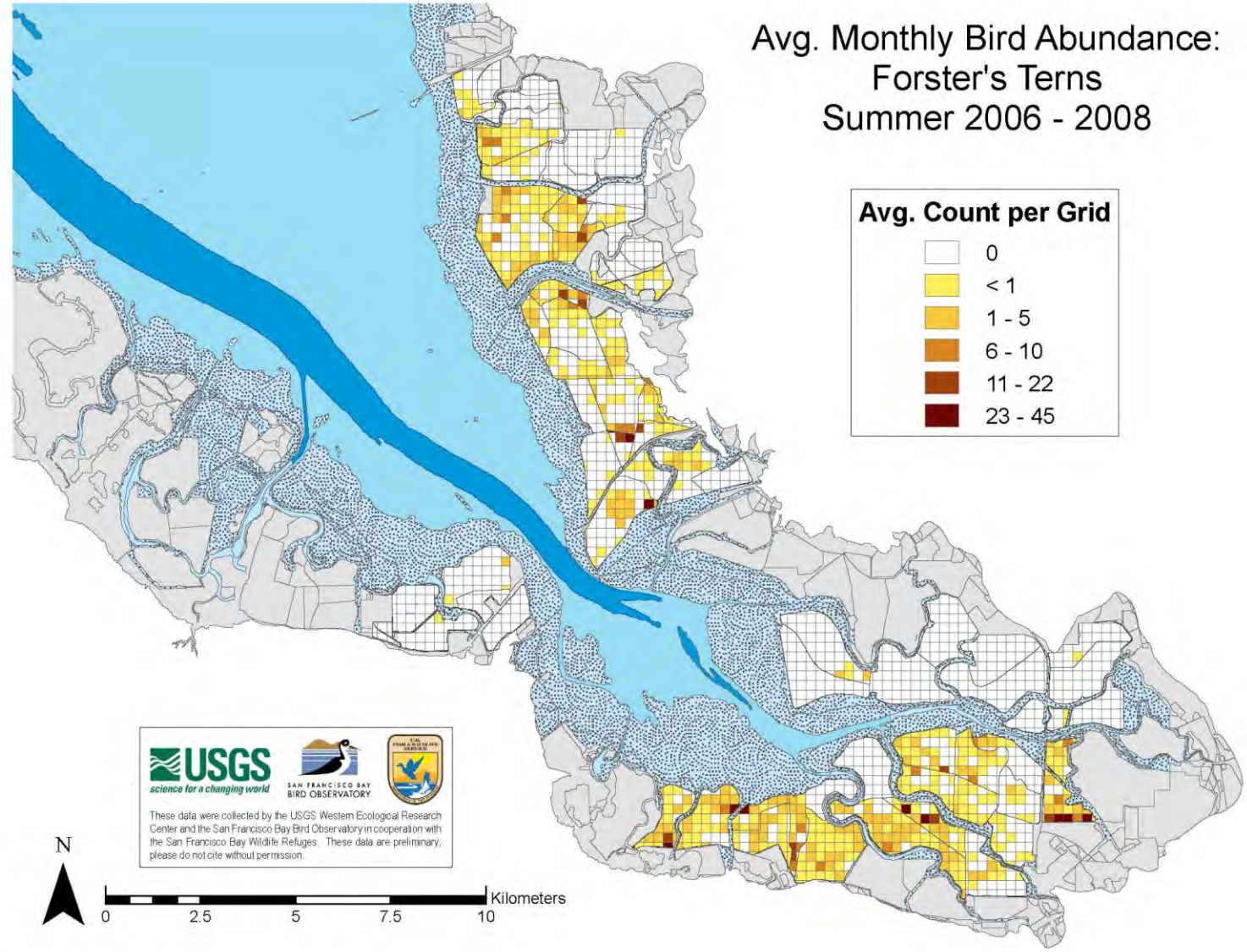
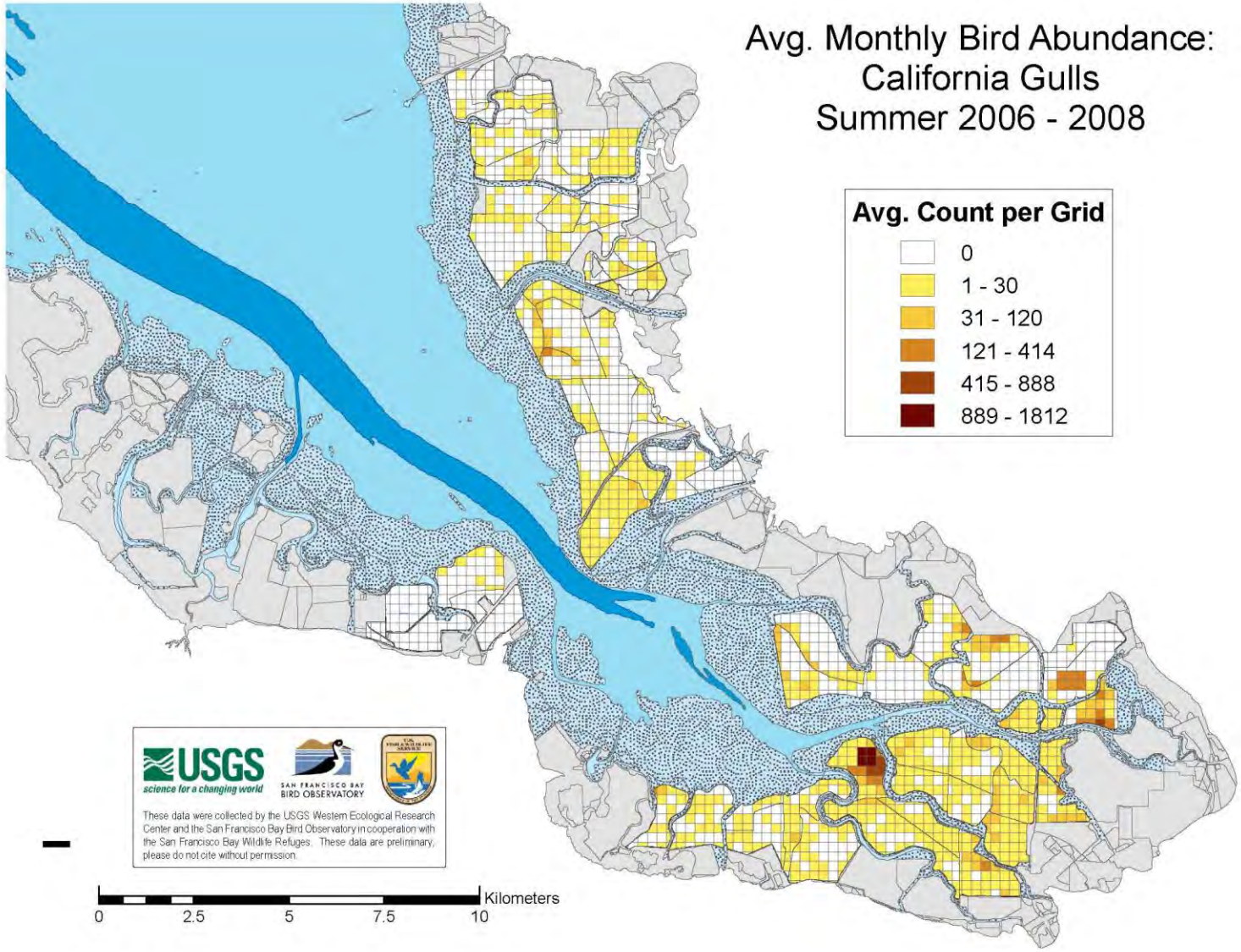


Figure 8: Average monthly abundance of California gull, summer 2006-2008.



Discussion

The waterbird species that use the South Bay ponds are diverse in their foraging strategies and habitat needs, and these differences were reflected in the relative densities of waterbird groups examined at the different pond complexes.

Bird Use of Pond Complexes

Ducks were primarily found in the Alviso ponds, which were generally low in salinity and provided a range of depths. Alviso ponds had significantly higher densities of total and foraging ducks than all other systems, including both northern shovelers (dabbling ducks) and ruddy ducks (diving ducks), species regularly observed in high numbers on ponds during the winter in the estuary (Figure 2).

Shorebirds were primarily found in low and mid salinity ponds at the Eden Landing complex, where saline-specialist invertebrates such as *Ephydra* spp. could be easily obtained. Shorebirds were a diverse group, but when not considering season, shorebirds had highest densities at the Eden Landing complex for both foraging and total birds. Relative use of Ravenswood ponds declined during fall, when the majority of ponds moved into the high salinity classification, while the majority of Eden Landing ponds remained in the low salinity classification. Eden Landing ponds were circulated with bay water, which may have prevented those ponds from becoming more concentrated in salts during the summer and fall. Although Newark ponds were similar in salinity to Eden Landing, sandpiper (and thus total shorebird) density at those ponds was low and restricted to a few ponds. Marbled godwits are larger shorebirds and were observed at similar densities in Newark ponds as in Eden Landing and Ravenswood ponds. This suggests that bird size (and perhaps water depth) is responsible for the distribution of shorebirds across ponds of similar salinity; however, foraging godwit density was lower in Newark ponds, so many godwits may have used these ponds for roosting rather than foraging (Figure 3).

Phalaropes are present in the Bay during their migratory periods. Because they migrate earlier than many other species, their highest numbers are found in the South Bay in summer (during their “fall” migration). Phalaropes are a specialized shorebird and forage by swimming in tight circles. They feed on aquatic invertebrates including *Artemia* and *Ephydra* and are therefore found on the higher salinity ponds in Newark ponds and in one pond in Alviso (Figure 4).

Piscivores were observed at highest densities in the Alviso and Mowry complexes, which were the lowest and highest salinity ponds. Because fish are only available in lower salinity ponds, bird use at the Mowry complex was likely limited to roosting, and foraging birds were primarily restrained to Alviso ponds, where foraging density was highest and pond salinity was lowest (Figure 5).

Eared grebes, like shorebirds, were observed at highest densities in the low and mid salinity ponds. They were predominately present in the Newark complex, which had ponds in similar salinity classes as Eden Landing. Grebes feed on water column invertebrates such as *Artemia*

and *Ephydra*, which should be present in both pond complexes. However, Eden Landing ponds were shallow and used by shorebirds, whereas Newark ponds were deeper and used by grebes. Eared grebes were also found in local high densities in a few ponds in Alviso, where some ponds are managed as high salinity ponds for grebes and other saline-specialist bird species (Figure 6). However, abundance of grebes has declined in recent years (Takekawa et al., 2005).

Colonial waterbirds nest in large numbers on islands and levees within the pond complexes. Forster's terns preferentially choose these habitats over other available habitats (Strong et al. 2004). Although colony locations change over time, some islands have been used consistently over the past few years (Figure 7). Double-crested cormorants, American avocets, Black-necked stilts, Black skimmers, Caspian terns, and California gulls also nest in colonies on the ponds. California gulls have consistently nested in some colonies over the past two decades; their numbers and colony locations have been expanding at the expense of other nesting species and they are considered a nuisance species in the South Bay (Figure 8).

Pond Salinity and Bird Use

Pond salinity varied throughout the year, with lowest salinities typically occurring during the winter rainy season, and the highest salinities recorded during the drier months of summer and fall. This is the expected pattern in the Bay region, where summers are hot and dry favoring evaporation and concentration of salts within ponds. The Alviso complex, included in the SBSPRP area, had the highest proportion of brackish ponds overall – 48% of its ponds were brackish during fall and winter, and 56-60% of ponds were brackish during spring and summer. More ponds were at lower salinities during the spring and summer due to management practices.

Brackish ponds support benthic invertebrates such as those used by shorebirds in shallow water and diving ducks in deeper water, and they also provide favorable conditions for birds that consume fish, which generally cannot survive in salinities > 80 $g \cdot l^{-1}$ (Takekawa et al., 2006). However, low to mid salinity ponds are particularly valuable for many shorebirds and other species that can forage on the dense populations of saline-specialist invertebrates *Artemia* and *Ephydra* that thrive there.

Bird Use among Sites

The abundance and species composition of macroinvertebrate prey is related to salinity, while the availability of prey to particular species of birds depends on depth (Velasquez 1992). Pond waters were generally well-mixed, so within-pond variation in bird abundance was a factor of pond topography rather than salinity. For example, distribution of eared grebes was likely due to a combination of moderately high salinity, providing the prey base in the pond, and sufficient depth, providing accessibility to prey. Ponds with appropriate salinity levels could not be used by eared grebes if they were too shallow to support a grebe's method of foraging within the water column. Shorebirds were most abundant in ponds with similar salinity levels as eared grebes, but required ponds that were sufficiently shallow for wading. Topographic variability within a pond enabled these species to coexist, with shorebirds using shallow areas and grebes using deeper areas. Topographic variability in general allows use of ponds by a greater number

of species and also retains the usability of ponds for single species during periods of water level changes.

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