Caspian Tern Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary

Final Environmental Impact Statement

by

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January 2005

Recommended Citation:
U.S. Fish and Wildlife Service. 2005. Caspian Tern Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary, Final Environmental Impact Statement. Portland, Oregon.

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Executive Summary

This Final Environmental Impact Statement (FEIS) describes and evaluates four alternatives for the purposes of reducing Caspian tern predation on juvenile salmonids in the Columbia River estuary, in compliance with the terms of a Settlement Agreement (see below) pertaining to tern and salmon management in the estuary. The specific components of the proposed action (identified as the preferred alternative in this FEIS) are described below. For more information on the preferred alternative (*Alternative C*: *Redistribution of the East Sand Island Tern Colony)*, as well as the other three alternatives considered, refer to Chapter 2 in this FEIS.

Recent increases in the number of Caspian terns nesting in the Columbia River estuary has led to concerns over their potential impact on the recovery of threatened and endangered Columbia River salmonids. In 1999, NOAA's National Marine Fisheries Service (NOAA Fisheries) called for the U.S. Army Corps of Engineers (Corps) to eliminate tern nesting from Rice Island (located in the upper estuary) in an attempt to decrease the number of juvenile salmonids eaten by terns. In 1999, the Corps initiated a pilot project to attract the Rice Island tern colony to East Sand Island, near the mouth of the estuary, where marine fish (i.e., non-salmon) were abundantly available to foraging terns. In 2000, the Corps proposed to complete the project to prevent all tern nesting on Rice Island while attracting terns to nest on East Sand Island. As a result of the proposed actions in 2000, Seattle Audubon, National Audubon, American Bird Conservancy, and Defenders of Wildlife filed a lawsuit against the Corps alleging that compliance with the National Environmental Policy Act for the proposed action of attracting the large colony of Caspian terns from Rice Island to East Sand Island was insufficient, and against the Service in objection to the potential take of eggs as a means to prevent tern nesting on Rice Island. In 2002, all parties reached a Settlement Agreement. The Settlement Agreement stipulates that the Service, Corps, and NOAA Fisheries prepare an EIS to address Caspian tern management in the Columbia River estuary and juvenile salmonid predation.

The purpose of the proposed action is to comply with the 2002 Settlement Agreement by identifying a management plan for Caspian terns in the Columbia River estuary that reduces resource management conflicts with ESA-listed salmonids while ensuring the conservation of Caspian terns in the Pacific Coast region. Although the relocation of terns from Rice Island to East Sand Island resulted in a decreased percentage of salmonids in the tern diet, NOAA Fisheries has determined that the current level of predation continues to have the potential to impede salmon recovery. This combined with predicted poor ocean conditions could impair the survival and recovery of threatened and endangered Columbia River salmonids. Thus, tern predation of juvenile salmonids remains a concern for salmon recovery.

PREFERRED ALTERNATIVE - Alternative C: Redistribution of East Sand Island Tern Colony

Alternative C, the Preferred Alternative, would reduce tern predation on juvenile salmonids in the Columbia River estuary by managing habitat to redistribute a portion of the tern colony on East Sand Island throughout the Pacific Coast region. This redistribution would be achieved by creating new or enhancing tern nesting habitat in Washington, Oregon, and California and ultimately reducing the tern nesting site on East Sand Island to approximately 1 to 1.5 acres. To ensure a suitable network of sites is available for terns on a regional scale, we propose to replace twice the amount of nesting habitat that is currently used and would be lost on East Sand Island. Since terns nested on an average of 4.4 acres on East Sand Island from 2001 to 2004, approximately 6 to 7 acres of replacement habitat would be needed to replace the loss of nesting habitat on East Sand Island.

The proposed tern nesting habitat enhancement/development in the region and reduction in occupied tern habitat on East Sand Island would be phased in at a 2:1 ratio. For example, 2 acres of habitat would be enhanced/developed prior to a reduction of 1 acre of habitat on East Sand Island. This alternative proposes to enhance/create approximately 8 acres of tern nesting habitat at seven alternate sites. These sites include Dungeness National Wildlife Refuge, Washington; Summer, Crump, and Fern Ridge lakes, Oregon; and San Francisco Bay (3 sites), California (Figure E.1 and Table E.1). See Appendix G for more detail on these sites and associated proposed management actions.

The proposed habitat acreage (approximately 1 to 1.5 acres) on East Sand Island is expected to be reached by 2010. Specific timing of management actions at each site will depend on available funding for habitat enhancement at alternate

FIGURE E.1 Map of Affected Environment

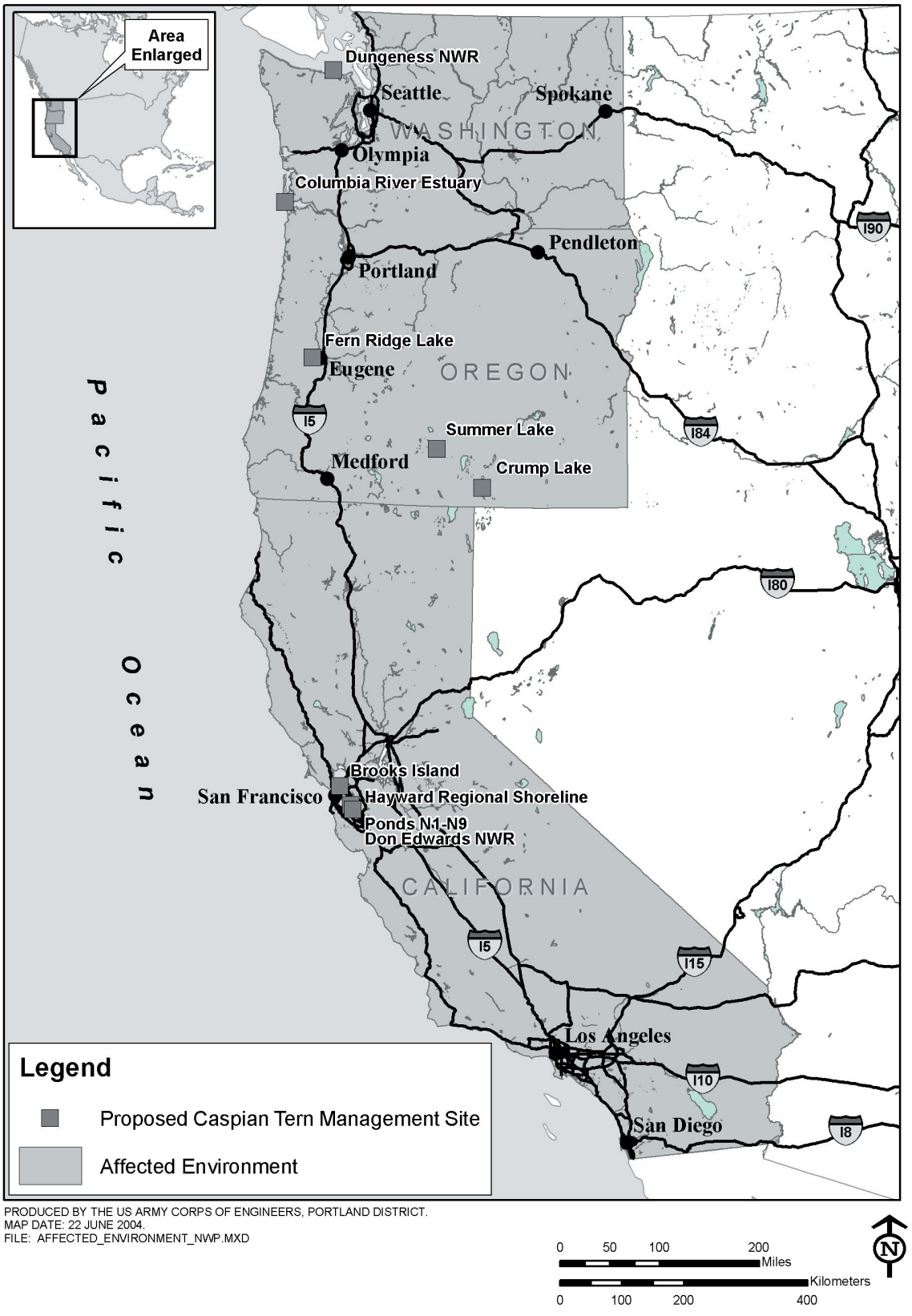

TABLE E.1 Potential Caspian tern nesting sites and proposed management actions associated with Alternatives C and D. Sites are listed in geographical order from north to south.[a]

Site Name	Proposed Management Action	Projected Available Acreage
WASHINGTON		
Dungeness NWR, Clallam County	Signs for area closure, monitor predator activities; and possible predator management	1+ acres
OREGON		
Crump Lake, Lake County	Enlarge and stabilize Crump Island at an elevation to prevent flooding; social facilitation	1 acres
Summer Lake Wildlife Area, Lake County	Create three one-half-acre islands in the East Link impoundment, and near Windbreak and Gold dikes; social facilitation	1.5 acres
Fern Ridge Lake, Lane County	Construct one island north of Royal Avenue near Gibson Island; social facilitation	1 acre
CALIFORNIA		
Brooks Island, Central San Francisco Bay, Contra Costa County	Remove exotic vegetation; predator control; gull harassment or control; protect shoreline; public use management and outreach.	2 acres
Hayward Regional Shoreline, Alameda County	Substrate enhancement; social facilitation; predator control; gull harassment or control	0.5 acre
Ponds N1/N9, Don Edwards, San Francisco Bay NWR, Alameda County	Substrate enhancement; social facilitation; predator control; gull harassment or control	0.5 - 1 acre

[a] See Table G.4 for list of sites eliminated from management consideration.

sites. The acreage of the tern nesting site at East Sand Island would be determined annually, and would be dependent upon how much acreage of alternate habitat has been created to date at the identified alternate sites. Habitat reduction on East Sand Island would be attained by allowing vegetation to grow in the current nesting area. The remaining tern nesting site would be cleared by using heavy equipment to till and smooth the site in late March or early April. Herbicide (Rodeo) may also be applied on the tern nesting site in the fall (September or October) to control vegetative growth in the managed nesting area.

The proposed habitat acreage on East Sand Island (approximately 1 to 1.5 acres) was selected for this alternative to reduce tern predation in the estuary on juvenile salmonids to a level that could increase salmonid population growth rates (lambda). Redistributing the high concentration of terns in the estuary will also reduce the vulnerability of the regional tern population to threats such as storms and disease that could result from such a large percentage of the regional population (70 percent) nesting on a single colony site. The colony size at East Sand Island is extremely atypical for this species.

In determining an acceptable predation level by terns, NOAA Fisheries conducted an analysis using a life cycle model and tern predation rates to estimate the impact of tern predation on the population growth rate of four Evolutionary Significant Units (ESUs) of Columbia River Basin steelhead (see Appendix C). Steelhead were the focus of this analysis because they are most affected by tern predation in the Columbia River estuary. Thus, estimates of the potential benefits of reducing tern predation would be the greatest for steelhead but benefits to other Columbia River salmonids consumed by terns are also expected.

The NOAA Fisheries analysis estimated that a reduction in the tern colony to approximately 3,125 nesting pairs could result in a 1 percent or greater increase in population growth rates for four Columbia River Basin steelhead ESUs. Because of uncertainties in the model, we propose to manage for a more conservative range of nesting pairs (approximately 2,500 to 3,125) on East Sand Island to ensure an increase in population growth rate for the four Columbia River Basin steelhead ESUs. Based on average nesting densities observed on East Sand and Rice islands (0.55 to 0.78 nesting pairs per square meter, respectively), this range of nesting terns would be able to nest on the proposed habitat acreage (approximately 1 to 1.5 acres). Based upon the average number of nesting pairs (approximately 9,175) in the Columbia River estuary for 2000 through 2004, approximately 6,000 to 6,675 breeding

pairs of Caspian terns would be displaced from nesting on East Sand Island with implementation of this alternative.

In addition, since the Corps would be resuming dredged material (e.g., sand) disposal on the downstream end of Rice Island, on the former Caspian tern nesting site, the Corps would continue non-lethal efforts, such as hazing, to prevent Caspian tern nesting on Rice Island and other upper estuary islands (e.g., Miller Sands Spit, Pillar Rock Island) of the Columbia River to prevent high tern predation rates of juvenile salmonids in compliance with the 1999 Corps Columbia River Channel Operation and Maintenance Program Biological Opinion. The Service would issue an egg take permit to the Corps for upper estuary islands (not including East Sand Island) if the non-lethal efforts to prevent tern nesting at these sites fail.

See Chapter 4 for full description of effects of the preferred alternative (Alternative C) as well as the other alternatives considered in this FEIS.

Chapter 1

Purpose of and Need for Action

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Chapter 1. Purpose of and Need for Action

1.1 Introduction

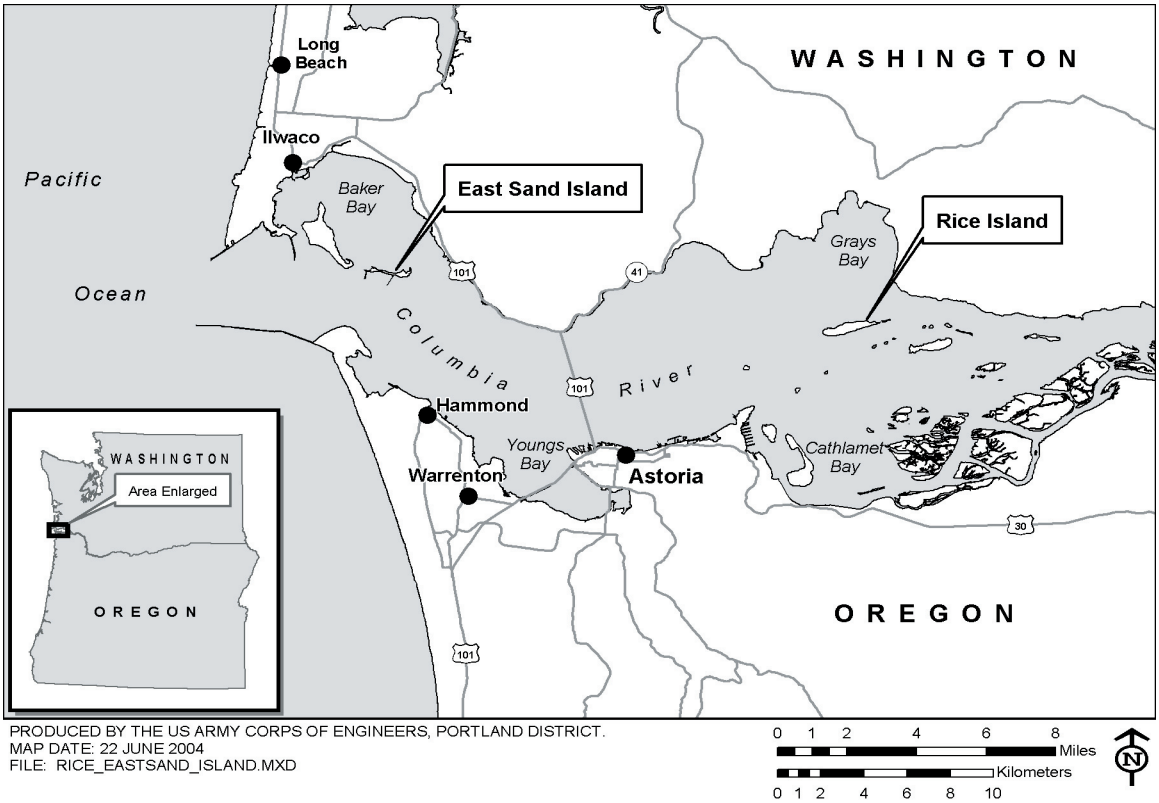
This section of the Final Environmental Impact Statement (FEIS) discusses the purpose of and need for the Federal action, the legal and policy context of the action, and stakeholder involvement in developing the FEIS.

Recent increases in the number of Caspian terns (*Sterna caspia*, hereafter, "tern" refers to Caspian tern) nesting in the Columbia River estuary has led to concerns over their potential impact on the recovery of threatened and endangered Columbia River salmonids (salmon and steelhead).

In 1999, NOAA's National Marine Fisheries Service (NOAA Fisheries) called for the U.S. Army Corps of Engineers (Corps) to eliminate tern nesting from Rice Island (located in the upper estuary) in an attempt to decrease the number of juvenile salmonids eaten by terns (NOAA Fisheries 1999). In 1999, the Corps initiated a pilot project to relocate the Rice Island tern colony to East Sand Island, near the mouth of the estuary (see Figure 1.1 for location of islands), where marine fish (i.e., non-salmon) were abundantly available to foraging terns (U.S. Army Corps of Engineers 1999). In 2000, the Corps proposed to complete the relocation effort to prevent all tern nesting on Rice Island while attracting terns to nest on East Sand Island (U.S. Army Corps of Engineers 2000).

As a result of the proposed actions in 2000, Seattle Audubon, National Audubon, American Bird Conservancy, and Defenders of Wildlife filed a lawsuit against the Corps and U.S. Fish and Wildlife Service (Service). The four groups alleged in the suit that compliance with the National Environmental Policy Act (NEPA) was not sufficient for the proposed action of relocating terns from Rice Island to East Sand Island.

FIGURE 1.1 Columbia River Estuary



Furthermore, the groups objected to the Service's issuance of a Migratory Bird Treaty Act (MBTA) permit authorizing the potential take of tern eggs as a means to prevent tern nesting on Rice Island.

In 2002, all parties reached a Settlement Agreement. Terms of the agreement required the Service (lead agency), Corps, and NOAA Fisheries to prepare an Environmental Impact Statement (this FEIS) to address long-term management of terns in the Columbia River estuary. The 2002 Settlement Agreement also required the Service and NOAA Fisheries to develop and publish three technical reports: (1) *Status Assessment and Conservation Recommendations for the Caspian Tern in North America* (Shuford and Craig 2002), (2) *Caspian Tern Predation on Salmon and Steelhead Smolts in the Columbia River Estuary* (NOAA Fisheries 2002), and (3) *A Review of Caspian Tern Nesting Habitat: A Feasibility Assessment of Management Opportunities in the U.S. Fish and Wildlife Service Pacific Region* (Seto et al. 2003).

Although the relocation of terns from Rice Island to East Sand Island resulted in a decreased percentage of salmonids in the tern diet, NOAA Fisheries remains concerned about tern predation on juvenile salmonids because the number of salmonids lost to tern predation annually is still substantial (e.g., 5.5 million, see discussion below) and there is potential for continued increases in tern predation.

Caspian tern with salmon smolt. Photo credit: OSU-RTR

1.2 Purpose of and Need for Action

The purpose of the proposed action is to comply with the 2002 Settlement Agreement by identifying a management plan for terns in the Columbia River estuary that reduces resource management conflicts with ESA-listed salmonids while ensuring the conservation of terns in the Pacific Coast/Western region (hereafter Pacific Coast region, see Chapter

Tern colony on East Sand Island, Columbia River estuary. Photo credit: Nanette Seto

3 for description). ESA-listed salmonids (Table 3.2) are those listed as threatened or endangered under the Federal Endangered Species Act (ESA) of 1973. The ESA provides for the conservation of species which are in danger of extinction throughout all or a significant portion of their range and the conservation of the ecosystems on which they depend. Managing terns to address salmonid predation would add to and complement other recovery efforts (described below), thereby, contributing to the overall recovery of ESA-listed salmonids in the Columbia River Basin.

The need for action has been driven by the recent increase of terns nesting in the Columbia River estuary and their associated predation on ESA-listed salmonids. Terns were first documented to nest in the Columbia River estuary in 1984. Since then, their numbers have increased from approximately 1,000 breeding pairs to a peak of nearly 10,000 pairs in 2002, the largest recorded tern colony in the world (Shuford and Craig 2002, Collis et al. 2002a). This increase strongly influenced the exponential growth of the regional tern population since the 1960s. From 2000 to 2004, terns on East Sand Island ate an average 5.5 million juvenile salmonids a year (the annual average ranged from 4.2 to 7.3 million), including ESA-listed salmonids (Collis et al. 2002a, 2002b, 2003a, and 2003b, K. Collis pers. comm.). NOAA Fisheries assessed the impact of tern predation on the population growth rate of four Columbia River Basin steelhead ESUs using a life cycle model and estimated predation rates from available research and monitoring data (NOAA Fisheries 2004a, Appendix C). Steelhead were the focus of this analysis because they are most affected by tern predation in the Columbia River estuary. Thus, potential benefits from reducing tern predation would be the greatest for steelhead but benefits to other salmonids outmigrating through the estuary are also expected.

The NOAA Fisheries model estimated the potential increase in population growth rates of the four steelhead ESUs based on various tern colony sizes. For example, if the number of breeding terns in the estuary was reduced by 50 percent (i.e, 5,000 pairs), steelhead population growth rates are projected to potentially increase by a maximum of 0.79 to 2.5 percent over a period of about 4 to 5 years (equal to one generation of steelhead). However, realized improvements in steelhead population growth rates

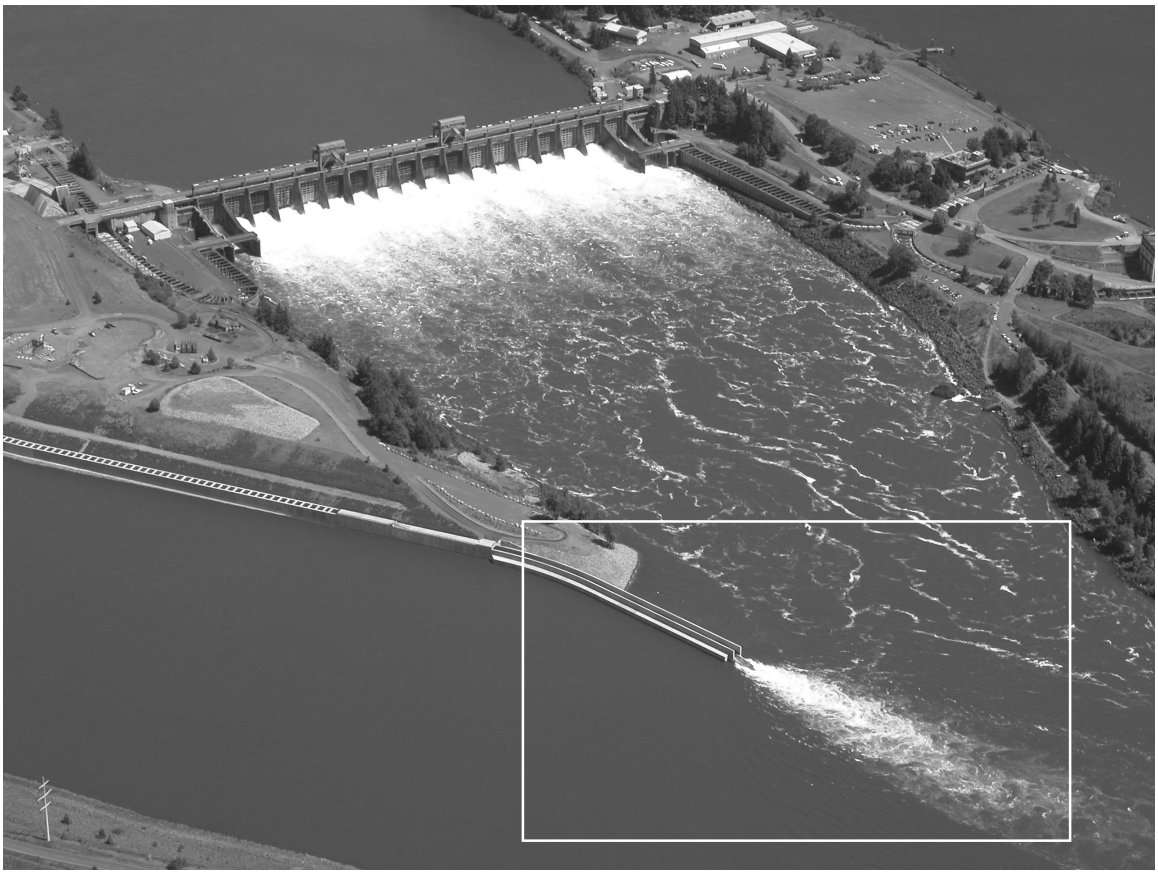
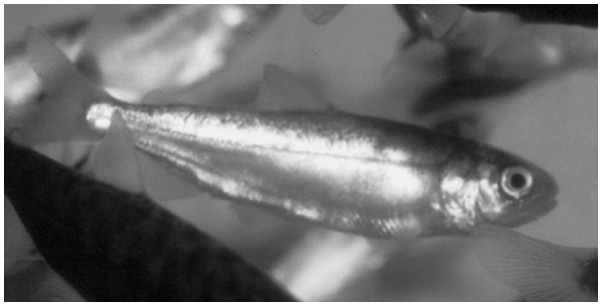


Photo inset: Second Powerhouse Corner Collector at Bonneville Dam which diverts juvenile salmonids away from dam turbines and safely back into the Columbia River. Photo credit: U.S. Army Corps of Engineers



Salmon smolt. Photo credit: Bonneville Power Administration

would likely be lower because the model assumes that there is no compensatory mortality (see glossary for definition). If all else were equal, this projected improvement in steelhead population growth rates is equivalent to projected changes in growth rates that would result from improvements in the hydropower system (e.g., increased spill, improved passage facilities, increased fish transportation, see photo inset on previous page) required by NOAA Fisheries (NOAA Fisheries 2000), but is well below improvements that have been largely realized through harvest reductions (e.g., timing, placement of nets, catch limits, McClure et al. 2003, NOAA Fisheries 2004a, Appendix C). The cumulative benefits from a reduction in tern predation, hydropower improvements, and other Columbia River Basin regional and local salmon recovery efforts are expected to result in improvement in the status of ESA-listed stocks.

An additional need for action stems from the concentration of terns on East Sand Island in the Columbia River estuary. Approximately 70 percent of the Pacific Coast regional population of terns nest in the Columbia River estuary in a single colony (Shuford and Craig 2002). This breeding concentration leaves terns more vulnerable to stochastic events, (e.g., storms, human disturbance, predation, and disease) as compared to a similar population that is dispersed among many smaller colonies (Roby et al. 2002, Shuford and Craig 2002). Management of this concentrated tern colony would help ensure the long-term conservation of the Pacific Coast regional tern population.

1.2.1 Guiding Principles

In 1998, an interagency Tern Working Group (CTWG) was formed and was comprised of representatives from Federal and State agencies, Tribes, and researchers. Their purpose was to address the role of tern predation in the estuary in the recovery of ESA-listed Columbia River salmonids. Agencies participating in the CTWG agreed to the following set of Guiding Principles in developing options for managing salmon recovery and tern resource conflicts:

1. Terns and salmonids are native species of the Pacific Northwest and the Columbia River estuary (defined as the Columbia River from its terminus to River Mile 46).

2. Terns and ESA-listed salmonids are protected under International Treaties and Federal and State laws.

3. Management actions will be implemented to ensure terns remain a viable and integral part of the estuarine, coastal, and interior ecosystems of the Pacific Coast region, including the Columbia River estuary, in a manner consistent with salmon recovery.

4. Tools are available to manage terns as one component of a comprehensive program to recover salmonids.

5. Management actions will be implemented to ensure the recovery of ESA-listed salmonids is not impeded by tern predation.

Guiding Principles 1 through 3 were included in the stipulations of the 2002 Settlement Agreement and, in combination with Principles 4 and 5, served to guide the development of management alternatives presented in this FEIS.

1.2.2 Context of Purpose and Need

Nearly every population of naturally producing anadromous salmonids in the Columbia River Basin is now listed (or is a candidate for listing) under the ESA (NOAA Fisheries 2004a). Overall salmon recovery efforts are primarily focused on in-stream improvements in both juvenile and adult survival (e.g., predator control, hydropower improvements, and habitat restoration) since management opportunities for enhancing survival in the ocean are limited. NOAA Fisheries recommends strategies to improve juvenile salmonid survival [e.g., predator control (birds and fish), increased spill, etc.] with the expectation that this will contribute to an improvement in adult returns and thereby overall recovery of ESA-listed salmonids. Reducing tern predation in the estuary would be one of several additional mechanisms that can be used to improve juvenile salmonid survival.

The tern colony in the Columbia River estuary, recently relocated to East Sand Island, continues to annually consume large numbers of juvenile

salmonids (average annual consumption for terns during 2000 to 2004 was 5.5 million juvenile salmonids, Collis et al. 2002a, 2002b, 2003a, 2003b, K. Collis pers. comm.). This high consumption level can be attributed to the large tern colony size in the estuary made possible due to modifications that have occurred in the Columbia River system.

For example, the creation of dredged material islands provide stable tern nesting habitat every year, circumstances that are atypical of naturally occurring tern nesting habitat. In addition, barging and release of hatchery-reared and wild salmonids into the estuary has altered the characteristics of the salmon outmigration (e.g. timing and concentrations) compared to what occurred under natural conditions. With the tern colony in the estuary anticipated to increase in size due to the high production of fledglings in 2001, 2002, and 2003 (Collis et al. 2002a, 2003a, 2003b), predation of juvenile salmonids by terns may also increase in the future.

Tern predation should also be considered in context with upstream investments that are implemented to improve juvenile salmonid survival. Many of the measures taken to restore salmonids in the Columbia River Basin have focused on improving survival of juvenile salmonids through the mainstem dams. These measures are associated with the operation and management of the Federal Columbia River Power System (FCRPS) and include research, development, and construction of measures under the Columbia River Fish Mitigation (CRFM) program of the Corps.

Costs associated with the implementation of the 2000 FCRPS Biological Opinion (BO) (e.g., aggressive hydropower measures, increased spill, improved passage facilities, increased fish transportation, NOAA Fisheries 2000), CRFM, and other salmon recovery efforts are substantial and are reported in the Endangered Species Act 2003 Check-In Report (U.S. Bureau of Reclamation et al. 2003). Tern predation on juvenile salmonids should be reduced to complement and protect benefits resulting from these upstream efforts (as described above) to increase the number of juvenile salmonids reaching the ocean.

Reducing tern predation in the estuary in combination with other mechanisms that aim to improve juvenile salmonid survival is anticipated to increase population growth rates of ESA-listed steelhead in the Columbia River Basin (NOAA Fisheries 2004a, Appendix C). Long-term success of efforts intended to increase population growth rates of ESA-listed salmonids must be placed in context with other sources of mortality subject to human intervention. Hydropower operations, harvest impacts, habitat conditions, hatchery operations, and introduced species all have the potential to affect population growth rates of ESA-listed salmonids, and are subject in various degrees to management efforts that are designed to alleviate detrimental effects. Actions to address these impacts have been implemented or proposed, and others may be developed in the future.

1.3 Authority and Responsibility

1.3.1 U.S. Fish and Wildlife Service

The primary responsibility of the Service is the conservation and enhancement of the nation's fish and wildlife populations and their habitats. The Service's mission is: "working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people." While the Service's responsibilities are shared with other Federal, State, Tribal, local, and private entities, the Service has specific trust responsibilities for migratory birds; threatened and endangered species; certain anadromous fish and marine mammals; and enforcing Federal wildlife laws. The Service's responsibilities for management of terns are authorized under the Migratory Bird Treaty Act. Consistent with the Settlement Agreement, the Service is the lead agency for preparation of this FEIS.

The Service also has responsibilities for the lands and waters it administers in the National Wildlife Refuge System to support the conservation and enhancement of fish and wildlife.

1.3.2 U.S. Army Corps of Engineers

The Corps, in its mission to serve the nation, is responsible for the implementation of terms and conditions of the biological opinions that pertain to the operation and/or maintenance of the Corps' civil works projects. The Corps (referred to as COE in excerpt below) responsibility regarding management of terns in the Columbia River estuary arises from implementation of mandatory terms and conditions of the September 15, 1999 NOAA Fisheries BO on the Corps' Columbia River Channel Operation and Maintenance Program (NOAA Fisheries 1999) and 2000 and 2004 FCRPS BOs (NOAA Fisheries 2000 and 2004b).

The 1999 BO addressed both tern and cormorant concerns, and included in sub-section C, the following Terms and Conditions (T&C):

Tern colony on Rice Island, before relocation to East Sand Island. Photo credit: Columbia Bird Research (OSU/RTR)

"1a. The COE shall modify the habitat on Rice Island by April 1, 2000, so that it is no longer suitable as a nesting site for Caspian terns or provide for the hazing of terns off the island in a manner that will preclude their nesting. The COE shall ensure that any terns hazed off the island do not nest on any dredge spoil islands in the action area (other than East Sand Island). The COE shall continue to prevent nesting of Caspian terns on disposal islands within the action area for the life of the project."

In accordance with the stipulations of this T&C, the Corps relocated the tern colony from Rice Island to East Sand Island in 1999 and 2000 and has annually maintained approximately 6 acres of habitat on East Sand Island for nesting terns. Hazing operations (see Chapter 2, section 2.2 for description) at Rice Island, Miller Sands Spit and/or Pillar Rock Island in the upper estuary (Columbia River mile 21 to 28) have been implemented annually as necessary to discourage terns from attempting to nest at these locations.

The Corps is also responsible for implementation of many of the reasonable and prudent alternatives identified in the 2000 FCRPS BO (NOAA Fisheries 2000) for protection and improvement of juvenile salmonid survival at their four mainstem Columbia River and four Snake River dams. The 2004 FCRPS BO (NOAA Fisheries 2004b) assessed predator control actions, including tern management. The Action Agencies (the Corps is one of the Action Agencies) intend to carry out tern management actions as proposed in this FEIS, aimed to redistribute a portion of the terns in the Columbia River estuary in order to reduce tern predation of juvenile salmonids.

Corps responsibilities for tern management are also identified under Public Law 106-53, Section 582c "(1) NESTING AVIAN PREDATORS - In conjunction with the Secretary of Commerce and the Secretary of the Interior, and consistent with a management plan to be developed by the United States Fish and Wildlife Service, the Secretary (Army) shall carry out methods to reduce nesting populations of avian predators on dredge spoil islands in the Columbia River under the jurisdiction of the Secretary."

1.3.3 NOAA's National Marine Fisheries Service

NOAA Fisheries is dedicated to the stewardship of living marine resources (i.e., Pacific salmonids, groundfish, halibut, marine mammals and their habitats) through science-based conservation and management and the promotion of healthy ecosystems. NOAA Fisheries conserves, protects, and manages living marine resources in a manner to ensure their continuation as functioning components of marine ecosystems, to afford economic opportunities, and to enhance the quality of life for the American public.

NOAA Fisheries is responsible for overseeing ESA implementation for salmonids. Under Section 7 of the ESA, Federal agencies must consult with NOAA Fisheries on any action they permit, fund, or manage that is likely to adversely affect a threatened or endangered species subject to NOAA Fisheries' jurisdiction. NOAA Fisheries must issue a "biological opinion" that explains how the Federal action affects the species and lays out what actions the agency should take to protect the species.

NOAA Fisheries also implements the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended by the Sustainable Fisheries Act of 1996. The MSA establishes a national program to manage and conserve the coastal fisheries of the United States through the development of Federal Fishery Management Plans (FMP) and Federal regulation of domestic fisheries under those FMPs within a 200-mile Exclusive Economic Zone.

Under the MSA, Congress also mandated the identification of habitats essential to managed species and measures to conserve and enhance this habitat. NOAA Fisheries, in coordination with Fishery Management Councils and Federal agencies, is required to protect, conserve, and enhance designated essential fish habitat (EFH). Congress defined essential fish habitat for federally managed species as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

1.4 Policy, Legal Compliance, Consultation, and Coordination with Others

1.4.1 Policy and Legal Compliance

In undertaking the proposed action, the cooperating action agencies must comply with a number of Federal laws, Executive Orders, regulations, and other guidance pertinent to a Federal action. These are listed and summarized in Appendix D.

The Service and Corps have initiated ESA-consultation for the preferred alternative. At this time, ESA-consultation has not been completed. A Record of Decision (ROD) on this EIS will not be signed and issued until ESA-consultation has been completed.

1.4.2 Consultation and Coordination with Others

This section describes consultation and coordination efforts with the public, interested groups, other agencies, and Tribes.

Public Outreach. On April 7, 2003, the Service, in cooperation with NOAA Fisheries and Corps, published a Notice of Intent (68 FR 16826) in the Federal Register to prepare an EIS for tern management in the Columbia River estuary. The notice also solicited public participation in the scoping process (see Section 1.5 below).

The Service mailed "Dear Interested Party" letters to 668 organizations and individuals as additional notification of the public meetings. These names were drawn from the three participating agencies' interested-party databases and additional names were provided by the States of California, Oregon, and Washington. Public scoping meetings were held in these three States (see Table 1.1 for a list of locations).

The public meeting format was in the style of an open house with information on table-top board displays. Representatives from the three agencies were available to answer questions.

Additionally, the Service created a website to provide the public with a continuous source of information about the project, access to the technical reports mentioned in Section 1.1, and various background documents. This website is located at: http://migratorybirds.pacific.fws.gov/CATE.htm. It was maintained throughout the EIS development process to keep the public updated on the project. In addition to the above public outreach, a planning update was distributed in September 2003. This was sent to people or groups who attended public meetings or sent in comments, to anyone who requested to be on our mailing list, and to other interested parties (see Appendix E for our project distribution list).

On July 23, 2004, the Service, in cooperation with the Corps and NOAA Fisheries, published a Notice of Availability (69 FR 44053) of the Draft EIS (DEIS) and 60-day public comment period in the Federal Register. Notices were also sent to more than 450 people that were either on our project mailing list or recommended for notification. The notice announced the availability of the DEIS, listed the opening and closing dates for the comment period, gave locations of three Federal websites and public libraries where copies of the document could be viewed, and provided an option for obtaining hard copies or CDs of the DEIS. Follow-up phone calls were also made by Service staff notifying key partners regarding the availability of the DEIS.

In addition, local media, and local congressional offices in Washington, Oregon, and California were sent a News Release and Q&As (questions and answers) via email or fax. One request was received from the public (Olympic Peninsula Audubon Society in Sequim, Washington) for a meeting to discuss the DEIS.

TABLE 1.1 Locations of Public Scoping Meetings

Date	Time	Location
April 14, 2003	5:30 – 8:30 pm	Marriott, Oakland, California
April 15, 2003	5:30 – 8:30 pm	Redwood Park Lodge, Arcata, California
April 28, 2003	5:30 – 8:30 pm	Grays Harbor College, Aberdeen, Washington
April 29, 2003	5:30 – 8:30 pm	Washington State Capital Museum, Olympia, Washington
May 5, 2003	5:30 – 8:30 pm	Duncan Law Seafood Center, Astoria, Oregon
May 6, 2003	5:30 – 8:30 pm	Doubletree Hotel, Portland, Oregon

Coordination with Other Agencies. Staff from the three cooperating agencies met with representatives from the wildlife agencies of the States of Washington and Oregon on May 30, 2003. The objectives of the meeting were to provide a summary report of Columbia River estuary management and research projects, an update on the status of this EIS, and discuss future plans, expectations, roles, and interagency coordination regarding tern management in the estuary and the Pacific Coast region. Meeting attendees also visited the tern colony on East Sand Island.

State agencies from Washington, Oregon, California, Idaho, and Nevada and the Bonneville Power Administration were given the opportunity to comment on an Administrative Review Draft of the DEIS prior to the public review period. Additionally, staff from the Service met with the California Department of Fish and Game (CDFG) on November 19, 2004 to clarify their concerns on the DEIS.

Coordination with Tribal Governments. Tribal governments that fell within the scope of the EIS were contacted during our scoping period and were invited to submit comments or attend our public scoping meetings. Tribes were also given the opportunity to comment on an Administrative Review Draft of the DEIS prior to the public review period. Additionally, a meeting was requested by the Quinault Indian Nation to clarify their concerns associated with the Grays Harbor area, and a member of the Jamestown S'Klallam Tribe attended the meeting requested by the Olympic Peninsula Audubon Society in Sequim.

1.5 Scoping

Scoping is the initial stage of the EIS process used to identify issues, alternatives, and impacts to be addressed in the NEPA analysis. Public comments were accepted from the date of publication of the Notice of Intent on April 7, 2003 until May 22, 2003.

Public meetings (Table 1.1) were held in California, Oregon, and Washington (see section 1.4.2.1 above). Sixty people attended the public scoping meetings. Attendees were asked to submit written comments at the meeting or through the mail. Thirty-seven comment letters were submitted from public meeting attendees and 79 comment letters were submitted outside of public meetings, either electronically (to cateeis@fws.gov) or by mail. Internal scoping meetings were also conducted during the scoping period. A full description of the scoping period can be found in the EIS Scoping Report prepared by the Service. Key issues identified during public and internal scoping are summarized below.

1.5.1 Issues of Concern Identified During Scoping

The majority of comments we received from the public and the coordinating agencies varied from concerns for local salmonid populations to potential

Federal and State agency representatives and Caspian tern researchers visit East Sand Island as part of an EIS coordination meeting, May 2003.

impacts of future management to the tern colony. Some comment letters expressed the need for justification to manage the tern population and the use of sound science in development of the EIS and management plan. Others expressed strong concern for declining salmon runs in the northwest.

Issue 1: Tern Predation Analysis. Many of the comments received expressed concern that the existing analysis of tern predation (NOAA Fisheries 2002) did not demonstrate "that Caspian terns are limiting the recovery of ESA-listed wild salmon in the Columbia River." Comments also expressed a concern that no evidence exists to suggest that there is a direct relationship between smolt and adult numbers, suggesting that "smolts saved from tern predation" will not result in a direct increase in adult salmonid numbers.

Comments called for a "rigorous" analysis of the impact of tern predation using peer-reviewed science. Additionally, some comments stressed that the EIS must discuss all factors limiting salmon recovery and put tern predation in that context. Some comments specifically stated, "Until the cost-effectiveness of hazing, relocating, and otherwise controlling terns has been firmly established in relationship to the four H's (hydropower, habitat loss, hatcheries, and harvest), the terns and other fish-eating birds should not be disturbed." Some also commented that the analyses should distinguish between tern consumption of hatchery salmonids and those that are listed under the ESA.

Issue 2: Impacts to Salmonids. Many comment letters expressed the concern for declining salmonids in the Columbia River. Some comment letters supported "relocation efforts to further disperse the massive tern colony on East Sand Island to areas where predation mortality is sustainable." However, comments received from the State agencies and the public expressed concern for salmon in various local communities. For example, comments received from the Grays Harbor, Washington area expressed concern for impacts to local salmon fisheries if terns were relocated to Grays Harbor. Comments specifically expressed a concern that relocating terns to sites outside the Columbia River estuary "would shift the impact to other regions." Some stated that communities surrounding Grays Harbor and Willapa Bay "are making significant investments in salmon recovery, in both volunteer time and Federal, State, and local funds." Therefore, relocating terns to those areas "would be counterproductive." The States of California and Oregon expressed concerns of introducing terns into non-historic nesting areas and subjecting salmon or other fish populations to tern predation.

Issue 3: Concentration of Terns at One Site (East Sand Island). There was substantial support for reducing the size of the tern colony on East Sand Island to decrease losses from catastrophic events as well as protecting endangered salmon. However, many of the public comments expressed that no efforts be undertaken to move terns from East Sand Island until suitable alternative sites are located and established. Comments specifically stated that the current management practice of providing 6 acres of habitat should be continued until alternative sites are fully developed.

1.5.2 Issues Raised, but Eliminated from Detailed Study

Four issues were raised during scoping that were outside the scope of this project. These issues, although significant, are not addressed in this FEIS.

Issue 4: Effects of Hydropower, Habitat loss, Hatcheries, and Harvest (Four H's) on Salmon. Many comment letters requested that the EIS include a detailed analysis of the four H's and their effects on salmon recovery. Commenters expressed their concern that the four H's "are the major causes of salmon declines, not avian predation." This FEIS is not addressing the issue of overall salmon recovery, and thus, will not thoroughly analyze the effects of the four H's and associated management actions to aid salmon recovery. Instead, the FEIS and proposed action is focused specifically on the management of terns in the estuary to reduce predation on juvenile salmonids as one measure to aid salmon recovery. A discussion placing tern predation in context with hydropower and harvest is presented in the NOAA Fisheries 2004 report, *Caspian Tern Predation on Juvenile Salmonid Outmigrants in the Columbia River Estuary* (NOAA Fisheries 2004a, Appendix C), Fresh et al. 2004, McClure et al. 2003, and in Chapter 4 of this FEIS. Additionally, a detailed analysis of the operation of the hydropower system is addressed in the 2004 FCRPS BO (NOAA Fisheries 2004b). Findings from these reports have been used and is frequently referenced in this FEIS for comparitive purposes to put tern predation in context with the four Hs.

Issue 5: Ownership and Management of East Sand Island. Many comment letters expressed the desire for East Sand Island to be managed as part of the

National Wildlife Refuge System for the protection of "significant wildlife resources" and habitat by the Service. On February 28, 2003, the Service and Corps issued a joint statement in compliance with the Settlement Agreement regarding the ownership and management of East Sand Island. The statement reiterates that the Corps "will retain ownership and management responsibilities for East Sand Island through the completion of the Environmental Impact Statement (EIS) and Management Plan for Caspian terns in the Columbia River estuary." During this time, the Corps will continue to provide 6 acres of habitat for terns. Since ownership status of East Sand Island would not affect implementation of the proposed action, the impact analysis of this factor is not necessary in this FEIS. The future owner and manager of East Sand Island, whether it is a Federal, State, or private entity, would need to adhere to the same regulations with respect to the Endangered Species and Migratory Bird Treaty Act regulations. The final recommendation regarding ownership and management of East Sand Island will be made when the EIS is completed and a proposed action, including management actions on East Sand Island, is identified.

Issue 6: Economic Value of Smolts Consumed by Terns. The State of Idaho's Office of Species Conservation comment letter stated "the economic value of smolts consumed by the Caspian tern colony…be a focus of this EIS." They requested that "all costs relative to smolt rearing, marking, and migration facilitation, along with costs associated with forgone power generation, flow augmentation, habitat improvement, and all other efforts undertaken to deliver smolts to the estuary be assimilated to produce a per smolt cost." Their justification for this analysis is to demonstrate the cost of "maintaining the status quo avian predation by this [East Sand Island] tern colony."

An economic analysis of this sort would not assist in the development of management alternatives aimed at reducing tern predation on salmonids in the Columbia River estuary to assist in salmonid recovery. The economic analysis proposed by the State of Idaho would not demonstrate the cost of maintaining avian predation by the East Sand Island tern colony. Rather, this analysis would demonstrate the costs of mitigating measures for a variety of activities that impact threatened and endangered salmonids in the Columbia River Basin. For example, devices are required at hydropower dams to provide fish passage; hatcheries are producing smolts to mitigate the effects of hydropower dams; and habitat restoration projects are being conducted throughout the region to restore and enhance salmonid habitat and watershed functions that have been lost or altered.

Numerous documents have already summarized costs of salmonid recovery efforts in the Columbia River Basin. These include a NOAA Fisheries Report to Congress on the Pacific Coastal Salmon Recovery Fund (NOAA Fisheries 2003a), a partial review of cost-effectiveness of artificial production programs published in 2002 by the Independent Economic Analysis Board, (Independent Economic Analysis Board 2002), a Report to the National Marine Fisheries Service on the Economics of Snake River Salmon Recovery (Huppert et al. 1996), and a General Accounting Office report on Federal agencies' recovery responsibilities, expenditures and actions (U.S. General Accounting Office 2002).

Issue 7: Tern Colony on Crescent Island
During internal scoping meetings, NOAA Fisheries expressed concern regarding predation of juvenile salmonids by terns nesting on Crescent Island, Washington. Crescent Island, in the mid-Columbia River, was created with dredge material originating from the Boise Cascade Mill channel, Port of Walla Walla. Crescent Island is managed by the Service as part of the Mid-Columbia River National Wildlife Refuge Complex through a cooperative management agreement with the Corps. In 2000, NOAA Fisheries issued a BO to the Corps, requiring the "Action Agencies… continue to conduct studies (including migrational behavior) to evaluate avian predation of juvenile salmon in the FCRPS reservoirs above Bonneville Dam." Researchers have been studying this colony since 1998, gathering the diet composition of nesting terns, colony size, and nesting success. These data are currently being analyzed and, as stated in the BO, "If warranted and after consultation with NMFS [NOAA Fisheries] and USFWS, the Action Agencies shall develop and implement methods of control that may include reducing the populations of these predators." If management actions are required for the Crescent Island tern colony, a separate management plan and associated NEPA document, if needed, will be prepared outside of this EIS. The scope of this EIS is focused on management of terns in the Columbia River estuary and extends beyond the estuary only in Alternatives C and D which discuss the potential to manage alternate sites for terns outside of the Columbia River.

Chapter 2

Alternatives

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Chapter 2. Alternatives

This chapter describes the process used to develop alternatives to the proposed action (identified as the preferred alternative in this FEIS), similarities among the alternatives, a detailed description of each alternative, and a summary comparison of the alternatives by each of the primary components. The Columbia River estuary, referred to in this chapter and throughout the FEIS, pertains to the river downstream of river mile 46 (Figure 2.1).

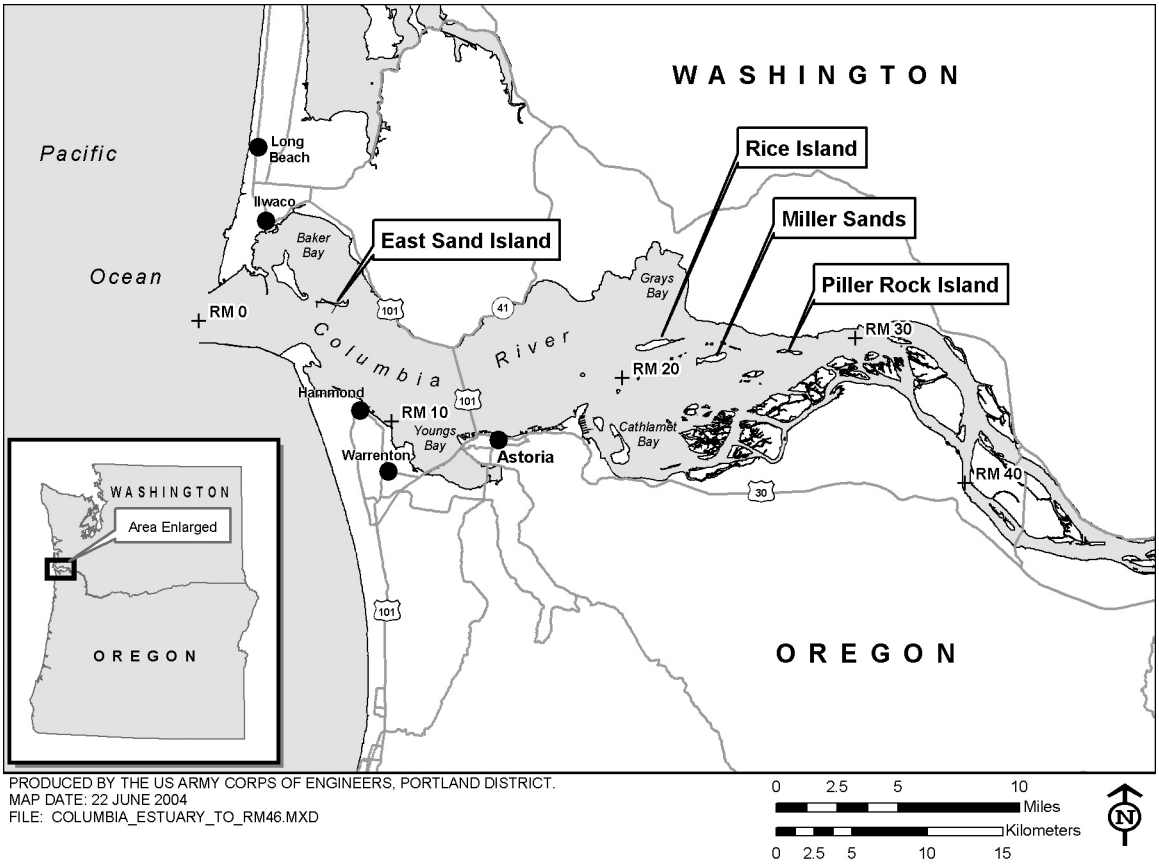
2.1 Alternative Development

The National Environmental Policy Act (NEPA) requires Federal agencies to evaluate a full range of reasonable alternatives to a Proposed Action. The alternatives should meet the purpose and need of the proposed Federal action while minimizing or avoiding detrimental environmental effects. The NEPA alternative development process allows the Service, Corps, and NOAA Fisheries to work with the public, stakeholders, interested agencies, and Tribes to formulate alternatives that respond to the issues identified during the scoping process. This FEIS documents the planning and decision-making process.

2.1.1 Rationale for Alternative Design

All alternatives considered were evaluated in relation to their ability to reduce tern predation on ESA-listed Columbia River salmonids while ensuring the conservation of terns in the Pacific Coast region. NEPA regulations require the analysis of a No Action alternative (Alternative A). The settlement agreement also required the analysis of a No Management alternative (Alternative B). The remaining alternatives were developed after evaluating comments received during the public scoping period, holding interagency meetings and internal discussions, and reviewing the best available scientific information. The effects of each alternative described below are analyzed in detail in Chapter 4, Environmental Consequences.

FIGURE 2.1. Columbia River Estuary (mouth to RM 46)



2.2 Similarities Among Alternatives

Although the alternatives differ in many ways, there are similarities (i.e., shared features or management components) among them as well. These similarities are listed below to reduce the length and redundancy of the individual alternative descriptions. The following is a description of features common to all alternatives (Alternative A through D).

Prevent tern nesting in the upper estuary. Since the shift of the Columbia River estuary tern colony from Rice Island to East Sand Island, the former Rice Island colony location is overgrown with vegetation. Terns no longer attempt to nest at this location. However, the Corps has decided to resume dredged material disposal on the downstream end of Rice Island, the location of nesting terns (U.S. Army Corps of Engineers 2003). Since this would recreate nesting habitat for terns, the Corps would continue efforts to prevent tern nesting on Rice Island and other upper estuary islands (e.g., Miller Sands Spit, Pillar Rock Island, see Figure 2.1). This will prevent high predation rates of juvenile salmonids and comply with the 1999 Corps Columbia River Channel Operation and Maintenance Program Biological Opinion. Management actions, as appropriate, may include repeated hazing of adult terns on islands from April 1 to June 15 to prevent colony establishment, nesting habitat modification through establishment of vegetation, or other measures (e.g., installation of silt fencing, see photo below). Hazing would consist of personnel or dogs directly disturbing terns that aggregate on upland habitat suitable for nesting purposes. Personnel may use all terrain vehicles for ease of access and to cover distances involved at these upper estuary islands.

Tern colony on Rice Island (2000) with silt fencing used to prevent terns from nesting on portions of the former colony site. Photo Credit: Tim Jewett

Eagle silhouette decoys and/or kites may also be employed to discourage nesting terns. Terns that aggregate (e.g., roosting, resting) below the high tide line would not be disturbed. Personnel involved in hazing would be restricted in their movements and presence to the potential tern nesting areas, and would remain out of vegetated areas that support other wildlife resources to the extent practicable.

Permit egg take from upper estuary islands. The Service would issue an egg take permit to the Corps for upper estuary islands (not including East Sand Island) to be used if early season hazing activities fail to prevent tern nesting,. This permit would assist in preventing the establishment of new tern colonies in the upper Columbia River estuary.

2.3 Detailed Description of Alternatives

2.3.1 Alternative A - No Action (Current Management Program)

This alternative assumes no change from the current management program and is considered the baseline from which to compare the other alternatives. Under this alternative, approximately 6 acres of nesting habitat would be maintained annually for terns on East Sand Island. This requires annual maintenance in order to provide proper nesting habitat conditions: a bare sand substrate free of vegetative cover.

To attain the proper habitat conditions on the 6-acre site, equipment is barged to the site during the last week of March or first week of April. Habitat management at this time allows terns to establish nests on the site before the reestablishment of vegetative cover from grasses and forbs. Typically, a tractor and disc are used to till the site, turning under herbaceous vegetation. This is generally followed by running a heavy drag harrow over the site to smooth the surface. Periodically (every 2-3 years), additional sand may be placed on the nesting site to fill erosion channels and low elevation spots as wind and water erosion remove sandy material from the site each year. Sand replenishment in 2003 was accomplished by borrowing sand from the upper beach on the east end of East Sand Island using a tracked excavator and a 25 cubic yard capacity off-road dump truck. This beach is the most likely source for borrowing sand material in the future. In September or October, herbicide (Rodeo) may be applied to European beachgrass and American dunegrass to control their presence on the tern nesting site. Tillage operations conducted earlier

Habitat enhancement on East Sand Island. Photo Credit: Columbia Bird Reserch (OSU/RTR)

in the year result in the spread of these plants over the nesting site. Herbicide is sprayed in a spot application manner with denser stands receiving a broadcast spray. Equipment and water for herbicide dilution are transported to the site via boat.

2.3.2 Alternative B – No Management

The Settlement Agreement requires analysis of this alternative in the EIS. Under this alternative, no management actions would occur on East Sand Island. The current tern nesting area would most likely become vegetated within 3 years post-implementation of this alternative (similar to that observed in 1985 and 1986 after the last dredged material was deposited), resulting in the loss of the tern nesting site. Thus, abandonment of this colony on East Sand Island would most likely occur. Hazing efforts and possibly egg take would be implemented, as in all alternatives, to prevent tern nesting at upper estuary islands. See section 2.2 for more details on these actions.

2.3.3 Alternative C –Redistribution of East Sand Island Tern Colony - PREFERRED ALTERNATIVE

Actions under this alternative aim to redistribute a portion of the large East Sand Island tern colony to other nesting sites within the Pacific Coast region. This redistribution would be achieved by ensuring that a network of sites with suitable nesting habitat is available to terns and reducing the tern nesting area on East Sand Island to approximately 1 to 1.5 acres. Specifically, twice the amount of tern nesting habitat that would be lost on East Sand Island would be created or enhanced at seven alternate sites in Washington, Oregon, and California.

Terns have nested on an average of 4.4 acres (range of 3.9 to 4.7) on East Sand Island from 2001 to 2004 (Collis et al. 2002a, 2003b, K. Collis pers. comm.). Since terns have always used less than 5 acres at this site, we propose to reduce the tern nesting area on East Sand Island to 5 acres prior to the first nesting season after completion of this FEIS. Further reduction of the nesting area to approximately 1 to 1.5 acres would require a minimum of 7 to 8 acres of replacement habitat in the region. Thus, we propose to create/enhance approximately 8 acres at alternate sites for nesting terns (see Table 2.1). The 1 to 1.5 acres on East Sand Island would be managed to maintain suitable tern nesting habitat in the Columbia River estuary to support approximately 2,500 to 3,125 breeding pairs. This colony size exceeds those typical of the Pacific Coast region as well as the colony size documented on East Sand Island in 1984 (approximately 1,200 breeding pairs).

The proposed reduction in occupied tern nesting habitat on East Sand Island would occur only after alternate nesting habitat is enhanced elsewhere in the region and is available to terns. Thus, habitat enhancement in the region and further reduction in habitat on East Sand Island would be phased in at a 2:1 ratio. For example, if 2 acres of nesting habitat is enhanced for terns outside of the Columbia River estuary (i.e., in 2005), the tern nesting area on East Sand Island would be reduced by 1 acre in the following year (i.e., in 2006). The approximately 8 acres of managed habitat that would be created/enhanced in the region would occur at the sites located in Table 2.1. Habitat alteration and enhancement would occur at most of these sites. Additional proposed management actions include management of predator or human disturbance and social facilitation (e.g., decoys, vocalizations, etc.). Table 2.1 summarizes proposed management actions at each site (See Appendix G for specific details).

The proposed habitat acreage (approximately 1 to 1.5 acres) on East Sand Island is expected to be reached by 2010. Timing of actions at specific alternate sites would depend on available funding for habitat enhancement. The size of the tern nesting site at East Sand Island (acreage) would be determined annually, and would be dependent upon how much acreage of alternate habitat has been created to date elsewhere in the region. Habitat reduction on East Sand Island would be attained by allowing vegetation to grow in the current nesting area. The remaining tern nesting site for that year would be cleared via the methods described above in Alternative A. Non-lethal measures (e.g., silt fencing) may also be used to prevent terns from nesting outside the designated tern nesting area on East Sand Island. After the proposed acreage on East Sand Island has been attained, annual maintenance would continue to clear the nesting site on East Sand Island using methods similar to those

TABLE 2.1 Potential Caspian tern nesting sites and proposed management actions associated with Alternatives C and D. Sites are listed in geographical order from north to south.[a]

Site Name	Proposed Management Action	Projected Available Acreage
WASHINGTON		
Dungeness NWR, Clallam County	Signs for area closure, monitor predator activities; and possible predator management	1+ acres
OREGON		
Crump Lake, Lake County	Enlarge and stabilize Crump Island at an elevation to prevent flooding; social facilitation	1 acres
Summer Lake Wildlife Area, Lake County	Create three one-half-acre islands in the East Link impoundment, and near Windbreak and Gold dikes; social facilitation	1.5 acres
Fern Ridge Lake, Lane County	Construct one island north of Royal Avenue near Gibson Island; social facilitation	1 acre
CALIFORNIA		
Brooks Island, Central San Francisco Bay, Contra Costa County	Remove exotic vegetation; predator control; gull harassment or control; protect shoreline; public use management and outreach.	2 acres
Hayward Regional Shoreline, Alameda County	Substrate enhancement; social facilitation; predator control; gull harassment or control	0.5 acre
Ponds N1/N9, Don Edwards, San Francisco Bay NWR, Alameda County	Substrate enhancement; social facilitation; predator control; gull harassment or control	0.5 - 1 acre

[a] See Table G.4 for list of sites eliminated from management consideration.

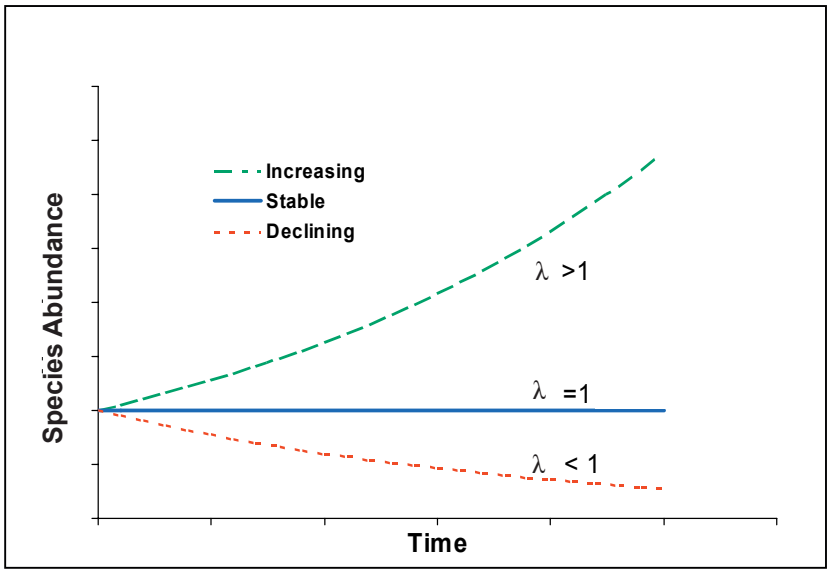
described in Alternative A, with a management area of 1 to 1.5 acres instead of 6 acres. Non-lethal measures would also continue to prevent terns from nesting on East Sand Island outside of the designated 1 to 1.5-acre nesting area.

The proposed habitat acreage (approximately 1 to 1.5 acres) on East Sand Island was selected to reduce tern predation in the estuary on juvenile salmonids to a level that could increase salmonid population growth rates (lambda, λ). Populations with a positive growth rate ($\lambda > 1$) increase in number and thus, would aid salmon recovery (Caughley 1994 and McClure et al. 2003, Figure 2.2).

In determining an acceptable predation level by terns, NOAA Fisheries conducted an analysis using a life cycle model and tern predation rates to estimate the impact of tern predation on the population growth rate of four Evolutionary Significant Units (ESUs, see Chapter 3, section 3.2.3 for definition) of Columbia River Basin steelhead (NOAA Fisheries 2004a, Appendix C). Steelhead were the focus of this analysis because they are most affected by tern predation in the Columbia River estuary. Estimates of the potential benefits of reducing tern predation are the greatest for steelhead but could also occur for other salmonids outmigrating through the estuary. Additionally, an ESU-specific analysis was conducted because NOAA Fisheries manages Columbia River steelhead at the individual ESU level.

The analysis compared the use of Passive Integrated Transponder (PIT)-tag and bioenergetics modeling data sets as sources to calculate an estimated tern predation rate and percent increase in steelhead population growth. PIT-tags are small tags inserted into the juvenile fish's body cavity which can be used to determine the location and status (e.g., live or dead) of tagged fish. Identifying PIT-tags on tern colonies can provide a minimum estimate of the proportion of stocks that are consumed by terns at any particular colony. Bioenergetics models are used to estimate consumption levels of piscivorous birds by calculating the amount of prey consumed in biomass or numbers based on diet composition, energy content of prey, energy requirements of individual consumers (i.e., terns), and the number of individual consumers present. Both PIT-tag and bioenergetics modeling analyses demonstrated that the percent increase in population growth rate (λ) is improved as the number of tern pairs are reduced on East Sand Island (NOAA Fisheries 2004a, Appendix C). However, the analysis also demonstrated that predation rates are not uniform for all salmonid species, thus, analysis of individual ESU-specific predation rates was necessary. Only PIT-tag data was suitable for analyzing benefits to individual steelhead ESUs.

FIGURE 2.2. Illustration of increasing, stable, or declining population growth rates (λ)



The NOAA Fisheries analysis estimated that a reduction in the tern colony to approximately 3,125 nesting pairs would result in a 1 percent or greater increase in population growth rate (recommended by NOAA Fisheries) for four Columbia River Basin steelhead ESUs (Table 2.2 or Table 5 in Appendix C). However, predation rates based on PIT-tag recovery data are considered minimal because not all tags are deposited on nesting islands (e.g., some PIT-tags can be excreted over water, removed by wind and water erosion, or damaged and undetectable). Additionally, realized improvements from the reduction of tern predation would likely be lower than estimated because the model assumes that there is no compensatory mortality (e.g., mortality from other sources). Thus, we propose to provide habitat for a more conservative range of nesting pairs (approximately 2,500 to 3,125) on East Sand Island to maximize the potential to increase population growth rates for each of the four Columbia River Basin steelhead ESUs included in the analysis. Based on average tern nesting densities observed on East Sand (average of 0.55 nesting pairs per square meter, Collis et al. 2003b, Roby pers. comm.) and Rice islands (peak of 0.78 nesting pairs per square meter, Roby et al. 2002), this proposed range of nesting terns would be able to nest on the 1 to 1.5 acres, as proposed for management in this alternative.

Other factors were also considered in determining the proposed habitat acreage on East Sand Island, including the average size of coastal tern colonies (e.g. 55 to 1,675 nesting pairs) and social behavior necessary for terns to nest successfully. The proposed range of nesting pairs on East Sand Island in this alternative (2,500 to 3,125 pairs) is substantially above the individual average colony sizes typically found along the Pacific Coast (Appendix F, Table F.2). This number also exceeds the size of the tern colony that historically colonized East Sand Island in 1984 (approximately 1,200 pairs). The proposed acreage and anticipated colony size should be suitable to encourage the social stimulus to breed and avoid colony abandonment on East Sand Island due to an insufficient number of breeding pairs.

Based upon the average number of nesting pairs (approximately 9,175) in the Columbia River estuary from 2000 to 2004 (Collis et al. 2002a, 2003a, and 2003b), approximately 6,000 to 6,675 pairs of Caspian terns would be displaced from nesting on East Sand Island with implementation of this alternative. As described above, to minimize any possible negative effect to the Pacific Coast regional tern population by this action and to encourage redistribution of terns within the region, we propose to enhance or create habitat for displaced terns prior to their dispersal from East Sand Island. Although some nesting habitat is currently available for displaced terns at existing sites within the Pacific Coast region (Appendix F, Table F.1 and Table F.2), this alternative ensures that suitable nesting habitat will be available for displaced terns by managing seven sites (Table 2.1) in both coastal and interior habitats of the Pacific Coast region specifically for tern nesting.

TABLE 2.2. Population growth rate (λ) and estimated percent increase in four listed steelhead ESUs in the Columbia River Basin given a range of Caspian tern nesting pairs on East Sand Island (taken from NOAA Fisheries 2004a, Appendix C).

	Snake River ESU		Upper Columbia River ESU		Middle Columbia River ESU		Lower Columbia River ESU	
No. of Tern Nesting Pairs	**% Δ λ**	**λ**	**% Δ λ**	**λ**	**% Δ λ**	**λ**	**% Δ λ**	**λ**
10000	0.000	1.020	0.000	1.000	0.000	0.970	0.000	0.920
9375	0.124	1.021	0.323	1.003	0.123	0.971	0.100	0.921
8750	0.248	1.023	0.644	1.006	0.245	0.972	0.200	0.922
8125	0.371	1.024	0.962	1.010	0.366	0.974	0.299	0.923
7500	0.494	1.025	1.277	1.013	0.487	0.975	0.398	0.924
6875	0.616	1.026	1.589	1.016	0.608	0.976	0.497	0.925
6250	0.738	1.028	1.898	1.019	0.728	0.977	0.595	0.926
5625	0.859	1.029	2.205	1.022	0.847	0.978	0.693	0.926
5000	0.979	1.030	2.510	1.025	0.966	0.979	0.791	0.927
4375	1.099	1.031	2.812	1.028	1.084	0.981	0.888	0.928
3750	1.219	1.032	3.112	1.031	1.202	0.982	0.985	0.929
3125	1.337	1.034	3.409	1.034	1.319	0.983	1.082	0.930
2500	1.456	1.035	3.704	1.037	1.436	0.984	1.178	0.931
1875	1.574	1.036	3.996	1.040	1.552	0.985	1.274	0.932
1250	1.691	1.037	4.287	1.043	1.668	0.986	1.370	0.933
625	1.808	1.038	4.575	1.046	1.783	0.987	1.465	0.934
0	1.924	1.040	4.861	1.049	1.898	0.988	1.560	0.934

% Δ λ = percent change in population growth rate
λ = estimated population growth rate

2.3.4 Alternative D – Redistribution and Lethal Control of East Sand Island Tern Colony

Similar to Alternative C, a portion of the tern colony on East Sand Island would be redistributed to other nesting sites within the Pacific Coast region by enhancing/creating habitat elsewhere and reducing habitat on East Sand Island. As with Alternative C, the proposed habitat acreage (approximately 1 to 1.5 acres) and anticipated number of nesting terns on East Sand Island was preferred to increase the population growth rate (λ) for four Columbia River Basin steelhead ESUs by at least 1 percent (Table 2.2, NOAA Fisheries 2004a, Appendix C). Also similar to Alternative C, approximately 8 acres from the same seven sites (Table 2.1) within the Pacific Coast region would be managed as potential tern nesting sites to replace the habitat lost on East Sand Island and ensure a network of suitable nesting habitat is available to displaced terns. Reduction in tern nesting habitat on East Sand Island would be phased in as habitat at alternate sites is developed at a 2:1 ratio (see description in Alternative C). Similar to Alternative C, we expect the tern nesting area would be reduced to 1 to 1.5 acres by 2010.

The East Sand Island tern colony may respond to habitat reduction efforts by compressing into the smaller acreage (at a higher nesting density). Thus, the above management actions could fail to disperse a majority of the tern colony. Unlike Alternative C, this alternative proposes to implement a lethal control program if habitat reduction on East Sand Island, combined with development of potential nesting habitat, is not sufficient to reduce the colony size by 2008, or within 3 years after implementation of this alternative. The lethal control program would attempt to achieve the proposed range of nesting terns (approximately 2,500 to 3,125 pairs) by killing up to 50 percent of breeding adult terns each year. Methods for killing adults would consist of euthanasia of terns after capturing them with a rocket net or the use of shotguns. Carcasses would be collected and provided to research facilities or museums. Any unused carcasses would be burned or buried off-site.

The actual number of terns that would be killed under this alternative would depend on the success of redistributing a majority of the colony to other sites in the region. If the entire colony compressed into the smaller acreage that would remain on East Sand Island, a substantial number of terns would need to be killed. If the colony was partially reduced (e.g., 50 percent) through habitat reduction, we can use a tern population model to project the number of terns that could potentially be killed (e.g., approximately 3,200 to 6,000 terns every year in the first 5 years, see section 4.2.1.4). Lethal control would most likely need to continue annually to keep the number of terns within the proposed range. An egg oiling or removal program was considered in this alternative as a means to decrease the tern colony size. However, population modeling and a literature review demonstrated that an egg oiling or removal

program only reduces productivity of the tern colony and thus, would not be effective in reducing the number of adult terns in a reasonable timeframe (Belant 1997, Seubert 1990, Christens and Blokpoel 1991, Blackwell et al. 2000).

2.4 Monitoring and Adaptive Management Plan

The intent of the proposed monitoring program is to determine the level of success and impacts associated with implementation of the proposed management actions identified in the preferred alternative. Monitoring after implementation of the preferred alternative would also allow for an adaptive management approach (e.g., altering management actions if response does not meet specified objectives). Specific details of the monitoring program will be described in a Monitoring and Adaptive Management Plan that would be developed upon completion of the FEIS and selection of a proposed action.

A monitoring program for the preferred alternative identified in this FEIS would be three-fold:

1. **Long-term monitoring of the regional Caspian tern population and the network of suitable nesting habitat within the region.** Monitoring of colony sizes for all colonies in the region would occur immediately following implementation of management actions and conclude 3 years after the proposed habitat acreage on East Sand Island has been attained. Following this period, monitoring of the regional population would occur every 10 years (as recommended in the Caspian Tern Status Assessment (Shuford and Craig 2002). Additionally a selected subset of breeding sites would be regularly surveyed every 2 to 3 years to more closely track the regional population trend. East Sand Island would be one of these sites.

2. **Short-term monitoring of the East Sand Island colony.** Monitoring colony size, reproductive success, and possibly diet composition would continue to occur on East Sand Island to determine the response of terns to the reduction of habitat. This monitoring would be completed 3 years after the proposed habitat acreage and number of nesting pairs has been attained.

3. **Short-term monitoring of managed alternate sites.** Monitoring of the presence, absence, and colony size at managed alternate sites would be initiated immediately following implementation of management actions at each site and conclude 3 years after the proposed habitat acreage is attained on East Sand Island. Monitoring and research of tern diet and reproductive success at managed alternate sites would also be initiated when the colony size at each site reaches a minimum threshold (e.g., 500 pairs). This threshold level will be reviewed further and defined during the development of the Monitoring and Adaptive Management Plan. Similar monitoring would be conducted at Grays Harbor if terns begin nesting in this area in response to our proposed action. Current studies being conducted at Dungeness NWR and San Francisco Bay will continue (for a total of 3 years at each site) as part of the initial studies implemented to obtain baseline data on tern diet at representative coastal sites .

2.5 Alternatives Considered but Eliminated from Detailed Study

The alternative development process under NEPA is designed to allow consideration of the widest possible range of issues and potential management approaches. During the alternative development process, many different solutions were considered. The following alternatives were considered but not selected for detailed study in this FEIS for the reason(s) described below.

2.5.1 Elimination of Caspian Terns from East Sand Island

This alternative would actively eliminate all nesting habitat for terns on East Sand Island, thus displacing the entire nesting colony. The open and sandy habitat would be eliminated by seeding the site and allowing the vegetation to grow into tall and dense cover, thus precluding terns from East Sand Island. In addition, hazing of adult terns would be conducted. This alternative was not acceptable since it would violate Guiding Principle number 3: "…ensure Caspian terns remain a viable and integral part of the estuarine, coastal, and interior ecosystems of the Pacific Coast region, including the Columbia River estuary…"

2.5.2 Maximum Redistribution of Terns throughout the Region

Similar to Alternative C, this alternative would reduce habitat on East Sand Island for terns to approximately 1 to 1.5 acres and actively facilitate the redistribution of displaced terns to alternate sites in Washington, Oregon, and California. However, this alternative differs from Alternative C by including nine sites in addition to the seven alternate sites identified in Alternative C. These nine sites met all of the biological criteria for site suitability used in the feasibility assessment (Seto et al. 2003) and this FEIS (see description below and in Appendix G). Three of the sites are located in Washington, three sites are located in Oregon, and the remaining three sites are located in California. This alternative was not considered in our analysis because tern management at all nine of these additional alternate sites was opposed by local or state governments and in some cases, the local community. Support from local communities and governments would be necessary for implementation of this alternative, therefore, this did not represent a reasonable alternative for further consideration in this FEIS. The section below describes the nine additional alternate sites considered in this alternative and the concerns associated with their development as alternate habitat for terns displaced from East Sand Island.

The three additional sites in Washington with potential for tern management are located in Grays Harbor, Padilla Bay, and Jetty Island (Puget Sound). Historic colonies in Grays Harbor constituted one of the larger coastal colonies in the region (peak number of 3,590 pairs in 1987) before loss of nesting habitat, predation, and disturbance apparently caused terns to abandon the site (Shuford and Craig 2002, Seto et al. 2003). Terns last nested in the harbor in 1989. Currently, non-breeding adults are observed feeding and roosting in low numbers (< 50) on four islands in the harbor and both adults and recently fledged chicks (>100) use the area during the post-breeding months (Seto et al. 2003, Columbia Bird Research 2003). Three of the four islands remaining in Grays Harbor are owned and managed by the Department of Natural Resources. These islands have limited human and mammalian predator access and would require moderate habitat enhancement to create open nesting habitat for terns. The fourth island, "Cate Island", is a mix of private and public ownership; is located closer to the mainland with greater potential for human disturbance and mammalian predator access; and would also require moderate habitat enhancement to accommodate nesting terns.

Padilla Bay, in northern Puget Sound, contains four dredge spoil islands along the Swinomish channel. Terns (peak number of 126 pairs in 1995) historically nested on a small, privately-owned island in the 1990s but in recent years only a small number of non-breeding adults have been observed (M. Davidson, pers. comm.). This island is small and dynamic, providing little management potential for habitat enhancement. However, the Washington Department of Fish and Wildlife (WDFW) is currently considering creating larger islands in the bay to benefit wintering gray-bellied brant (M. Davidson pers. comm.). If this occurs, these enhanced islands could be managed for nesting terns in the spring and summer months when brant are absent. Jetty Island, an artificial dredge spoil island that parallels the Everett waterfront in northern Puget Sound was used unsuccessfully by a small number (<20) of nesting terns in the mid-1990s (R. Milner, pers. comm.). Extensive, habitat enhancement activities (e.g., removal of Scotch broom, area closures) could be implemented to create habitat for nesting terns at this site.

Although the above sites have potential for tern management, WDFW does not support active management of sites in Washington as alternate nesting habitat for displaced terns. WDFW supports the goal of reducing tern predation on salmonid stocks in the Columbia River. However, they have concerns about the possible impacts to salmon from the redistribution of terns to locations in Washington. Additionally, the local community and local governments opposed any proposal to attract terns to nest in Grays Harbor. Thus, although these three sites in Washington were all historically colonized by terns and are in close proximity to the Columbia River estuary, we did not include these sites in management alternatives considered in this FEIS. WDFW also stated that they would not oppose any colonization of terns in Washington if the terns were to recolonize a historic site or establish a new colony of their own accord. Thus, the recently colonized nesting site at Dungeness NWR is included in two management alternatives considered in this FEIS.

The feasibility assessment also identified three sites on the Oregon coast (in Coos Bay and the Umpqua River estuary) because they met all of the tern habitat management criteria described in Seto et al. (2003). These sites are islands that would require moderate to extensive habitat enhancement to accommodate nesting terns. None of these sites are historical Caspian tern nesting sites. Oregon Department of Fish and Wildlife (ODFW) does not want to introduce "predation to other fish stocks that have never historically been subjected to Caspian

tern predation" and therefore they do not support managed relocation of Caspian terns to any site in Oregon other than historic sites (Klumph 2003). Thus, we did not include these Oregon coastal sites in any management alternatives considered in this FEIS.

Although ODFW expressed concern for developing habitat at sites not historically used by terns, they remain "committed to significantly reducing the potential impact of avian predators on Columbia River Basin stocks of salmon and steelhead." They acknowledge that the best way to accomplish this is to "disperse" the East Sand Island colony and manage colonies outside the estuary "at levels in balance with their local ecosystems and species communities." Fern Ridge Lake, near Eugene, Oregon was also identified as a site with potential for tern management in Seto et al. 2003 and this FEIS. Although this site was not historically occupied by breeding terns, it is an interior site and we do not anticipate effects to fish species of concern (salmonids). Further communication with ODFW (Anglin 2004) acknowledged that non-breeding terns frequent this site and that the local prey base consists of introduced exotic species. However, ESA-listed salmonids are found in the Willamette and McKenzie rivers located within a 15 mile radius from Fern Ridge. This site was included in our analysis of alternatives (Alternatives C and D) to fully assess the site's potential to accommodate displaced terns and the potential effects to off-site ESA listed salmonids. In accord with ODFW recommendations, site monitoring and an adaptive management approach are included as components of the alternatives that include the Fern Ridge Lake as proposed alternate habitat for terns.

The three additional sites identified with potential for tern management in California are located in Humboldt Bay and the Sacramento Valley. Teal Island in the Humboldt Bay National Wildlife Refuge (NWR) was identified as a potential site for tern habitat management in the feasibility assessment (Seto et al. 2003). Since the 1960s, terns have sporadically nested on a small dredge spoil island Humboldt Bay (Sand Island). From the 1970s to 1990s, no terns were observed to nest in the bay, except for a report of 20 pairs in 1979 (Gill and Mewalt 1983). Terns returned to the site in 2001 and have continued to nest in low numbers through the present. Sand Island is small and limited in size. Teal Island is larger and with vegetation management could provide more nesting habitat for an increased number of terns in the bay. CDFG (Morey 2004) and the Service's California/Nevada Operations (CNO) Office expressed concerns about the impact of tern predation on ESA-listed salmonids and partnership efforts associated with salmon recovery in the Humboldt Bay area. Thus, CDFG and CNO do not support the development of tern nesting habitat in the bay, and Teal Island was not included in any management alternatives considered in this FEIS.

The scoping process and development of alternatives for this FEIS identified development of tern nesting habitat at the Yolo Bypass Wildlife Area and City of Davis Wetlands in the Sacramento Valley. Both of these sites are not historical Caspian tern nesting sites and CDFG expressed concerns for listed salmonids in the Sacramento River (Morey 2004). CDFG "supports Caspian Tern management in California only at historic colonies." Thus, although it appears that habitat could be developed for terns at these two sites in the Sacramento Valley, they were not included in any management alternatives considered in this FEIS.

2.5.3 Lethal Control of East Sand Island Tern Colony

Under this alternative, a lethal control program on terns would be the only management action implemented to reach and maintain a proposed range of nesting terns (2,500 to 3,125 nesting pairs) on East Sand Island. This proposed range was selected because this reduction was estimated to increase the population growth rate (λ) for four Columbia River Basin steelhead ESUs by at least 1 percent (Table 2.2, NOAA Fisheries 2004a, Appendix C). In order to achieve this proposed range of nesting pairs, up to 50 percent of breeding adult terns each year would be killed beginning in 2005. Based on the same population model used in Alternative A (see Chapter 4), this control program would need to kill a substantial number of terns (up to 10,000 terns in the first year, 5,000 to 8,000 terns in subsequent years) to reach the proposed range. The killing of such a large number of terns would be unacceptable to the Service as it would be contrary to the conservation of this species. In addition, it is anticipated that a lethal control program of this magnitude would not be acceptable to the public.

2.5.4 Reduction of Caspian Tern Nesting Habitat on East Sand Island and No Active Facilitation to Other Sites within the Region

This alternative would reduce the tern nesting habitat on East Sand Island to approximately 1 to 1.5 acres, but there would be no active management of potential nesting sites to redistribute the nesting population of terns within the Pacific Coast region. Displaced terns would need to use existing habitat elsewhere in the region (see Appendix F for a list of existing nesting habitat currently available to terns in the region). Displaced terns would nest at these locations, establish new colonies elsewhere,

or continue to nest or feed in the estuary. This alternative was not considered in detail because of the uncertainties with respect to success of achieving the proposed range of nesting pairs, or where displaced terns would go to nest. For example, terns may nest at other Columbia River sites, resulting in no reduction of tern predation on Columbia River salmonids. Additionally, management at alternate sites is expected to influence where displaced terns would nest (e.g, sites that would have minimal conflicts with ESA-listed salmonids). Lastly, plaintiffs of the 2000 lawsuit (see Chapter 1) wanted to ensure that suitable nesting habitat was established in the region prior to reduction in colony size on East Sand Island. This alternative would not ensure suitable habitat was available to terns in the region.

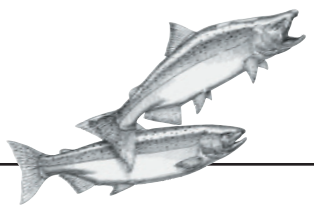
2.6 Comparison of Alternatives

Table 2.3 summarizes and compares the alternative components of the four alternatives described above and associated anticipated effects.

Table 2.3 Comparison of Caspian tern management EIS alternatives by component and associated anticipated effects

ALTERNATIVE COMPONENTS				
	ALTERNATIVE A No Action-Current Management Program	**ALTERNATIVE B** No Management	**ALTERNATIVE C** Redistribution of ESI Tern Colony **PREFERRED ALTERNATIVE**	**ALTERNATIVE D** Redistribution and Lethal Control of ESI Tern Colony
East Sand Island (ESI) Habitat Management	Annually maintain 6 acres of open sand habitat	No preparation of nesting habitat	Reduce nesting habitat on ESI to approximately 1 – 1.5 acres	Same as Alternative C
Habitat Management to Facilitate Redistribution	No	No	Yes; manage alternate sites in the region	Same as Alternative C
Tern Control Program	No	No	No	Yes, removal of adults, if necessary, to obtain target colony size of 2,500 to 3,125 breeding pairs, beginning in 2008
ANTICIPATED EFFECTS				
Regional Tern Population	Maintain current trend	Stabilized or declining trend	Initial decrease in productivity but overall stabilization of population	Same as Alternative C, except if lethal control is implemented; then population anticipated to decline
East Sand Island Tern Colony	Potential increase until nesting habitat is maximized (possibly in 2009)	Loss of colony on East Sand Island and entire Columbia River estuary	Colony size range between 2,500 and 3,125 breeding pairs	Same as Alternative C
Columbia River ESA-listed salmonids	Continued/anticipated increase in juvenile smolt consumption; no improvement in population growth rate of ESA-listed steelhead	Decreased or potential elimination of juvenile smolt consumption; anticipate increase in population growth of ESA-listed steelhead	Substantial reduction in juvenile smolt consumption; anticipate increase in population growth of ESA-listed steelhead	Same as Alternative C
ESTIMATED COSTS [a]				
Habitat Management	$ 30,000/yr	$0	$ 2,422,093 (first year costs, includes construction, habitat enhancement, predator management, and social attraction costs at all sites)	$ 2,422,093 (first year costs, includes construction, habitat enhancement, predator management, social attraction costs at all sites); $ 65,400/yr for lethal control, if implemented
Short-term Monitoring	$ 165,000/yr	$0	$ 269,000/yr	$ 269,000/yr
Long-term Monitoring	$ 5,000/yr	$ 100,000 (baseline regional monitoring– first year and every 10 years) $ 10,000/yr (annual colony monitoring)	$ 100,000 (baseline regional monitoring– first year and every 10 years) $ 10,000/yr (annual colony monitoring)	$ 100,000 (baseline regional monitoring – first year and every 10 years) $ 10,000/yr (annual colony monitoring)

[a] Detailed estimated costs for each proposed alternate site are located in Appendix G.



Chapter 3

Affected Environment

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Chapter 3. Affected Environment

The EIS study area encompasses ESA-listed salmonid habitat in the Columbia River Basin and tern nesting habitat in the States of Washington, Oregon, California, Idaho, and Nevada. This study area falls within the breeding range of the Pacific Coast regional population of terns and the management jurisdiction of the three cooperating Federal agencies (U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, NOAA Fisheries).

During the planning process, the affected environment for this FEIS was more specifically identified as those tern nesting areas within Washington, Oregon, and California that are most likely to be affected by proposed management alternatives under consideration in this FEIS. The affected environment (Figure 3.1) extends from the Columbia River estuary, the area of primary management concern, into those sites proposed for Caspian tern management for displaced terns from East Sand Island (as described in Chapter 2, Table 2.1). Although we anticipate that the boundaries of the affected environment extends to all areas potentially affected by proposed management alternatives, terns may pioneer into locations not discussed in this FEIS on their own volition. Thus, since this species takes advantage of ephemeral habitat and forage conditions over a wide geographical range, we cannot predict with complete certainty where colonies would establish themselves in the future.

The following description of the affected environment, organized by State, summarizes those aspects of the environment that could potentially be affected by direct management actions at proposed alternate sites (Table 2.1 and Appendix G) identified for proposed management alternatives. Scientific names of the plants and wildlife discussed in this chapter are listed in Appendix H. Specific anticipated effects of the proposed management alternatives are described in Chapter 4, Environmental Consequences.

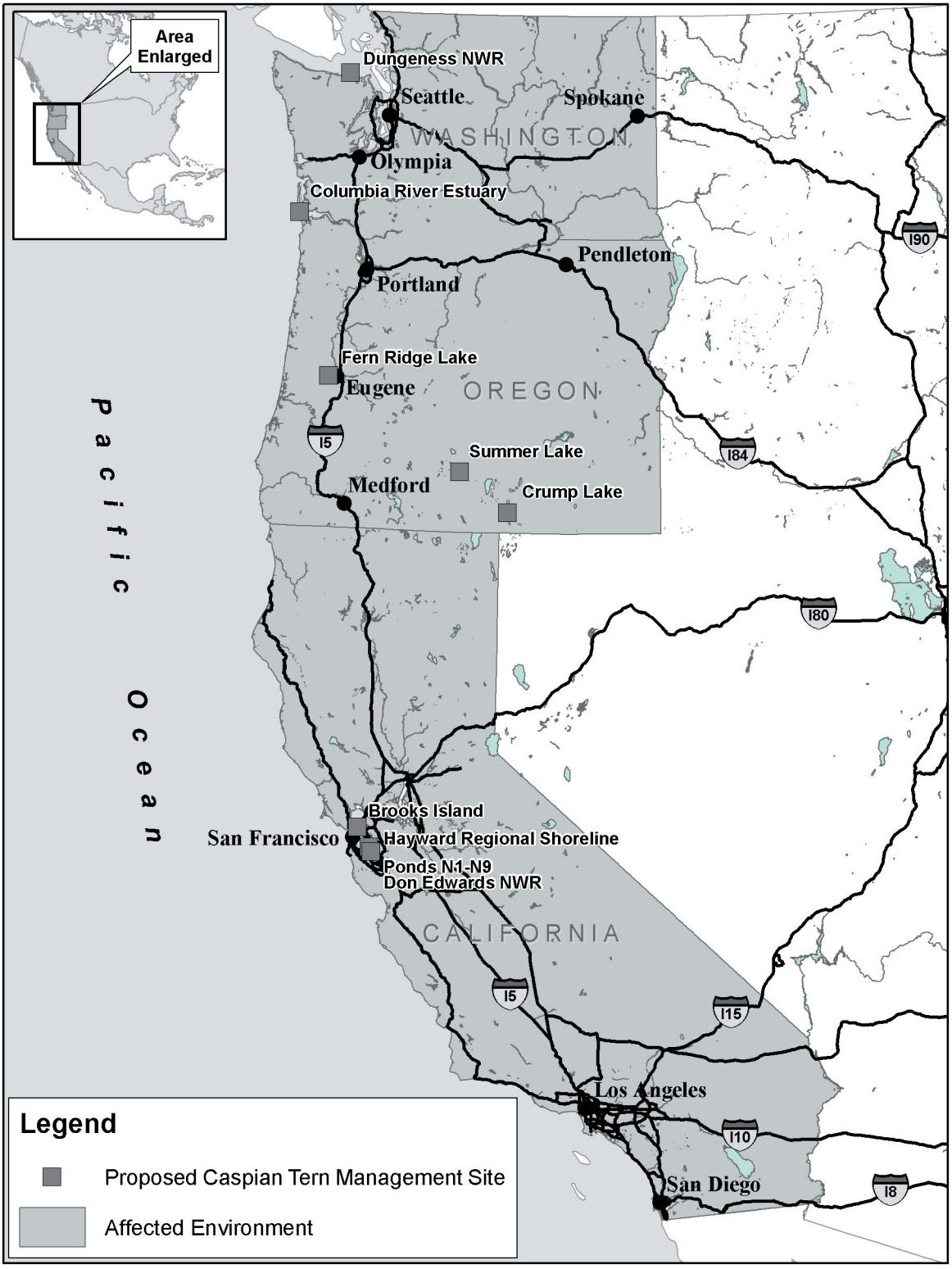
3.1 Physical Environment

Nesting habitat for terns in the Pacific Coast region includes both coastal and interior sites. Colonies are located in estuarine or marine habitats or freshwater lakes, rivers, marshes, sloughs, reservoirs, irrigation canals, and (low salinity) saline lakes (Cuthbert and Wires 1999). Many sites are ephemeral and their suitability for nesting varies with water levels, vegetation density, and prey availability as affected by droughts, floods, erosion (Shuford and Craig 2002), ocean conditions, or other factors.

Washington. Interior nesting sites consist of rock or silt islands in natural lakes or human-created reservoirs, the majority of which are relatively flat with little to no vegetation. Coastal nesting

Caspian terns nesting among driftwood on Dungeness Spit, Dungeness NWR, Washington. Photo credit: OSU/RTR

FIGURE 3.1 Map of Affected Environment

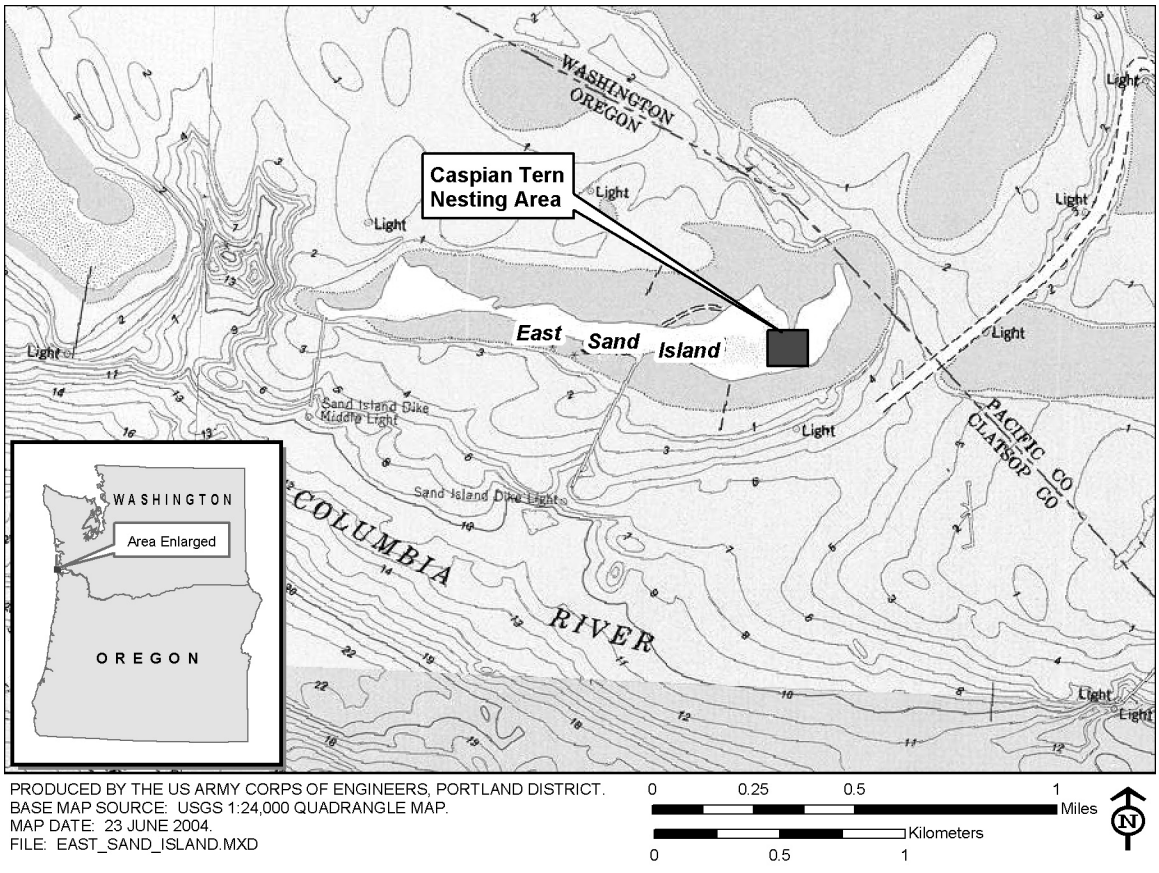


sites have varied considerably through the years, occurring both in Puget Sound and the coastal bays (e.g., Willapa Bay and Grays Harbor). Nesting habitat has primarily been sandy, flat islands with little to no vegetation but also includes sites on the mainland that are sandy or bare, but typically near the shoreline [e.g., Dungeness Spit (see photo on page 3-1), Everett Naval Base]. Atypical sites have also been used by terns and include roof tops of large buildings, barges, and broken sandbags atop covered piles of contaminated soil (i.e., ASARCO site). The use of these atypical nesting sites are indications of the lack of suitable natural habitat in Washington, and the tern's adaptive behavior.

The only documented coastal tern colony in 2003 and 2004 (and the only site in Washington proposed in this FEIS) occurs at Dungeness NWR, located on Dungeness Spit near Sequim in Clallam County, Washington, on the southern side of the Strait of Juan de Fuca. The 6-mile long Dungeness Spit is characterized on its north (Strait) side by sand and cobble beaches. The bay side is more sandy, resembling the character of the shoreline on the Strait side, but driftwood and a variety of grass are also present (U.S. Fish and Wildlife Service 1996).

Oregon. The only coastal tern nesting activity in Oregon has been restricted to islands (natural and artificial) in the Columbia River. The colony on East Sand Island (Figure 3.2), located in the Columbia River estuary, is the primary management focus of this FEIS. The Columbia River estuary is 4 to 5 miles wide, and, for the purposes of this FEIS, extends upriver to around river mile (RM) 46 (Figure 2.1, although tidal influence extends up to Bonneville Dam, RM 146). The main navigation channel is dredged annually by the Corps to maintain the authorized 40-foot-deep, 600-foot-wide navigation project. Miller Sands Spit and Rice and Pillar Rock islands are active disposal sites for operations and maintenance dredging actions (U.S. Army Corps of Engineers 2003). Active disposal areas/islands typically have little vegetation on the upland portion of the site. The high tide lines at these islands contain lush vegetation communities because of accumulated organic material (debris) and availability of water. East Sand Island is located near the mouth of the Columbia River and is a naturally occurring island. Stone fill was placed on the western end of East Sand Island in 1950 and persists to date. Dredged material was placed in a diked containment area on the eastern end of the

Figure 3.2 Caspian Tern Nesting Area on East Sand Island



island in 1983. Terns initiated nesting on the dredged material disposal site in 1984. Alders and willows form the dominant vegetative cover beginning at the western boundary of the disposal site and extending eastward to the area managed for tern nesting habitat (bare ground). A wet, hummocky, driftwood strewn flat occurs northeast of the tern nesting area with a sandy spit extending towards the water at this location. The southern shore is beaten by ocean swells, waves and tidal currents, and is rocky from the western end to approximately the mid-point of the island, thereafter, the shoreline is a sandy beach.

Two of three proposed tern management sites in Oregon (Summer and Crump lakes) are located in natural lakes, with terns primarily nesting on silt islands with little vegetation. Exposure of islands, and thus availability of nesting habitat, varies considerably from year to year based on lake water levels. The Summer Lake Wildlife Area, managed by the ODFW, is located at the north end of Summer Lake and was established in 1944 (St. Louis 1993). The lake and marsh are primarily fed by the Ana River that arises from a series of springs located 5 miles to the north in the Ana Reservoir. The majority of the area is a very shallow, primarily man-made alkaline and freshwater marsh.

Crump Lake is located in the southern end of the Warner Basin. Crump Island is a barren, flat island in the central part of the lake, north of the peninsula that nearly bisects the lake. In the 1990s, ODFW attempted to restore the island; the island was not rebuilt to an elevation above highest water levels in the lake, thus, is regularly underwater during high water levels (C. Foster pers. comm.).

Fern Ridge Lake, the third site proposed in Oregon, is a reservoir located on the Long Tom River approximately 6 miles west of Eugene, Oregon in the southern Willamette Valley. The primary purpose of the lake is for flood control. More than 5,000 acres are licensed to ODFW for wildlife management. Currently, there is no suitable habitat for nesting terns in the lake, but habitat can be created adjacent to a sub-impoundment project constructed by the Corps (U.S. Army Corps of Engineers 1988). Additionally, prey appear to be available and abundant for a future tern colony as the lake supports large populations of common carp, bullheads, and various species of the sunfish family (U.S. Army Corps of Engineers 1988).

California. Tern nesting sites in California have been numerous in both interior and coastal areas. Interior sites consist of natural and artificial wetlands, lakes, or reservoirs and coastal sites can be found in almost all the coastal bays and estuaries in the State. Sites of management concern in this FEIS are located in San Francisco Bay.

San Francisco Bay and estuary contain a variety of habitats, ranging from deep bays, channels, and tidal marshes to artificial salt ponds. The Sacramento and San Joaquin rivers enter the bay in the northeastern portion, forming a delta. These rivers drain California's Central Valley, including parts of the Sierra Nevada and Cascade mountains, forming the largest estuary on the west coast of North America. The freshwater runoff in the delta flows seaward, mixing with ocean water through Suisun Bay, San Pablo Bay, and lastly, San Francisco Bay. Tern nesting in the bay has usually been associated with artificial salt ponds. Commercial salt production has been discontinued in many of the salt ponds. These inactive salt ponds have been transferred to Federal, State, or local governments and are managed primarily as wildlife habitat. Some have been or will be restored to tidal influence.

Ponds N1-N9 are active salt ponds included within the Don Edwards San Francisco Bay NWR. Although active salt harvest is occurring, internal levees are free from disturbance and have provided habitat for small numbers of nesting terns in the past. Also of management concern in San Francisco Bay is Brooks Island and Hayward Regional Shoreline, both managed by the East Bay Regional Parks District. Brooks Island, a 373-acre island located in the east-central part of the bay off the Richmond Inner Harbor, consists mostly of upland habitat, rising 163 feet. A low-lying spit northwest of the main part of the island contains salt marshes, tidal flats, and a sandy shoreline. Terns and gulls nest on upper parts of the beach on the northeast shore. Parts of this area is vegetated with a non-native ice plant and a Mediterranean aster.

Hayward Regional Shoreline is located near the San Lorenzo bayshore, just north of the San Mateo bridge. A portion of the Hayward Regional Shoreline consists of a series of freshwater marsh impoundments with islands. Water in these impoundments are a mixture of treated wastewater and bay water (salt water). The islands are bare, sparsely, or heavily vegetated with non-native grasses. Some of these islands offer the potential for tern habitat management. One to two pairs of terns have nested at this site in the past (Shuford and Craig 2002). Modification of island surface substrate would produce suitable habitat conditions for terns.

3.2 Biological Environment

3.2.1 Caspian Terns

The 2002 Settlement Agreement required the Service to prepare a technical report summarizing the distribution, abundance, and conservation needs of Caspian terns in North America. Much of the information presented below is derived from this report, entitled: *Status Assessment and Conservation Recommendations for the Caspian Tern (Sterna caspia) in North America* (Shuford and Craig 2002). Other references are identified for information derived from other sources.

Species Range. Terns breed at widely scattered sites across North America. Wires and Cuthbert (2000) described five disjunct breeding regions in North America (Figure 3.3). Terns breeding in the Columbia River estuary are in the Pacific Coast/ Western (Pacific Coast) region. This region includes coastal Alaska, southwestern British Columbia, Washington, Oregon, California, Baja California, and Sinaloa, Mexico; and interior Washington, Oregon, California, southern Idaho, Montana, Wyoming, western Nevada, and northern Utah. See Appendix F (Table F.1) for a complete list of current and historic tern nesting sites within the Pacific Coast region.

Pacific Coast Region Overview. Since the beginning of the 20th Century, the Pacific Coast regional population has shifted from nesting in numerous small colonies associated with freshwater marshes in interior California and southern Oregon, to primarily larger colonies along the coast extending into the State of Washington (Gill and Mewaldt 1983). Caspian terns adapt to spatial and temporal variability of breeding habitat and prey, leading to highly variable colony locations and sizes within the region.

In recent years, terns were documented to have nested on about 60 sites scattered throughout the Pacific Coast region, including Alaska (Table F.2). This habitat base serves as a network of sites, which individually may vary in suitability from one year to the next but collectively provide a suite of locations for terns on a regional scale. Colonies in the interior are characteristically small in size (few to hundreds of birds, Table F.2) and are subject to substantial shifts in location, quantity, and quality corresponding to cycles of flood and drought. Interior sites may also be subject to intensive management such as the control of reservoir and irrigation water. Larger colonies (e.g., many hundreds to thousands of terns) have been documented primarily along the Pacific Coast.

Coastal nesting habitat can be managed or natural and is typically subject to erosion and vegetation changes over time. Although ocean conditions may affect prey availability, coastal prey resources are typically more diverse, abundant, and stable in comparison to prey resources at interior sites which are highly variable from year to year and typically less abundant and diverse. For a detailed review of current, historic, and potential tern nesting habitat throughout the Pacific Region see: *A Review of Caspian Tern Nesting Habitat: A Feasibility Assessment of Management Opportunities in the U.S. Fish and Wildlife Service Pacific Region* (Seto et al. 2003).

Regional Population Trends. The tern breeding population in the Pacific Coast region is the largest within the United States (see Table 3.1 for a breakdown of regional populations). This regional population has increased exponentially since the early 1960s (Gill and Mewaldt 1983) but has stabilized since 1997 (Figure 3.4). Although actual

TABLE 3.1 Estimates of the Caspian tern breeding population in the United States, by region, from 1976 to 1982 and 1997 to 1998, including current Pacific Coast regional population estimate.

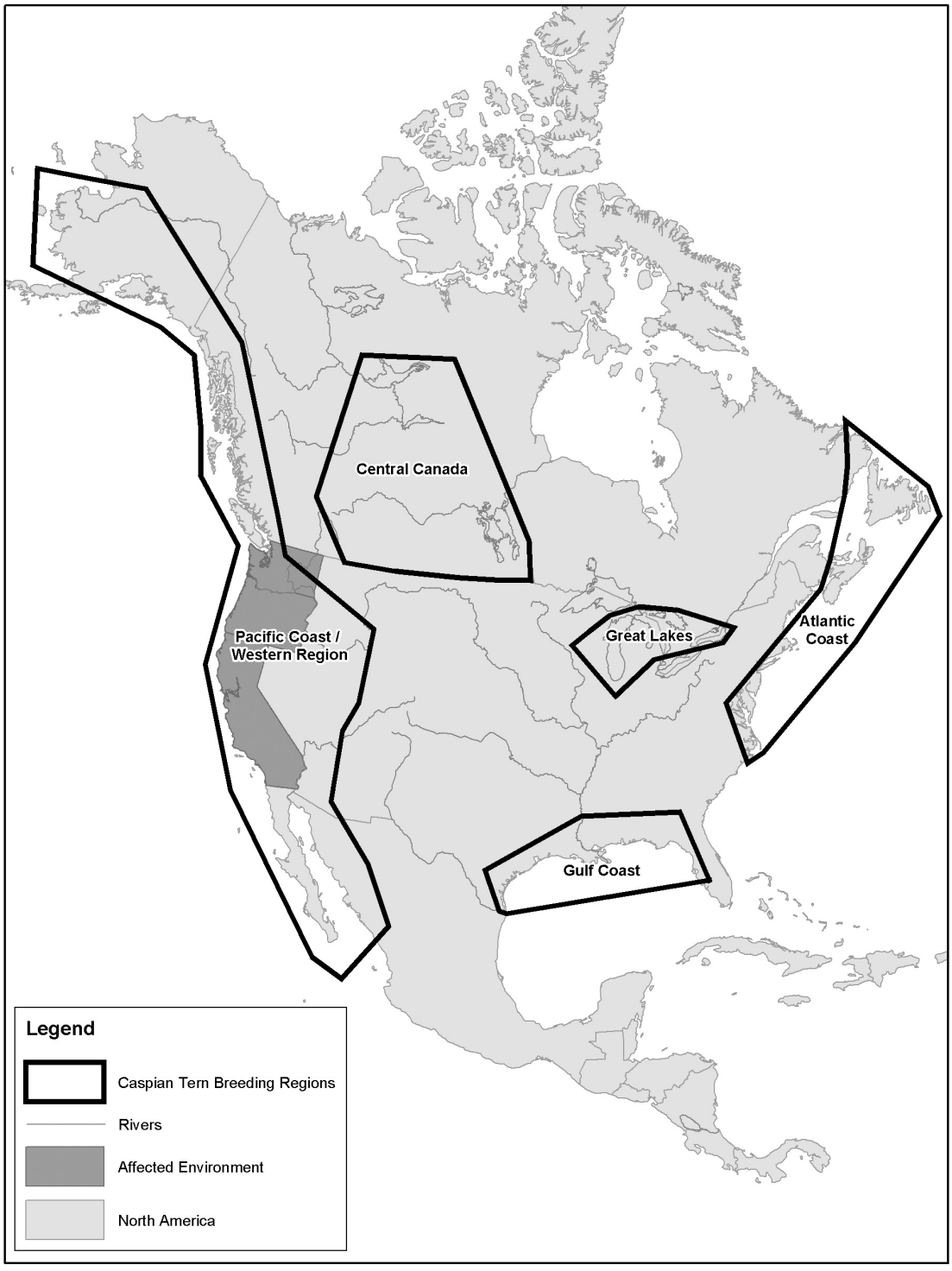
	1976-1982[a]		1997-1998[b]		2003[c]
	Estimated Pairs	% U.S. Population	Estimated Pairs	% U.S. Population	Estimated Pairs
Pacific Coast	6,218	66.4	14,534	69.4	11,756
Great Lakes	1,682	18.0	3,979	19.0	-
Gulf Coast	1,456	15.5	2,303	11.0	-
Atlantic Coast	10	0.12	122	0.6	-
TOTAL	9,366	100.00	20,938	100.00	-

[a] Spendelow and Patton 1988. Numbers of adults divided by two to estimate nesting pairs. Some of the original data were raw counts of adults, thus, these numbers are likely underestimated given some adults are usually away from the colony at any given time.

[b] Shuford and Craig 2002.

[c] U.S. Fish and Wildlife Service, unpublished data.

FIGURE 3.3 Caspian Tern Breeding Regions in North America (from Wires and Cuthbert 2000)

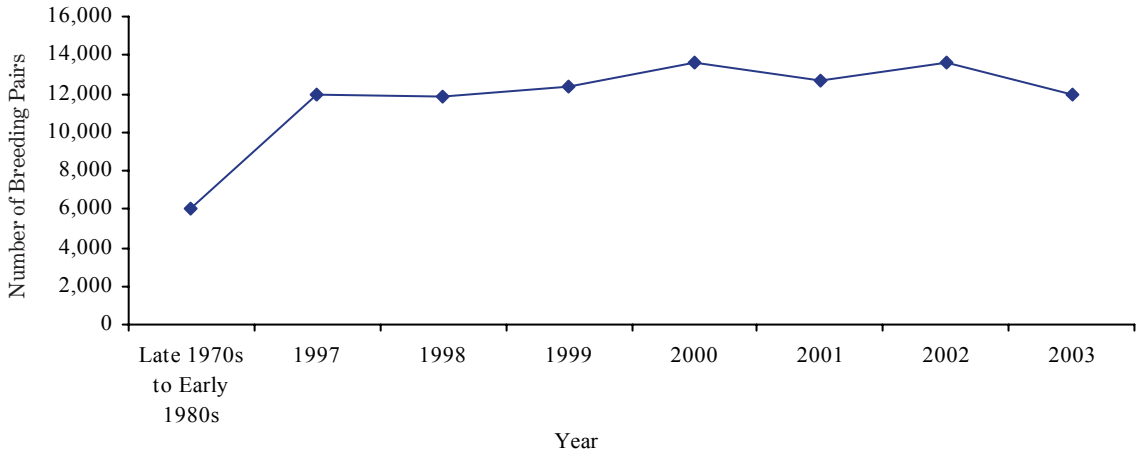


numbers were not reported for the early 1960s, Gill and Mewaldt (1983) described a regional population estimate of approximately 6,000 pairs in the late 1970s and early 1980s as a 74 percent increase from the 1960s. Thus, the regional population in the 1960s would have been around 3,500 pairs. Shuford and Craig (2002) reported that this increase may have represented a rebound to, or below, the population size that likely existed before the great loss of wetland habitat at interior portions of the region. A second increase occurred in the late 1990s with an estimated 14,500 breeding pairs reported in the region (Table 3.1).

The regional population increase, (Figure 3.4), beginning in the mid-1980s, is mainly attributable to the large colony increase observed in the Columbia River estuary (see section below) from 1984 to 2002. Numerous anthropogenic and natural factors are thought to have contributed to this increase in tern numbers but the interactions among them are not well understood. The initial colonization and growth of the Rice Island tern colony appears to have occurred because of the immigration of terns from large colonies in Washington (e.g., Grays Harbor and Willapa Bay). A number of factors such as habitat loss (e.g. erosion of islands, vegetation of nesting sites), decreased prey availability, and increased predators (gulls, eagles) may have contributed to the shift of nesting terns from coastal Washington to the Columbia River estuary. The continued growth and success of this colony at Rice Island, and now East Sand Island, are attributed to the stability of the human-created and/or maintained nesting habitat, reliable food supply, vulnerability of some hatchery smolts to tern predation, and the apparent immigration of terns that have lost nesting habitat or were hazed from other colonies (e.g., Everett Naval Base). Highly productive ocean conditions which supported an abundance of marine prey species most likely also contributed to the high tern reproductive success observed on East Sand Island from 1999 to 2003. In 2003, the East Sand Island colony comprised 71 percent of the regional population (approximately 11,756 nesting pairs, Table F.2), which has declined slightly since the 1997-1998 estimate.

Colony Sizes and Growth Rates. Tern colony size varies widely among locations and years, but typically ranges from tens to hundreds of pairs. Terns rarely breed in colonies greater than 1,000 nesting pairs (Cuthbert and Wires 1999, Wires and Cuthbert 2000). Development of dredge material islands and the outmigration and production of hatchery reared and barged salmonids have provided an abundance of stable and predictable nesting and concentrated foraging resources for breeding terns in the Columbia River estuary. These unique characteristics enabled the unprecedented growth

FIGURE 3.4 Pacific Region Caspian Tern Population Trend



Data Sources:

Late 1970s to Early 1980s - Spendelow and Patton 1988.
1997 to 2001 - Shuford and Craig 2002. Data for 1997 and 1998 consists of data for individual sites in the region for each year and differs slightly from that reported in Wires and Cuthbert 2000 for the two years combined.
2002 to 2003 - U.S. Fish and Wildlife Service, unpublished data.

rate and size of the tern colony in the estuary. These characteristics are not representative of tern habitat elsewhere in the Pacific Coast region and North America.

In contrast to the colony in the Columbia River estuary (average size of 7,248, Table F.2), the average sizes of other individual tern colonies in the Pacific Coast region since 1997 ranges from 8 to 681 nesting pairs (Table F.2), often fluctuating from year to year (Shuford and Craig 2002, D. Shuford and U.S. Fish and Wildlife Service unpublished data). In California, colonies fluctuated in growth rates and size but the overall breeding population remained stable for over 30 years. The trends observed in California are characteristic of the region overall, excluding the Columbia River estuary. Colony sizes along the Washington coastline averaged from 820-1,675 pairs between 1957 to 1991. In 1987, the colony at Grays Harbor, Washington peaked at 3,590 pairs, representing the second largest colony historically in the Pacific Coast region. By 1989 terns abandoned this site and Grays Harbor has since been used only intermittently as a foraging area (no nesting activity) by a small number of terns (e.g., 50 to 100 adults, Seto et al. 2003, Columbia Bird Research 2003).

Habitat Requirements. Terns nest in single-species colonies or in multi-species assemblages with other ground nesting waterbirds (gulls, skimmers, other terns, and cormorants). Terns breed in a variety of habitats ranging from coastal estuarine, salt marsh, and islands. Terns typically nest in open, barren to sparsely vegetated areas, but also among or adjacent to driftwood, partly buried logs, rocks, or tall annual weeds. Nest substrates vary from sand, gravel, spongy marshy soil, or dead or decaying vegetation to hard soil, shell banks, limestone, or bedrock. Nests range from simple depressions in a bare substrate to nests lined with debris, such as shells, crayfish chelipeds, dried grasses and weed stems, wood, or pebbles.

Diet. Breeding terns eat almost exclusively fish, catching a diverse array of species with shallow plunge dives, usually completely submerging themselves underwater (Cuthbert and Wires 1999). The sizes of fish caught and diet composition are largely determined by geography and annual and seasonal prey availability, but most fish are between 5 to 25 cm and occur near the surface of the water. In the Columbia River estuary, diet studies of the tern colonies on Rice and East Sand islands documented that terns nesting on Rice Island (1999 to 2000) had an average of 83 (77 to 90) percent juvenile salmonids in their diet (Roby et al. 2002), while on East Sand Island (1999 to 2004), terns had an average of 33 (17 to 47) percent juvenile salmonids in their diet (Collis et al. 2002a, 2002b, 2003a, 2003b, K. Collis pers. comm.). From 1999 to 2003, the tern diet on East Sand Island, closer to the mouth of the Columbia River than Rice Island, was primarily non-salmonids, including northern anchovy, herring, shiner perch, sand lance, sculpins, smelt, and flatfish (Roby et al. 2002, Collis et al. 2002b and 2003a). As ocean conditions improved, and thus, ocean productivity, the percentage of juvenile salmonids in the diet of terns in the estuary has continued to decline in recent years.

Salmonid composition at other sites that have been studied were found to be variable. For example, in Grays Harbor, Washington, chum and coho salmon were found in the tern diet in low numbers (14 to 21 percent) and primary prey taken were shiner perch and northern anchovy (Penland 1976). At Dungeness NWR, salmonid composition of the tern diet was observed to be the second most important prey species (31 percent of tern diet) in 2004 (Roby et al. 2004). Both of these sites in Washington differ from that observed in Commencement Bay, a location south of Dungeness NWR in Puget Sound, Washington. In 2000, terns in Commencement Bay were observed to have an average of 52 percent salmonids in their diet (Thompson et al. 2002). It is possible that these observed differences in diet composition is because Grays Harbor and Dungeness NWR contain a greater diversity and/or abundance of marine prey species than found in Commencement Bay due to the adjacent marine waters in these two locations.

In San Francisco Bay, diet studies conducted in 2003 and 2004 found that the tern diet varied among the various nesting locations in the bay, but primary prey species included anchovy, surf perch, silversides, herring, sunfish, gobies, and toadfish (Roby et al. 2003a and 2004). In 2003, salmonids (not including trout from reservoirs) were found in the diets of four out of five nesting colonies, ranging from 0.1 (Agua Vista Park and Baumberg Pond) to 8.7 (Knight Island) percent of prey items (Roby et al. 2003a). In 2004, juvenile salmonids were more prevalent in the tern diets, ranging from 1.4 (Agua Vista Park) to 26.1 (Knight Island) percent, and consisted primarily of non-ESA-listed species (Roby et al. 2004). The higher prevalence of salmonids in the tern diet was apparently due to a lower availability of marine fish during that year (e.g., northern anchovy and surfperch, Roby et al. 2004).

In interior Oregon (Summer and Crump lakes), a study conducted in 2003 found tui chubs to be the primary prey of nesting terns (Roby et al. 2003a). In San Diego, food habits of terns were studied in 1995,

1997, and 1998. These studies consistently found terns to feed primarily on sardines, anchovies, and topsmelt (Horn et al. 1996, Horn and Dahdul 1998 and 1999).

Migration. Terns migrate singly or in groups that can be as large as thousands (Shuford and Craig 2002). Most terns congregate for migration at traditional foraging locations along marine coasts and major rivers or freshwater lakes about a month after young have fledged (Shuford and Craig 2002). Timing of migration varies with region; fall movement typically occurs between mid-July and mid-September along the Pacific Coast (Shuford and Craig 2002).

Colony Descriptions. Two documents describe and summarize tern colony information: (1) *Status Assessment and Conservation Recommendations for the Caspian Tern in North America* (Shuford and Craig 2002), and (2) *A Review of Caspian Tern Nesting Habitat: A Feasibility Assessment of Management Opportunities in the U.S. Fish and Wildlife Service Pacific Region* (Seto et al. 2003). Full descriptions of tern colonies found in the Pacific Coast region can be found in these documents. The following section summarizes tern nesting activity within the affected environment. See Table F.2 for a summary of all current nesting sites within the Pacific Coast region and estimated nesting tern numbers for 1997 to 2003.

Washington. The distribution and abundance of terns in the State has fluctuated dramatically since they were first reported along the coast at Westport in 1929 (Shuford and Craig 2002). Breeding activity was first recorded at Moses Lake (eastern Washington) in the 1930s, and on the coast in the 1950s with small colonies in Grays Harbor. The Washington breeding population peaked in 1982 with nesting colonies in Grays Harbor, Willapa Bay (coast), and the Potholes Reservoir (eastern Washington). By 1995, several tern nesting islands were lost in Grays Harbor and Willapa Bay to erosion, a characteristic of naturally occurring ephemeral habitats. The one remaining tern nesting island in Grays Harbor, Sand Island, is now vegetated. Some terns moved to nest in Puget Sound (Padilla Bay, Everett Naval Base, and Commencement Bay), but urban development, active hazing, and habitat loss ultimately precluded nesting terns from using those sites. In 2003 and 2004, nesting Caspian terns were only documented at Dungeness NWR (coast), and at the Potholes Reservoir, Banks Lake, and Crescent Island in the interior. All of these were small colonies consisting of less than 1,000 nesting pairs.

Adult Caspian tern with chick. Photo credit: Keith Larson

The newly colonized Dungeness NWR colony constitutes the only current coastal nesting site in Washington. Terns have been observed in small numbers in Dungeness Bay since the late 1990s but nesting activity was never documented until 2003 (P. Sanguinetti pers. comm.). About 200 adult terns were observed in late July with at least 50 young chicks (P. Sanguinetti pers. comm.). In 2004, approximately 233 to 293 pairs nested in a sandy and open area, with pieces of driftwood and very little vegetation (Roby et al. 2004). Although the terns nested only on approximately 0.25 acre in 2004 (K. Bixler pers. comm.), more nesting habitat is available in the immediate area.

Oregon. Local summer residents and migrants occur along Oregon's coast, major rivers, and inland water bodies. In 1940, less than 1,000 pairs nested throughout Oregon. Historically, breeding terns were restricted to shallow lakes and reservoirs of the Klamath Basin and Great Basin. In recent years, tern numbers in Oregon averaged around 9,000 pairs. Currently, what has been considered the world's largest colony is found near the mouth of the Columbia River on East Sand Island, and small colonies still occur in interior Oregon. Recent trends in Oregon reflect the population trend observed in the Pacific Coast regional population (see Regional Population Trends section, above).

Although terns were observed near East Sand Island in 1975 (Tabor 1976), nesting activity in the Columbia River estuary was first documented in 1984 (1,164 nesting pairs, Shuford and Craig 2002). Terns used habitat created by deposition of dredged material on the eastern tip of East Sand Island. By 1985, vegetation covered the East Sand Island nesting site and by 1986, most of the colony shifted

to Rice Island, a large sandy dredge disposal island 21 km farther upriver. From 1987 to 1998, no terns attempted to breed on East Sand Island. The tern colony on Rice Island increased rapidly from the initial estimate of 1,000 pairs in 1986 to about 6,200 pairs in 1991. Growth of this colony slowed after 1991, but it again increased substantially in size in 1995 and 1996, coincident with loss of a colony at the U.S. Naval Base at Everett, Washington. The number of terns peaked on Rice Island at 8,700 pairs in 1998. In 1999, a pilot study to attract the breeding colony of terns on Rice Island to East Sand Island resulted in approximately 550 pairs nesting at the eastern end of East Sand Island (Roby et al. 2002) while approximately 8,300 pairs remained on Rice Island. This relocation effort included the removal of vegetation to create bare sand nesting habitat and social attraction techniques (i.e., decoys and audio playback systems) on East Sand Island and seeding and installation of silt fencing on Rice Island. Terns that nested on East Sand Island were presumably from the nearby Rice Island colony (Roby et al. 2002). In 2000, the colony continued to relocate, resulting in only about 590 nesting pairs on Rice Island and approximately 8,500 pairs on East Sand Island (Roby et al. 2002). Thereafter, all terns in the Columbia River estuary have nested on East Sand Island and terns attempting to nest elsewhere in the estuary have been hazed. In 2002, 2003, and 2004, 9,933, 8,352, and 9,500 pairs, respectively, nested on East Sand Island (Collis et al. 2003a and 2003b, and K. Collis pers. comm.).

Terns were described as "usually breeding" at Summer Lake in 1940; in recent years observations of terns have been less than 50 pairs. At Crump Lake, tern numbers are slightly higher. In 2000, approximately 150 pairs were observed in Crump Lake. Since then, water levels have been high and the island used for nesting has been underwater and unavailable to terns. In 2003, 49 active tern nests were monitored on an artificial platform constructed by a research group in Crump Lake (Roby et al. 2003a). Currently, terns are a regular visitor at Fern Ridge Lake during spring migration and in late summer during the post-breeding season dispersal and/or migration. Fern Ridge Lake does not contain a suitable nesting site for this species at present.

California. There is very little historical information on tern nesting activity in California. Prior to 1945, only six breeding sites were known for the State, five in the interior and one in San Francisco Bay. In the late 1970s, approximately 2,586 pairs nested at 10 sites (78 percent on coastal locations and 22 percent on interior locations). By 1997, a colony at the Salton Sea increased, bringing the State population to 4,350 pairs; but by 2000, the California breeding population declined to about 2,583 pairs at 12 sites. Other than for the very brief period when peak numbers were reached at the Salton Sea in the mid-1990s, the Statewide breeding population appears to have been relatively stable in the last 30 years despite shifts in the number and location of breeding sites.

In San Francisco Bay, Caspian terns initially nested in salt ponds but later expanded or relocated to new sites, typically in response to disturbance from routine maintenance of salt pond levees or predation. A study which monitored nesting tern colonies in San Francisco Bay between the years of 1982 to 2003 found that the numbers of nesting terns in the bay have remained relatively stable during the past 20 years, but considerable annual movement among colony sites was observed (Strong et al. 2003). During this same period, tern numbers in the entire bay ranged from approximately 1,000 to 2,600 pairs (Strong et al. 2003), with approximately 1,190 pairs nesting in 2003 (Roby et al. 2003a). In 2004, approximately 1,372 pairs were observed nesting in the Bay (Roby et al. 2004).

3.2.2 Fish

A variety of fish are found within the affected environment. These vary greatly based on their location (coastal vs. interior waterbodies). Generally, coastal areas contain a larger diversity of fish including marine and anadromous fish (e.g., salmon). Abundance of these fish is heavily dependent upon ocean conditions. In contrast, interior sites contain fish such as trout, tui chub, bass, crappie, or suckers. Abundance and availability of these fish are heavily dependent upon drought conditions and water levels. The section below describes an overview of fish that could be affected by proposed management alternatives of this FEIS. Fish listed under the ESA are described in section 3.2.3.

Salmonids. Salmonids (salmon and steelhead) discussed in this FEIS refer to anadromous species only. Salmon and steelhead are similar in their ecological requirements. They spend most of their lives in the ocean where they grow to relatively large size, and then return to freshwater to spawn. Steelhead are the anadromous form of rainbow trout (a salmonid native to western North America and the Pacific Coast of Asia) and do not necessarily migrate to sea at a specific age or die after spawning. Even though repeat spawning is common, post-spawning survival rates are quite low (10 to 20 percent, California Department of Fish and Game 2001).

Salmonids exhibit two principle life history types. The first is stream-type, in which fish rear in fresh water, usually remaining in the stream where they hatched for a year or more before beginning their

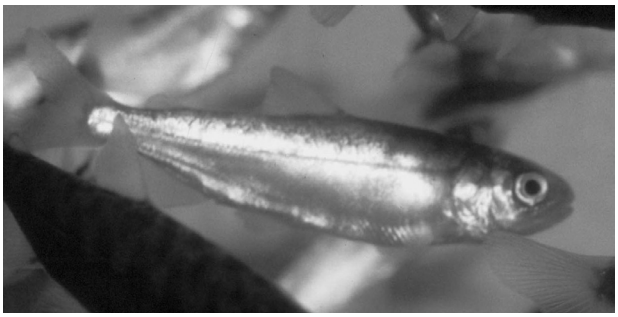
downstream migration to the ocean. Stream-type salmonids include some of the Chinook, sockeye, and coho salmon and steelhead. The second life history type is ocean-type, in which fish migrate downstream to and through the estuary as sub-yearlings (less than one year old), generally leaving the spawning area where they hatched within days to months following their emergence from the gravel. Ocean-type salmonids include Chinook and chum salmon. Ocean-type subyearlings arrive in estuaries at a small size (generally 3 to 7 cm) and can remain in the estuary for weeks to months until they reach the transitional size necessary to migrate to the ocean (U.S. Army Corps of Engineers 2001, California Department of Fish and Game 2001).

Washington. Dungeness NWR and Harbor are important nursery habitats for salmonids. Large numbers of ESA-listed (see section 3.2.3) and unlisted juvenile salmonids transit and are presumed to rear along the shore in this vicinity. Non-ESA-listed salmonids include Puget Sound pink salmon, coho, Puget Sound sockeye, Puget Sound steelhead, cutthroat, and possibly Fraser River (Canadian) sockeye. The nearshore Strait (shorelines stretching from Neah Bay to Admirality Inlet including Port Angeles, Dungeness, Sequim, and Discovery bays, Kilsut, and Port Townsend Harbors) provide a critical feeding, refuge, and migration corridor for many species, including three federally ESA-listed salmonids (see section 3.2.3), as well as sockeye, pink, and chum salmon. Washington coastal waters also include designated Essential Fish Habitat (EFH) for salmonids (see section 1.3.3 for description of EFH).

Oregon. All Columbia River Basin salmonids pass through the Columbia River estuary during their migration out to the sea and back upstream to their natal spawning grounds. The Columbia River estuary is also an important nursery area for some stocks of salmon, in particular, chum and fall Chinook (Fresh et al. 2004). Many of the salmonids found in the river are ESA-listed species (see section 3.2.3). The Columbia River estuary also includes designated EFH for salmonids.

Salmonids do not occur within Summer and Crump lakes. At Fern Ridge Lake, salmonids do not occur within the lake proper, however, they do occur in the Willamette and McKenzie rivers which are greater than six miles from Fern Ridge Lake, within foraging range of terns (if terns were to nest at Fern Ridge Lake). These include spring and fall Chinook and winter and summer steelhead.

California. California coastal waters also include designated EFHs for salmonids. Native salmonids found in San Francisco Bay include Chinook salmon and steelhead, the only non-ESA-listed salmonids is the Central Valley fall and late-fall run Chinook ESU (see section 3.2.3 for description of ESA-listed species). Coho salmon were historically found in the estuary but are now believed to be extirpated (Brown et al. 1994).



Salmon smolt. Photo credit: Bonneville Power Administration

Other Fish. A variety of marine and freshwater fish that are not part of the salmonid family also occur within the affected environment. Abundance and diversity varies greatly among locations.

Washington. Several species of cod and sole rear in the shallow nearshore marine and estuarine habitats of Dungeness Bay. Surf smelt, sand lance, herring, anchovies, and a variety of rockfish are also found in the area. Juvenile surf smelt reside in nearshore waters and may use estuaries for feeding and rearing (Emmett et al. 1991, Lemberg et al. 1997). Surf smelt are a widespread and important member of the nearshore fish community throughout Puget Sound. Although surf smelt movements within Puget Sound are unstudied, a number of genetically distinct stocks are thought to occur. Because no stock assessment studies have been done, the status of Puget Sound surf smelt populations is currently unknown (Lemberg et al. 1997). EFH has been designated for certain groundfish and coastal pelagic species in Washington coastal waters.

Oregon. Other fish that occur in the Columbia River estuary include some anadromous species such as green and white sturgeon, Columbia River smelt, stickleback, shiner perch, and shad. Marine species such as anchovies, Pacific herring, sardines, surf smelt, surf perch, rockfish, and flounder are also present. EFH has been designated for certain groundfish (Pacific Fishery Management Council 1998a and 1998b) and coastal pelagic species in Oregon coastal waters. At Summer, Crump, and Fern Ridge lakes, primary fish species include tui chub, rainbow trout, carp, bass, crappie, bullhead catfish, and suckers.

California. Northern anchovy and Pacific herring are the most abundant fish species in San Francisco Bay. Other fish found in the bay include smelt, flounder, sole, sturgeon, Sacramento splittail, and shad. In addition, the introduced striped bass range throughout San Francisco, San Pablo, and Suisun bays (Herbold et al. 1992).

3.2.3 Federally Endangered and Threatened Fish

A complete list of federally endangered and threatened (ESA-listed) fish that may be affected by the proposed action is located in Appendix H. This is a comprehensive list that was received from the Service and NOAA Fisheries associated with ESA-consultation. However, not all of these species occur in the affected environment. ESA-listed fish that occur in the affected environment are discussed below and can be either anadromous or non-anadromous.

The discussion of anadromous fish species involves species within Evolutionary Significant Units (ESU) or Distinct Population Segments (DPS). An ESU includes "any distinct population segment of any species of vertebrate fish or wildlife that interbreeds when mature" (Waples 1991). This population segment must be reproductively isolated from other nonspecific population units. It also must represent an important component in the evolutionary legacy of the species. All ESU designations used by NOAA Fisheries, including steelhead trout, are associated with salmonids. Although steelhead trout are commonly called trout, they are closely related to other salmon scientifically grouped with them in the *Oncorhynchus* genus. The definition of DPS used by the Service is essentially the same as that for an ESU but is a designation for any distinct vertebrate population segment of a fish or wildlife species. The Service and NOAA Fisheries issued a joint policy describing DPSs in *Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act* (61 CFR 4722).

A description of the species and available historical and most recently published abundance information for ESA-listed salmonids, as well as life history and biological requirements, are summarized in *Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California* (Myers et al. 1998), *Status Review of Coho Salmon from Washington, Idaho, Oregon, and California* (Weitkamp et al. 1995), *Status Review of Chum Salmon from Washington, Oregon, and California* (Johnson et al. 1997), *Status Review Update for Chum Salmon for Hood Canal Summer-Run and Columbia River ESUs* (Grant et al. 1999), and *Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California* (Busby et al. 1996). Table 3.2 lists all threatened and endangered anadromous fish and associated ESUs or DPSs protected under the ESA that occur in the affected environment. Figure 3.5 illustrates known occurrence times for the various salmonids in comparison to the tern nesting season.

Washington. ESA-listed Puget Sound Chinook salmon, Hood Canal summer-run chum salmon, and bull trout occur in Dungeness Bay. The Puget Sound Chinook ESU includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca to the Elwha River. Chinook salmon from the following hatchery stocks are considered part of the ESA-listed ESU: Kendall Creek (spring run); North Fork Stillaguamish River (summer run); White River (spring run); Dungeness River (spring run); and Elwha River (fall run, NOAA Fisheries 2003c). The bay's location at the southeastern end of the Strait of Juan de Fuca indicates that Chinook juveniles that emigrate annually from Puget Sound may travel along the nearshore of Dungeness Spit (M. Longenbaugh pers. comm.).

Ocean-type Chinook salmon predominately occur in coastal regions, including Puget Sound, and use estuaries and coastal areas more extensively for juvenile rearing (Levy and Northcote 1982, Pearce et al. 1982). Juvenile Chinook may be present in nearshore areas from May through mid-September (NOAA Fisheries 2004a, Marlowe et al. 2001) and may reside up to 189 days in estuarine habitats (Wallace and Collins 1997, Levy and Northcote 1982). Overall, the abundance of Chinook salmon in the Puget Sound ESU has declined substantially, and both long and short term abundance trends are predominantly downward (Myers et al. 1998). Increasing harvest, coupled with generally increasing trends in spawning escapement, provides evidence that chum salmon, while still ESA-listed, have been increasing in recent years within the Hood Canal ESU (Johnson et al. 1997). Juvenile chum salmon depend on estuarine and nearshore habitats for rearing, and usually have longer residence times (from days to three months) in estuaries than other anadromous salmonids besides Chinook (Pearce et al. 1982, Johnson et al. 1997).

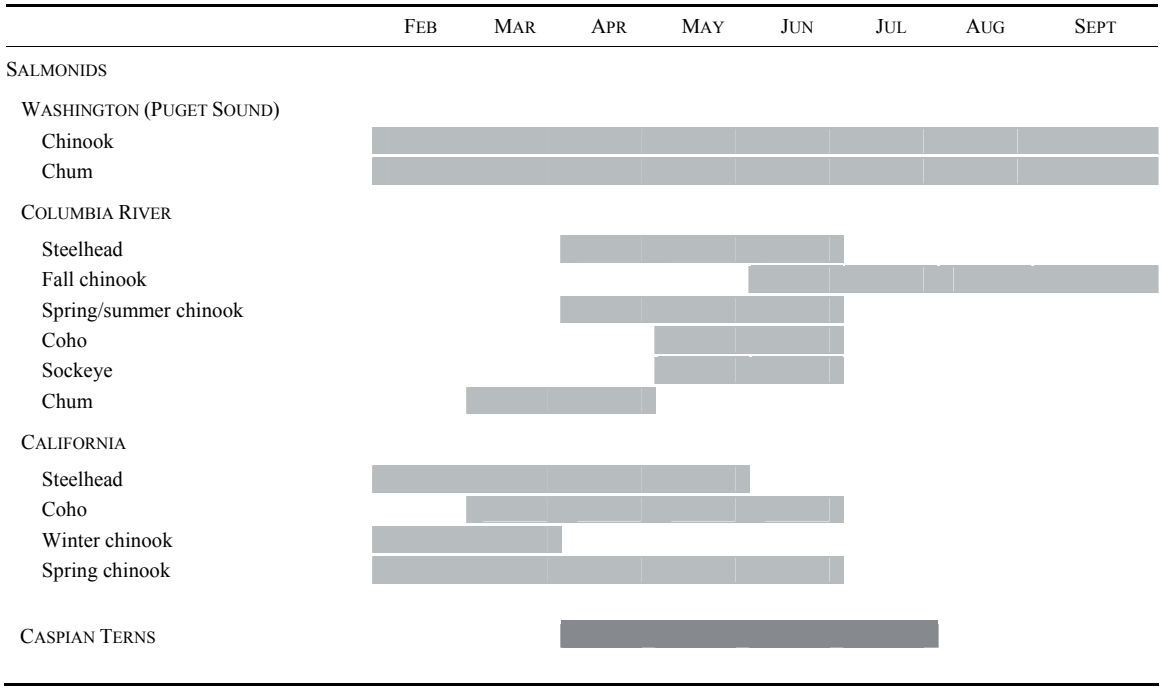
Bull trout are char native to the Pacific Northwest and western Canada. Bull trout within the Coastal/ Puget Sound DPS were listed as threatened under the ESA in 1999. Bull trout generally spawn from August through November in small tributaries and headwater streams. Anadromous bull trout juveniles typically spend 2 to 3 years rearing in tributary streams before migrating to sea.

TABLE 3.2 Federally Listed ESUs/DPSs that Occur in the Affected Environment.[a]

Evolutionarily Significant Unit (ESU) or Distinct Population Segments (DPS)	Status	Life History Type
CHINOOK		
Puget Sound	Threatened	Stream/Ocean
Snake River spring/summer	Threatened	Stream
Snake River fall	Threatened	Ocean
Lower Columbia River	Threatened	Ocean
Upper Columbia River spring	Endangered	Stream
Upper Willamette River	Threatened	Ocean
Sacramento winter-run	Endangered	Stream
Central Valley spring-run	Threatened	Stream
COHO		
Lower Columbia River/Southwest Washington	Candidate	Stream
Central California Coast	Threatened	Stream
Southern Oregon/Northern California Coasts	Threatened	Stream
CHUM		
Hood Canal summer-run	Threatened	Ocean
Columbia River	Threatened	Ocean
SOCKEYE		
Snake River	Endangered	Stream
STEELHEAD TROUT		
Snake River	Threatened	Stream
Lower Columbia River	Threatened	Stream
Middle Columbia River	Threatened	Stream
Upper Columbia River	Endangered	Stream
Upper Willamette River	Threatened	Stream
Central Valley	Threatened	Stream
Central California Coast	Threatened	Stream
BULL TROUT		
Puget Sound	Threatened	Trout
Columbia River	Threatened	Trout

[a] Based on species lists provided by NOAA Fisheries and the U.S. Fish and Wildlife Service associated with ESA-consultation for this FEIS.

FIGURE 3.5 Arrival times of juvenile salmonids and nesting period of Caspian terns in the affected environment.



Oregon. Eight salmonid species runs have population segments that are ESA-listed and/or spend a portion of their lives in the lower Columbia River (Figure 3.5). These species include 20 ESUs from the Columbia River Basin identified by NOAA Fisheries, 12 of which are ESA-listed (Table 3.2). The first outbound migrants of the lower Columbia River fall Chinook and chum (ocean-type) may arrive in the lower Columbia River as early as late February (Herrmann 1970, Craddock et al. 1976, Healey 1980, Congleton et al. 1981, Healey 1982, Dawley et al. 1986, and Levings et al. 1986). The majority of these fish are present from March through June. Outbound Snake River fall Chinook begin their migration much farther upstream. They arrive in the lower Columbia River approximately a month later. As Chinook fry migrate to the estuary, they may remain in the low salinity or even freshwater areas for some time until they have grown somewhat larger (Kjelson et al. 1982, Levings 1982, Levy and Northcote 1982, MacDonald et al. 1986, Shreffler et al. 1992, and Hayman et al. 1996). However, some Chinook fry appear to move immediately to the outer edges and higher salinity portions of the estuary (Stober et al. 1971, Kask and Parker 1972, Sibert 1975, Healey 1980, Johnson et al. 1992, and Beamer et al. 2000).

Stream-type or yearling steelhead and Chinook migrate to the ocean in their second year of life or later as relatively large smolts [generally 10 to 30 cm (4 to 12 inches)] and move through the lower Columbia River and estuary within days to weeks (U.S. Army Corps of Engineers 2001).

Bull trout are relatively dispersed throughout the tributaries of the Columbia River Basin, including its headwaters in Montana and Canada (U.S. Fish and Wildlife Service 2002a). The Columbia River DPS includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin and currently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997). The Columbia River DPS comprises 141 bull trout sub-populations in four geographic areas of the Columbia River Basin. The current distribution of bull trout in the lower Columbia River Basin is less than the historical range (Buchanan et al. 1997).

Incidental catches of bull trout in the Bonneville Pool (Wachtel 2000) indicate that bull trout are using the mainstem reach of the lower Columbia River. Bull trout have been reported from the lower reaches of the Kalama and Lewis rivers (J. Byrne pers. comm.) and Sandy River (Portland General Electric 2000). One bull trout was reportedly caught and released in the Columbia River downstream from Bonneville Dam between the dam and Reed Island in 1994. Another was harvested from the area below Bonneville Dam in 1998 (Wachtel 2000). Three other bull trout have been reported as having been caught in Bonneville Pool during 1998 by anglers participating in the northern pikeminnow Sport-Reward fishery (Wachtel 2000). There have been two reports of bull trout caught by anglers in the White Salmon River downstream from Condit Dam in recent years.

The endangered Oregon chub was formerly distributed throughout the lower elevation backwaters of the Willamette River drainage. Decline of the Oregon chub is attributed to loss of its backwater habitats. Habitat at the remaining population sites typically consists of low- or zero-velocity water flow conditions, depositional substrates, and abundant aquatic or overhanging riparian vegetation. Currently, known populations are restricted to an 18.6 mile stretch of the Middle Fork Willamette River in the vicinity of Dexter and Lookout Point Reservoirs in Lane County (58 FR 53800).

Threatened Warner suckers are endemic to the Warner Valley (Crump Lake). Warner suckers are bottom dwellers and comprise less than five percent of the total fish population in the Warner Valley (C. Allen pers. comm.). There are no ESA-listed fish species in Fern Ridge Lake. However, ESA-listed Upper Willamette River Chinook and Upper Willamette River steelhead occur in the Willamette and McKenzie rivers, approximately 6 miles east of the lake.

California. ESA-listed salmonid ESUs that occur in the San Francisco Bay estuary include the Sacramento River winter-run Chinook; Central Valley spring Chinook; Central Valley steelhead; Central California Coast steelhead; and Central California Coast coho.

Adult Sacramento River winter-run Chinook salmon leave the ocean and migrate through the Sacramento-San Joaquin delta to the upper Sacramento River from December through June. Most juveniles distribute themselves to rear in the Sacramento River through the fall and winter months. Some Sacramento River winter-run Chinook salmon juveniles move downstream to rear in the lower Sacramento River and delta during the late fall and winter and may begin migrating downstream from December through March (Moyle et al. 1989, Vogel and Marine 1991).

Most yearling Central Valley spring-run Chinook salmon move downstream in the first high flows of the winter from November through January

(U.S. Fish and Wildlife Service 1995, California Department of Fish and Game 1998), while some remain throughout the summer and exit the following fall as yearlings. At present, all Central Valley steelhead are considered winter-run steelhead (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento River system prior to the commencement of large-scale dam construction in the 1940s (Interagency Ecological Program Steelhead Project Work Team 1999). Juveniles live in freshwater from one to four years (usually two years in California, Barnhart 1986), then smolt, and migrate to the sea from February through April. However, some steelhead smolts may outmigrate during the fall and early winter months.

Central California Coast steelhead spawn in coastal California streams from the Russian River to Aptos Creek, and drainages of San Pablo and San Francisco Bays. Steelhead in most tributaries of San Francisco and San Pablo Bays have been virtually extirpated. Population numbers of the Central California Coast coho are not well known, but are low. CDFG introduced coho salmon into the Sacramento River in 1956 but populations waned by 1963 (Bettelheim 2002).

The delta smelt, which is endemic to the upper Sacramento-San Joaquin estuary, is federally listed as threatened. Delta smelt inhabit open surface waters where they school. The green sturgeon is a candidate species and is comprised of two DPSs (68 FR 4433). The green sturgeon is anadromous but is the most marine oriented sturgeon species (Adams et al. 2002). Green sturgeon adults and juveniles occur throughout the upper Sacramento River.

3.2.4 Other Birds

Bird species other than terns that could potentially be affected by proposed management alternatives of this FEIS are described below, except for those species listed under the ESA. Descriptions of ESA-listed bird species are located in section 3.2.6 with other ESA-listed wildlife.

Washington. A variety of shorebirds and waterbirds use Dungeness Bay throughout the year. The bay is one of Washington's major wintering and spring staging areas for brant (U.S. Fish and Wildlife Service 1996). One to three pairs of black oystercatchers nest near the site at Dungeness NWR used by terns in 2003. Numerous glaucous-winged gulls and double-crested cormorants also use this area.

Oregon. Two species of cormorants nest on East Sand Island. East Sand Island supports the largest known colony of double-crested cormorants on the Pacific Coast (Roby pers. comm.). These cormorants nest on the western end of the island, separated from the tern nesting site by dense upland shrub habitat. The nesting colony has increased nearly 100-fold since it was first recorded in 1989 (Anderson 2002). In 2003, about 10,600 pairs of cormorants nested on East Sand island (Roby pers. comm.). Brandt's cormorants nest on a pile dike offshore of East Sand Island. A large gull colony is also located on East Sand Island both at the eastern end near the tern colony and at the western end near the cormorant colony site. Nesting gulls consist mostly of glaucous-winged/western gull hybrids but several hundred pairs of ring-billed gulls also nest on the island. Mallards and western Canada geese are probably the most abundant breeding waterfowl on the island. Songbirds also use the vegetated habitat on the upland portion of the island.

Several species of colonial waterbirds and shorebirds use Summer and Crump lakes. These include American avocet, black-necked stilt, willet, common snipe, California gull, ring-billed gull, double-crested cormorant, Forster's tern, and American white pelican. Some of these species may compete for nesting habitat with terns. Gulls are common in Fern Ridge Lake but no nesting occurs since habitat is currently unavailable.

California. Double-crested cormorant, California gull, and Forster's tern are commonly found in San Francisco Bay. These bird species use habitat similar to terns and may nest adjacent to or near tern colonies. The numbers of Forster's terns in the bay have declined significantly between 1984 and 2003 (Strong et al. 2003). Much of this decline is attributed to fluctuating water levels, encroachment by gulls, predation, human disturbance, and contaminants.

3.2.5 Mammals

Washington. Coyote, skunk, river otter, red fox, weasel, and raccoon all occur on Dungeness NWR in low numbers (P. Sanguinetti pers. comm.). All of these species could be potential predators of terns. Up to 600 harbor seals have been observed on Dungeness NWR (U.S. Fish and Wildlife Service 1996). Dungeness Spit is a traditional haul-out and pupping site. In recent years, pupping activity here occurred near the tern nesting site used in 2003.

Oregon. Nutria, vole, mice, and rat are residents on East Sand Island. Occasionally, visitors such as deer can be found on the island. None of these species are predators of terns. Mammals found in the Summer Lake Wildlife Area include coyote, skunk, mink, raccoon, and feral cat (St. Louis 1993). Coyote and raccoons are in the area around Crump Lake but do

not have access to the tern nesting island. Beaver, nutria, raccoon, and muskrat are common species at Fern Ridge Lake. River otter and mink are likely present and could be potential predator species. More terrestrial species such as red fox, coyote, and black-tailed deer are also present at Fern Ridge Lake.

California. Mammals commonly found in San Francisco Bay include river and sea otters, coyote, grey fox, raccoon, skunk, long-tailed weasel, feral cats and dogs, and the red fox. The red fox has been implicated in the population declines of the endangered California clapper rail, Caspian tern, and other colonial nesting species, such as the great blue heron and great egrets (Goals Project 2000). The Service began a Predator Management Program in 1991 which focused on removing red fox and other targeted predators on refuge lands (Goals Project 2000).

3.2.6 Federally Endangered and Threatened Wildlife and Plants

A complete list of federally endangered and threatened (ESA-listed) wildlife and plants that may be affected by the proposed action is located in Appendix H. This is a comprehensive list that was received from the Service associated with ESA-consultation. However, not all of these species occur in the affected environment. ESA-listed species that occur in the affected environment are discussed below.

Washington. The threatened bald eagle also occurs here, with as many as 24 birds seen feeding or roosting on the Refuge at one time. Several nests occur in the area (not directly on Dungeness Spit) and numbers of feeding and roosting birds on the spit increase in the winter and spring months when food availability (e.g., waterfowl, marine mammals) increases (P. Sanguenetti pers. comm.). Small numbers of marbled murrelets also occur in the Dungeness Bay area, while larger numbers are observed in the Strait of Juan de Fuca (K. Flotlin pers. comm.).

Oregon. The endangered California brown pelican typically occurs from late spring to mid-fall along the Oregon Coast. Concentrations of this species form at the mouth of the Columbia River at the South Jetty and at East Sand Island-Baker Bay. This species forages in nearshore waters of the Pacific Ocean and estuarine waters of the Columbia River. Up to 10,800 birds were observed roosting on East Sand Island in 2002, primarily, on the western end of the island (Fischer 2004). In 2003, a peak of 6,700 pelicans was observed on East Sand Island (Fischer 2004). In recent years, nest building behavior by a few pelicans has been observed, however, egg-laying has never been documented. The Columbia River estuary supports a healthy bald eagle population with approximately 46 nesting territories. In Summer Lake, bald eagles occur in large numbers, especially in the spring when 50 to 100 birds may be found using the lake. An active nesting territory is found two miles west of the area (St. Louis 1993). One bald eagle territory is located on Fern Ridge Lake (Issacs and Anthony 2003). Resident, transient, and wintering bald eagles occur at Fern Ridge Lake.

Lands around Fern Ridge Lake support important populations of Bradshaw's lomatium. The Fern Ridge population consists of three distinct sub-populations encompassing nearly 240 acres within remnant wetlands. A small patch of Bradshaw's lomatium was located along Royal Avenue ditch in the early 1990s. Also in the vicinity of Royal Avenue, there are three known Kinkaid's lupine occurrences.

California. Western snowy plovers are present in San Francisco Bay. Salt ponds, their levees, and pond edges, which may mimic historic salt pan habitat, provide almost all known western snowy plover nesting habitat in the bay. Specifically, western snowy plovers have not been observed at Brooks Island or in the Hayward Regional Shoreline freshwater wetlands, but has been observed nesting within the Ponds N1-N9 complex.

The endangered California least tern also nests in the bay. California least terns were first recorded in the San Francisco Bay Area in 1927, in Alameda, where currently, the largest northern California colony breeds (Goals Project 2000). The proposed Alameda NWR is the only known California least tern nesting location in San Francisco Bay. The Bay Area colony is considered a critical population, vital to the Statewide species recovery effort (Goals Project 2000). California least terns also occur in coastal sites in southern California (e.g., Bolsa Chica Ecological Reserve and South San Diego NWR).

The endangered California brown pelican and threatened bald eagle also occur regionally in the bay, but no nesting activity has been documented. The endangered California clapper rail and endangered salt marsh harvest mouse occur in salt marsh habitat near the Hayward Regional Shoreline and Ponds N1-N9 sites.

3.3 Socioeconomic Environment

3.3.1 Commercial and Recreational Fisheries

Because fish are exposed to harvest from commercial and recreational fisheries across large geographic regions of the West Coast, Pacific salmon and steelhead management is governed by numerous regional organizations. The Pacific Salmon Commission (PSC) implements the Pacific Salmon Treaty between Canada and the U.S. to achieve optimum production and divide the harvests so that each country reaps the benefits of its investment in salmon management. The Pacific Fishery Management Council (PFMC), established by the MSA, regulates commercial fisheries off the coasts of California, Oregon, and Washington, including groundfish, shellfish, and salmon.

Coastal ocean fisheries in Washington and Oregon became important in the late 1950s as more restrictions were imposed on freshwater and coastal estuary fisheries. Ocean harvest of salmonids peaked in the 1970s and 1980s. In recent years, commercial and recreational ocean harvest of salmonids have generally been reduced as a result of international treaties, fisheries conservation acts, regional conservation goals, and State and Tribal management agreements.

Washington. Commercial fisheries that occur in Dungeness Bay include Dungeness crab, clams (including geoduck), octopus, coho and steelhead trout. In addition, a number of marine species for which EFH is designated are likely to spend part of their life history in the vicinity of Dungeness Bay. Recreational fishing and crabbing are also intensive uses in Dungeness Bay. In 1997, the Washington State Department of Health reported increasing levels of fecal coliform bacteria in Dungeness Bay. Since then, bacteria levels have continued to increase. As a result of this, 300 acres near the mouth of the Dungeness River has been closed to shellfish harvest. There are increasing concerns that marine sources, including wildlife, are contributing to this decrease in water quality.

At least 18 Pacific herring stocks, defined by spawning grounds, occur inside Puget Sound (Lemberg et al. 1997). Currently, there are two commercial herring fisheries in Washington; the principal one is in south-central Puget Sound and has an annual average catch (1992 to 1996) of 510 tons (Lemberg et al. 1997). Currently, Puget Sound herring are fished at a conservative level (Puget Sound Water Quality Action Team 2002). Although Puget Sound herring stocks have declined over the past 20 years, NOAA Fisheries decided they did not warrant listing under the ESA in 2001. It is probable that Pacific herring of all ages pass through nearshore habitats, including Dungeness Bay, especially as juveniles rearing in the summer months and as adults migrating to holding areas near natal spawning grounds.

Oregon. Before 1975, lower Columbia River recreational fisheries focused primarily on salmonid and steelhead harvest. Season closures to protect declining salmonids transitioned much of the recreational fisheries to sturgeon. Salmonid fishing efforts have rebounded with recent improvements in fish returns and selective fishery opportunities. Recreational fisheries for salmonids, white sturgeon, and steelhead can be quite extensive in the Columbia River estuary depending on stock populations and associated regulations. Recreational crabbing is also pursued extensively in the lower estuary. The lower Columbia River mainstem below Bonneville Dam is separated into two main areas for recreational harvest management: Buoy 10 (ocean/in-river boundary) to the Astoria-Megler Bridge, and the Astoria-Megler Bridge to Bonneville Dam. Columbia River tributary recreational fisheries occur throughout the lower Columbia. Depending on the time of year, different salmonids are targeted, including spring Chinook, summer steelhead, fall Chinook, coho, and winter steelhead.

Columbia River commercial fisheries became important in the 1860s. Since the early 1940s, Columbia River commercial catches of salmon and steelhead have steadily declined, reflecting changes in fisheries in response to declines in salmonid abundance. Lower Columbia River non-Indian commercial fisheries occur below Bonneville Dam in the mainstem or in select off-channel fishing areas. The Columbia River above Bonneville Dam to McNary Dam (Zone 6) was open to non-Indian commercial fishing until 1956. Commercial fishing for salmonids (gillnet and tanglenet) occurs in the estuary and lower Columbia River although it is heavily restricted in time and space. Groundfisheries and trolling occur offshore. Commercial crabbing occurs to a limited extent in the estuary with the primary focus occurring offshore.

Washington and Oregon establish season dates and gear restrictions for mainstem commercial fisheries according to the Columbia River Compact (organization charged by congressional and statutory authority to adopt seasons and rules for Columbia River commercial fisheries). Columbia River fisheries are also regulated according to the Columbia River Fish Management Plan adopted by

the U.S. District Court order in 1988 and agreed to by the parties of U.S. v. Oregon: the United States; the States of Oregon, Washington, and Idaho; and the four treaty Indian Tribes (the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakama Nation, and the Nez Perce Tribe). Finally, because of the ESA status of many Columbia River salmonids, harvest managers must consult annually with NOAA Fisheries to ensure fishers are regulated to meet no-jeopardy standards established for ESA-listed salmonids.

There are no commercial fisheries at Crump and Summer lakes. Recreational fishing occurs primarily along the upper four miles of the Ana River but no fishing occurs within the Summer Lake Wildlife Area. Largemouth bass, white and black crappie, and brown bullhead primarily make up the recreational fisheries at Crump Lake. The fisheries are highly dependent upon water levels and crappie fishing is the primary fishery (C. Edwards pers. comm.). No commercial fishery occurs at Fern Ridge Lake. Recreational fishing for introduced warmwater species is a common recreational pursuit at Fern Ridge Lake and on the Long Tom River. The Willamette and Mackenzie rivers, approximately 6 miles east of Fern Ridge Lake, support recreational fisheries for salmon, steelhead, and trout, plus some warmwater fish species.

California. In San Francisco Bay, special status fisheries of the San Francisco Bay estuary include anadromous and resident species, crab, and shrimp. All portions of the bay/delta support commercially and/or recreationally important fisheries. Important sportfish that forage and/or rear young in intertidal mudflat and rocky shore habitats include native species such as Chinook salmon, white sturgeon, diamond turbot, and a variety of sharks in addition to the introduced striped bass. Pacific herring support a large fishery in the estuary as bait and human food, but more importantly as the roe and roe-on-kelp fishery for export to Japan. The roe fishery is closely regulated by CDFG (California Department of Fish and Game 2001). Depressed herring populations were observed in San Francisco resulting from the 1977/1978 El Nino event (California Department of Fish and Game 2001), although recently they appear to be recovering (E. Larsen pers. comm.).

Anchovies support a commercial bait fishery. As juveniles in the near shore areas, anchovies are vulnerable to a variety of predators, including birds and some recreationally and commercially important species of fish. Total anchovy harvests and exploitation rates since 1983 have been below the theoretical levels for maximum sustained yield, and stock biomass estimates are unavailable for recent years. Based on abundance index data, the stock is thought to be stable at a modest biomass level (California Department of Fish and Game 2001). Introduced species that have commercial and recreational value in the estuary include American shad and striped bass. American shad supported a large commercial fishery soon after its introduction. Commercial fishing was later banned in 1957 due to declining populations. Today a sport fishery exists in the estuary. Despite a ban on commercial fishing of the striped bass, its population continues to decline. The white sturgeon is also an important fishery resource. White sturgeon are particularly vulnerable to the effects of over-harvesting because they mature slowly. Commercial fishing of sturgeon dates back to the mid-1800s, but declined by the early 1900s. In 1954, the Fish and Game Commission abolished the commercial fishery and established a sport fishery that continues today. Populations have continued to decline in recent years. The major factor affecting sturgeon populations is believed to be decreased river outflow into the bay (California Department of Fish and Game 2001). Adult English sole and starry flounder support a small commercial ocean fishery. While English sole shows no signs of decline, the starry flounder has declined specifically in San Pablo and Suisun bays. The starry flounder appears to be more sensitive to hydrologic and environmental changes (San Francisco Estuary Project 1992). Dungeness crab has provided a valuable commercial fishery for San Francisco for over a century.

3.4 Tribal Fisheries

Washington. Jamestown S'Klallam, Lower Elwah Klallam, and Port Gamble Klallam have Tribal treaty rights for fisheries associated with the Point No Point Treaty. Dungeness Bay is the main fishing area for the Jamestown S'Klallam Tribe. The Tribe operates a commercial fishery for coho (of hatchery origin), primarily from September through October (S. Chitwood pers. comm.). The Jamestown S'Klallam Tribe also operates a small commercial net fishery for steelhead (December to February), commercial oyster operation (in the bay), commercial and recreational crab fishery (in the bay), and a commercial geoduck harvest (outside the bay, S. Chitwood pers. comm.).

Oregon. Tribal (treaty) fisheries on the Columbia River occur upstream of Bonneville Dam. Treaty Indian harvest includes commercial, ceremonial,

and subsistence (C&S) fisheries. The four Columbia River treaty Indian Tribes include the Bands of the Yakama Nation, Confederated Tribes of the Warm Springs Reservation of Oregon, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe. Treaty Indian commercial catches became a larger portion of the total Columbia River commercial catches following the 1968 Federal court ruling regarding equitable Indian and non-Indian harvest sharing. Since 1968, commercial fishing in the area between Bonneville and McNary dams (Zone 6) has been the exclusive province of the Treaty Indian Tribes. No Tribal fisheries occur at Summer, Crump, and Fern Ridge Lakes.

California. No Tribal fisheries occur in San Francisco Bay.

3.5 Cultural Resources

Washington. The New Dungeness Lighthouse on Dungeness NWR is located approximately 0.5 mile from the tern colony. The lighthouse was established in 1857 and was placed on the National Register of Historic Places in 1993. The concrete foundations and rubble remains of a small WWII naval station is on Graveyard Spit about three-quarters of a mile southwest of the colony.

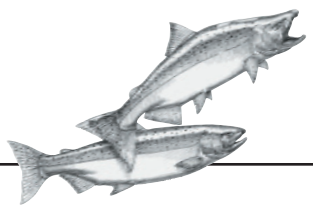
The S'Klallam Indian Tribe inhabited the Dungeness area when the first European settlers arrived. Their use of Dungeness and Graveyard spits probably included temporary camping and food gathering. The Tribe lived on Dungeness Spit from 1872 to 1873 after being asked to move off land which had been homesteaded in the Dungeness community. Dungeness and Graveyard spits are known S'Klallam burial grounds. In 1980, a burial canoe was collected from Graveyard Spit by the Service.

Oregon. The Columbia River has a rich history of cultural resources associated with Native Americans and European exploration and settlement. Shipwrecks are particularly abundant in the area. East Sand Island was formerly a part of a mid-estuary shoal that migrated north and west to its present location apparently due to various navigation improvements. Cultural resources on the island are primarily associated with the early commercial fishing industry and military blockade of the mouth of the Columbia River during the World Wars.

Cultural resources associated with Native Americans are abundant in southeastern Oregon. Artifacts are especially prevalent around waterbodies such as Summer and Crump lakes. Human occupation at these locations goes back at least 11,500 years. Sites found in both areas range from large village sites located on the shores of each lake to small camp sites in the adjacent uplands or on playas. Depending upon water levels, sites may be inundated on both lakes, may appear as islands within the lakes or may be located high above the present shoreline. Crump Island in Crump Lake is a natural island and contains Native American artifacts. Native Americans with interests in Summer and Crump lakes include the Fort Bidwell Tribe, the Burns Paiute Tribe, Paiutes from the Confederated Tribes of Warm Springs, and the Yahuskin Band of the Klamath-Modoc Tribe.

Fern Ridge Lake has high value as an archaeological and historical resource. Native Americans used the area heavily. The Indian bands that ceded this area are documented under a treaty by the Confederated Bands of the Willamette Valley, January 22, 1855. Their descendants are included in the modern Confederated Tribes of Grand Ronde. A travel route for early settlers passed through the now inundated portions of Fern Ridge Lake, including the historic Applegate Trail (U.S. Army Corps of Engineers 1988). Native Americans were also a substantial presence in the Long Tom River channel, Coyote Creek, and areas adjacent to Orchard Point Park, which represent major archaeological areas. A Cultural Resources Management Plan has been prepared for known cultural resource sites at Fern Ridge Lake.

California. There are no cultural resources located in the areas proposed for management actions in San Francisco Bays with the exception of Brooks Island. Brooks Island was home to local natives for two or three thousand years. The Ohlone Indians originally settled the island. Their shell mounds and burial sites, up to 2,500 years old, are an archaeological treasure being preserved and protected on Brooks Island.



Chapter 4

Environmental Consequences

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Chapter 4. Environmental Consequences

This chapter identifies the effects of the four alternatives (summarized in Table 4.1, below) described in Chapter 2 on the affected environment (Chapter 3). The effects of each alternative on the affected environment are described in the same order as presented in Chapter 3.

4.1 Effects to Physical Environment

4.1.1 Alternative A

Washington. No habitat modification would occur at Dungeness NWR or other sites in Washington under this alternative. Thus, no effects to the physical environment in Washington are expected and existing nesting sites in the State would remain available to terns, when environmental conditions allow.

Oregon. Current habitat management practices (see section 2.3.1), to maintain 6 acres of nesting habitat on East Sand Island, would remain in place. Thus, no change to the current physical environment is expected. However, we expect limited effects to the physical environment at the upper estuary islands (Miller Sands Spit, Rice and Pillar Rock islands) that would result from proposed management actions under Alternative A and all other remaining alternatives. These actions may entail development of vegetative cover to preclude tern nesting. Hazing (e.g., personnel/dogs disturbing birds) and/or egg take operations on upper estuary islands would not affect the physical environment.

No habitat modification would occur at Summer, Crump, and Fern Ridge lakes under Alternative A. Thus, no effects to the physical environment at these locations are expected. Existing habitat at Summer and Crump lakes would continue to be available to terns in years with appropriate environmental conditions (e.g., adequate water levels).

California. No habitat modification would occur in California under Alternative A. Thus, no effects to the physical environment are expected and existing nesting sites would remain available to terns.

Region. Under this alternative, we do not expect effects to the physical environment within the region. Existing habitat management actions would continue on East Sand Island and current nesting sites (Table F.1 and F.2) throughout the region would most likely continue to be available to nesting terns on a regional scale, when environmental conditions allow.

4.1.2 Alternative B

Washington. Similar to Alternative A, no habitat modifications are proposed in this alternative. Thus, we expect no effects to the physical environment at Dungeness NWR or other sites in Washington. Existing nesting sites in the State would most likely remain available to terns.

Oregon. Current habitat management practices (see section 2.3.1) for maintenance of tern nesting habitat on East Sand Island would be discontinued with implementation of Alternative B, resulting in a substantial change in the physical environment of the tern nesting area. Based upon current annual maintenance requirements, we expect natural revegetation of the site used by nesting terns to occur in a 2 to 3 year timeframe. European beachgrass, American dunegrass, and various

TABLE 4.1 Summary of Alternatives

Alternative	Habitat Management Program on East Sand Island (ESI)	Redistribution of ESI Tern Colony	Lethal Control of ESI Tern Colony
A	Annually maintain 6 acres of open sand habitat	No	No
B	No preparation of nesting habitat	Yes; indirectly in response to loss of habitat on ESI	No
C	Reduce nesting habitat on ESI to approximately 1 - 1.5 acres	Yes; actively develop and attract birds to potential nesting sites throughout region	No
D	Same as Alternative C	Same as Alternative C	Yes, if necessary, beginning in 2008

forbs would achieve sufficient coverage and density to preclude nesting by terns within 3 years after implementation of this alternative.

Similar to Alternative A, actions (e.g., development of vegetative cover and hazing) to preclude Caspian terns nesting at upper estuary islands (Miller Sands Spit, Rice and Pillar Rock islands) would continue. However, we expect that hazing operations would be substantially more intense and prolonged (e.g., frequent disturbance to birds with personnel and/or dogs from April 1 through June 15 or longer) under this alternative because the entire tern colony would be displaced from East Sand Island. No habitat modification would occur at Crump, Summer, and Fern Ridge lakes under this alternative, thus, no effects to the physical environment are expected.

California. Similar to Alternative A, no effects to the physical environment are expected because habitat modification actions are not proposed in California under this alternative. Existing nesting sites in the State would most likely remain available to terns.

Region. Effects to the physical environment include the loss of tern nesting habitat on East Sand Island, an important nesting site in the region. Current nesting sites (Table F.1 and F.2) throughout the region outside the Columbia River estuary would continue to provide nesting habitat for terns on a regional scale, when environmental conditions allow.

4.1.3 Alternative C

Washington. Similar to Alternatives A and B, habitat modification actions at sites in Washington are not proposed in this alternative. Thus, we expect no effects to the physical environment at Dungeness NWR or other sites in Washington. Existing nesting sites in the State would most likely remain available to terns, when environmental conditions allow.

Oregon. Under this alternative, effects to the physical environment on East Sand Island would occur in association with the reduction in size of the tern nesting area. Current habitat management practices (see section 2.3.1) would be reduced to provide approximately 1 to 1.5 acres of tern nesting habitat. The timeframe for this to occur would be dependent on the creation of tern nesting habitat at alternate sites in the region (projected to occur within 3 to 5 years after implementation of this alternative). Natural revegetation of the current nesting area would be allowed to attain the reduced nesting area. Effects to upper estuary islands (Miller Sands Spit, Rice and Pillar Rock islands) would be similar to that described in Alternatives A and B. However, similar to Alternative B, we expect that hazing operations would be intensified and prolonged to prevent new colonies from forming in the upper estuary as the tern nesting area on East Sand Island is reduced and more terns seek nesting habitat elsewhere.

Nesting islands would be created at the Summer Lake Wildlife Management Area in wetland impoundments (three, one-half acre islands) and Crump Lake (1 acre island). See Appendix G for a full description of island construction.

At Summer Lake, island construction may occur in the dry, in water, or in both conditions depending upon whether an impoundment is flooded or dry and how many islands are constructed during one season. Construction under dry conditions is not expected to impact frequency, magnitude or duration of sedimentation and siltation at these locations. Construction in water would result in temporary increases in sedimentation and siltation behind the Gold/Windbreak Dikes or at the East Link impoundment. Water movement through these shallow impoundments is either slow or nonexistent depending on inflow and control structure operations. Short-term siltation and sedimentation is expected to occur within the impoundments and to be minor in magnitude. Frequency and duration are limited to the construction period, as armored shorelines would protect the islands from wave-induced erosion after construction. A Section 404 (b)(1) evaluation would be prepared and water quality certification obtained from the Oregon Department of Environmental Quality prior to island construction.

At Crump Lake, the existing island (Crump Island) is approximately 1.25 miles offshore and is situated in water 2 to 10 feet in depth. This alternative proposes to build-up the island to a 1-acre size. A "mudcat" hydraulic dredge would be used to place material to build up the island. To hold material pumped to the location, we propose to construct a revetted rock berm, artificial retaining wall, or comparable feature for the island perimeter prior to emplacement of the bulk of the material to build up the island. A settling pond to lessen siltation and sedimentation is also proposed. Dredged material would be pumped to the point furthest from the settling pond location and then moved closer as

material accumulates. A short-term increase in sedimentation or siltation would occur in the lake as a result of the construction activities. These effects, however, are expected to subside once construction activities are completed. A Section 404 (b)(1) evaluation would be prepared and water quality certification obtained from the Oregon Department of Environmental Quality prior to island construction. Construction of the islands at both Summer and Crump lakes is expected to have a negligible effect on the water storage capacity at both sites given the small size of the proposed islands relative to the impoundment or lake area.

On Fern Ridge Lake, a 1-acre island near the intersection of Royal Avenue and Gibson Island Road within the pool, would be constructed under Alternative C. See Appendix G for a full description of construction of the island. Construction would occur in the fall when the lake bottom in this portion of the lake is exposed due to drawdown for winter flood control storage. This allows for habitat development under dry conditions. Construction access would be on the portions of a former road (Royal Avenue and Gibson Island) within the boundaries of Fern Ridge Lake. Primary borrow material for the island would come from the dry lakebed; rock and filter fabric would be used to prevent perimeter erosion of the island when the lake is full. Fern Ridge Lake is on Oregon's Water Quality Limited Streams – 303(d) List for turbidity and Water Contact Recreation (Fecal Coliform) – Fall through Spring. A Section 404 (b)(1) evaluation would be prepared and water quality certification obtained from the Oregon Department of Environmental Quality prior to island construction. Flood control is one of the primary purposes for Fern Ridge Lake. The proposed island would reduce flood control storage by approximately 3 to 5 acre-feet. Fern Ridge Lake provides approximately 110,000 acre-feet of flood control storage. Similar to Summer and Crump lakes, a short-term increase in sedimentation or siltation would occur around the construction area within the lake as a result of the construction activities. These effects, however, would subside once construction activities are completed. We expect no increase in the frequency, magnitude, and duration of sedimentation or siltation over baseline levels, post-construction.

California. Under this alternative, management actions that would affect the physical environment are proposed at three locations in San Francisco Bay under Alternative C: Brooks Island, Hayward Regional Shoreline, and Ponds N1-N9. Brooks Island and Hayward Regional Shoreline are managed by East Bay Regional Parks. Habitat management efforts at Brooks Island would focus on hand or mechanical removal of non-native plants and other vegetation from 1 to 2 acres on the island at or adjacent to the location currently used by nesting terns. Removal of vegetation would cause minimal disturbance to the area and is not expected to affect the soils and substrate of the nesting area. Vegetation removal may be required annually to maintain the tern nesting area. In addition, efforts would be made to evaluate erosion of the spit and long-term protection options. Shoreline protection and potentially placement of additional soil may be required to develop 1 to 2 acres of suitable tern nesting habitat on Brooks Island. Further coordination with East Bay Regional Parks and site inspection would occur during the development of implementation plans and specifications for this site. Additional State and Federal environmental clearances would be obtained as necessary upon determination that additional construction measures are required at this location.

Hayward Regional Shoreline contains numerous islands in former salt ponds. Management actions at this site would focus on Islands 2, 6, and 7 and include removing existing vegetation, installing a weed barrier fabric, saturating the site with salt to prevent revegetation, improving the substrate with sand or oyster shells, and use of social facilitation to attract terns. A small amount of siltation may occur during the vegetation removal process, but would subside immediately following completion of the project. Ponds N1–N9 are located within the Don Edwards San Francisco Bay NWR. Management actions proposed at these sites include the utilization of social facilitation and improvement of nesting substrate (e.g., deposition of sand or gravel material). The dike surface may also require some leveling or flattening to make the site suitable for nesting terns. All material for both sites would be imported via a shallow draft craft or helicopter transport and no material would be dredged or placed in water. Thus, negligible effects to the physical environment at these two locations are expected. All three sites may include predator management, if necessary, consistent with programs currently occurring in the Bay at these locations.

Region. Under this alternative, we expect negligible effects to the physical environment at the sites described above. Proposed habitat management

actions would add to current nesting sites (Table F.1 and F.2) to ensure a network of suitable habitat is available for terns throughout the region.

4.1.4 Alternative D

Since proposed management actions that could affect the physical environment in Washington, Oregon, and California are the same as Alternative C, expected effects at specific sites and within the region would be similar to that described above in Alternative C.

4.2 Effects to Biological Environment

4.2.1 Effects to Caspian Terns

4.2.1.1 Alternative A

Washington. Under this No Action alternative, available nesting sites and the number of terns nesting in Washington are not expected to substantially change. The newly established nesting site on Dungeness NWR may grow slightly in subsequent years as birds are able to nest successfully and through immigration. However, although nesting substrate is not limiting at this site, we do not expect this colony to grow substantially because of potentially limiting factors, such as predators. Mammalian predators (e.g., fox, coyote, mink) have access to the tern colony site on Dungeness NWR and may reduce or preclude successful nesting in some years. Other predators may include eagles or a small colony of gulls which nest nearby.

Additionally, food resources at Dungeness NWR are most likely not as concentrated during the tern nesting season as those in the Columbia River estuary. Thus, we do not expect this site to support a substantially large number of terns such as the colony in the Columbia River estuary. The barging and release of large numbers of hatchery reared juvenile salmonids (as in the Columbia River estuary) resulting in a concentration of prey coinciding with the tern breeding season does not occur in the Dungeness River and Bay. The East Sand Island tern colony in the Columbia River estuary is atypical of all other colonies observed in the region and is unlikely to occur elsewhere because of the unique conditions described in Chapter 3, section 3.2.1 (also see Table F.2 for a comparison of average colony sizes in the region). Historically, the colony sizes of terns nesting on the Washington coast ranged from 100 to 3,500 nesting pairs (Shuford and Craig 2002). However, we expect the tern colony at Dungeness NWR to be close to the lower end of that range because predators (e.g., coyote) or prey availability may likely limit the growth of this colony.

Terns would most likely continue to nest in the Columbia River estuary since nesting habitat and abundant food resources are predictable and available every year. If nesting habitat in the estuary becomes fully occupied (projected in 2009, see Table 4.2 and discussion below), the likelihood of terns immigrating into Washington could increase. Sites in coastal Washington may be limited by lack of suitable habitat, as documented in the feasibility assessment (Seto et al. 2003), and evidenced by the use of atypical nesting sites (e.g., soil waste piles, barges, warehouse rooftops) in recent years. Terns may instead attempt to nest in eastern Washington (e.g., Potholes Reservoir, Sprague Lake, etc.). Although terns from some of these sites are believed to consume juvenile salmonids from the Columbia River (Glabek et al. 2003), most of these sites are limited by size of available nesting area (e.g., Crescent Island), disturbances to the colony (e.g. human access to the nesting islands in Potholes Reservoir, fluctuating water levels, etc.), or prey availability (e.g. at Sprague Lake, Seto et al. 2003). Thus, we do not expect the size of these colonies to increase substantially, which limits potential increases in consumption of Columbia River juvenile salmonids. However, if nesting tern numbers do increase substantially at these sites, Federal, Tribal, and State partners, including appropriate land owners and managers, may initiate discussions as part of an adaptive management approach proposed in this FEIS to ensure that impacts to Columbia River salmonids are minimized.

Oregon. Under this alternative, available nesting sites in Oregon are not expected to change. Although the tern colony in the Columbia River estuary has remained relatively stable in recent years (Figure 3.4), we expect the Caspian tern colony on East Sand Island to grow in size because of the expected recruitment from the high number of fledglings produced from 2001 to 2003 (since terns have been observed to have a high natal site fidelity). We used a simple deterministic model developed by D. Roby (pers. comm.) to calculate projected tern colony sizes on East Sand Island from 2004 to 2009 (Table 4.2 and inset box). This model was based on data collected from 1997 through 2003 and other currently available data on tern breeding biology

TABLE 4.2 Actual and Projected Caspian tern colony size in the Columbia River estuary, 1997 to 2009.

Year	Island	Estimated No. of Terns[a] (breeding pairs)	Projected No. of Terns (breeding pairs)
1997	Rice Island	7,134	-
1998	Rice Island	8,766	-
1999	Rice and East Sand Islands	8,875	-
2000	East Sand Island	9,101	-
2001	East Sand Island	8,982	-
2002	East Sand Island	9,933	-
2003	East Sand Island	8,325	-
2004	East Sand Island	9,500	-
2005	East Sand Island	-	~12,000
2006	East Sand Island	-	~14,000
2007	East Sand Island	-	~15,000
2008	East Sand Island	-	~16,500
2009	East Sand Island	-	~18,500

[a] Colony counts based on data from the Columbia River Avian Predation Project (Roby et al. 2002, Collis et al. 2001, Roby et al. 2003b, Collis et al. 2003b, K. Collis pers. comm.).

(Cuthbert and Wires 1999, Suryan et al. 2004). Projections from this model may change based on changes in available data, violations of assumptions, or changes in conditions in the estuary. For example, in 2003, the model projected that approximately 10,500 breeding pairs would nest on East Sand Island. Instead, only approximately 8,300 pairs actually nested on the island. Clearly, one of the assumptions in the model did not apply over the last year. One or more of the original input values of the model appear to no longer be valid. For example, preliminary band returns indicate that the age of first breeding in the Pacific Coast region is not 4 years, as observed in the Great Lakes region, but possibly older (D. Roby pers. comm.). Nonetheless, this model can be used to project a reasonable population trend (rather than an accurate estimate of tern numbers) for the East Sand Island colony, which is a projected increase. If all of the assumptions in the model are met, the colony on East Sand Island would increase to fully occupy the available nesting area (6 acres) on the island by 2009 (based on the highest nesting density that has been observed in the estuary, 0.78 pair/sq. m., Roby et al. 2002). This breeding concentration would leave a larger number of terns (and percentage of the regional population) more vulnerable to stochastic events (e.g., storms, human disturbance, oil spills, predation, and disease) as compared to similar populations dispersed among many smaller colonies (Roby et al. 2002, Shuford and Craig 2002).

If the colony increases as projected are realized, terns would need to look for habitat elsewhere in the estuary (e.g., Rice Island, Miller Sands Spit,

Simple Deterministic Population Model for Caspian Terns (D. Roby pers. comm.):

Model Assumptions:

- All Caspian terns nesting in the Columbia River estuary nest on East Sand Island
- 6 acres of usable nesting habitat are available for terns each year on East Sand Island
- Each tern nesting pair raises 1.0 young per year (the average productivity observed on East Sand Island in the last 5 years)
- Annual adult survival is 0.91, based on band recoveries during 1981 to 2000 (Suryan et al. 2004)
- Survival of fledglings to average age of first reproduction (4 years) is 0.59, based on band recoveries during 1981 to 2000 (Suryan et al. 2004)
- Emigration of terns raised on East Sand Island to other locations is balanced by immigration to East Sand Island (nesting site philopatry subsequently is 100%)
- Frequency of severe storm events during the breeding season remains comparable to the 1999 - 2003 period (as it affects tern production on East Sand Island)

The resulting formula used in the model is:

Projected number of terns =

0.91(prior year breeding bird estimate) + 0.59 (number of chicks fledged 4 years prior)

or Pillar Rock Island) or the Pacific Coast region. Aggressive hazing early in the nesting season would be implemented to prevent terns from nesting on other islands in the estuary (as it would in all alternatives). These islands would be monitored regularly to detect nesting behavior as it is initiated. If the hazing is unsuccessful in preventing nesting, egg removal would be initiated immediately. Since egg removal would be conducted with the earliest nesting attempts, we expect a relatively small number of eggs would be collected, thus, effects to the breeding birds and regional tern population trend would be minimal. In addition, since egg removal would be conducted early in the breeding season, nesting terns would have the opportunity to renest at other sites.

Although this alternative proposes to maintain nesting habitat for terns on East Sand Island, terns may not choose to nest there every year. Fidelity of terns to breeding sites in successive years varies in response to factors such as habitat stability, predator disturbance, and prey availability. Thus, even though nesting habitat may be available in the estuary, other factors (e.g., prey abundance based on ocean conditions and availability of nesting habitat elsewhere) may affect whether and to what extent terns nest in the estuary.

Existing colonies at Summer and Crump lakes would most likely not be substantially affected under this alternative because terns would still be attracted to nest in the Columbia River estuary. Even if nesting habitat in the estuary is saturated by the growing tern colony, these sites are limited in nesting habitat, and thus, would not be able to accommodate large numbers of terns. Thus, we expect nesting tern numbers at Summer and Crump lakes to continue to change every year depending on fluctuating water levels, exposure of nesting islands, and available prey. Nesting habitat does not currently exist at Fern Ridge Lake and we do not expect terns to nest in this area under this alternative.

California. As in Washington, available nesting sites and the number of Caspian terns nesting in California are not expected to change substantially under this alternative. The relatively stable overall population trend that has been observed in the last 30 years would most likely continue, with shifts in the number and location of breeding sites, characteristic of tern breeding ecology. Existing colonies are expected to continue fluctuating in numbers from year to year. Establishment of new nesting sites may occur if current sites are lost or others become available. The likelihood of terns immigrating into California from the Columbia River estuary could increase as nesting habitat on East Sand Island becomes saturated. Colony sizes are expected to be similar to that observed historically on the coast (22 to 2,100 breeding pairs) or in the interior (4 to 500 breeding pairs, Table F.2).

Region. *Regional Population.* Under this alternative, the overall Pacific Coast regional tern population is expected to maintain its' current trend (increasing since the early 1980s) until nesting habitat is fully occupied on East Sand Island. Since the regional population is primarily influenced by the growth of the colony in the Columbia River estuary, we expect the regional population trend to stabilize once the East Sand Island colony growth stabilizes. Specific colony locations and sizes throughout the region are anticipated to change from year to year, typical for this species.

Regional habitat. Current nesting sites (Table F.1 and F.2) throughout the region would most likely continue to provide a suite of locations for terns on a regional scale. Many of these sites vary in suitability every year based on fluctuating water levels, exposure of nesting islands, prey resources, and predators, contributing to the changes in colony locations and sizes throughout the region. Terns are well adapted to responding to these changes both within and between years. An exception to these conditions is East Sand Island, because 6 acres of nesting habitat would be maintained annually and prey resources are expected to remain abundant in the Columbia River.

4.2.1.2 Alternative B

Washington. Under this alternative, the potential for new colonies to become established or the growth of existing colonies in Washington is expected to be high after tern nesting habitat is lost on East Sand Island (due to vegetation encroachment on the nest site). At that time, terns would need to seek nesting habitat outside the Columbia River estuary. It is difficult to accurately predict where displaced terns will nest, but some redistribution is anticipated in Washington. Existing colonies on Dungeness NWR and in eastern Washington

could grow in size. However, as described in Alternative A, we do not expect these colonies to increase substantially in numbers, limiting potential increases in consumption of juvenile salmonids. If nesting tern numbers increase substantially at the eastern Washington sites, Federal, Tribal, and State partners may initiate discussions to ensure that impacts to Columbia River salmonids are minimized.

Terns would probably continue to try to colonize new areas (including urban areas such as rooftops or airports) along the Washington Coast and Puget Sound as seen in previous years (e.g., Commencement and Padilla bays, and Dungeness NWR). However, as described in Alternative A, establishment of new and growth of existing colonies are expected to be limited. If new colonies are established (on their own accord), we expect individual colony sizes could range from 100 to 3,500 nesting pairs, based on historic colony sizes observed on the Washington Coast.

Oregon. With no management of nesting habitat on East Sand Island, the tern nesting area would become vegetated within 3 years, making the site unusable for nesting terns. Terns would need to look for nesting habitat elsewhere in the region or estuary. This would increase the possibility that terns would attempt to return to nest on Rice Island or other islands in the upper estuary. However, similar to Alternative A and all other alternatives, active measures would be implemented to prevent tern nesting on these islands. Effects in the estuary would be similar to that described in Alternative A, except that the potential take of eggs could be higher since the entire East Sand Island tern colony would be displaced and probably attempt to nest on upper estuary islands.

The number of terns nesting in Oregon are expected to decrease substantially once the colony on East Sand Island is lost. Remaining habitat in Oregon is limited and restricted to sites in interior Oregon (e.g., Summer, Malheur, and Crump lakes) which are heavily dependent on annual water levels. As described in Alternative A, we do not expect the number of nesting terns at Crump and Summer lakes to increase substantially because of limited nesting habitat and prey resources. No nesting habitat is currently available at Fern Ridge Lake, thus tern nesting is not expected at this location.

California. As in Washington, existing tern colonies in California may see an influx of displaced terns from the Columbia River estuary, resulting in growth of colony sizes or establishment of new colonies. Displaced terns, however, would need to select from existing nesting sites currently available, as this alternative does not propose any habitat management actions. Sites within San Francisco Bay appear to have available nesting habitat that is most similar to that found in the Columbia River estuary. However, as described in Alternative A, increases in the number of nesting terns at individual colonies are expected to be within the range observed in the past (e.g., 22 to 2,100 nesting pairs).

Region. *Regional Population.* The increasing trend in the overall Pacific Coast regional tern population is expected to stop once the highly successful colony on East Sand Island is lost. We expect an initial decrease in reproductive success because displaced terns from East Sand Island may not be able to breed for a year or two before they find new nesting sites or breed successfully. However, since Caspian terns are long-lived birds, opportunistic, and very mobile, they adapt well to habitat loss and gain (due to natural events such as drought, vegetation succession and high water which provide or take away nesting habitat or prey resources). These factors have contributed to their ability to move great distances, adapt to different situations, increase in numbers, and maintain a viable breeding population over time even as breeding site conditions, availability, and locations change from year to year. Thus, we expect most of the displaced terns to eventually find alternate nesting sites elsewhere within the Pacific Coast region and potentially in other regions within their continental distribution.

Based on the feasibility assessment conducted by the Service in 2002 (Seto et al. 2003), there appears to be nesting habitat elsewhere in the region that could be used by some of these displaced terns. Whether these sites are sufficient to accommodate all of the displaced terns from East Sand Island is unclear. If displaced terns are not able to find sufficient nesting habitat elsewhere in the region, the regional population trend could decline. In addition, although terns displaced from East Sand Island may find nesting sites elsewhere in the region, those sites may not be as productive as sites in the Columbia River estuary (see Table 4.3 for documented productivity at sites outside the estuary). Thus, even though displaced terns are able to find alternate nesting sites, the expected lower productivity could still result in an overall decrease

in productivity of terns in the region. Caspian tern life history is well suited to fluctuating levels of reproductive success that occurs at various sites. Ultimately, we expect the regional population trend would stabilize, possibly at a lower number than currently observed, but above numbers documented in the late 1970s and early 1980s (approximately 6,200 breeding pairs).

Regional habitat. After the loss of nesting habitat on East Sand Island, existing sites (Table F.1 and F.2) throughout the region would need to support breeding terns on a regional scale. As described above, whether these sites are sufficient to accommodate all of the displaced terns remains unclear. The majority of the available sites that do not require habitat enhancement in order to support more pairs of nesting terns are located in California. Other sites in Washington or Oregon require management and/or enhancement and would most likely not be used by displaced terns.

4.2.1.3 Alternative C

Washington. Similar to Alternative B, the colony on Dungeness NWR could increase in size from the immigration of displaced terns from East Sand Island under this alternative. However, factors that could limit reproductive success and size of the tern colony (e.g., predators and human disturbance) would still be present. Management actions may be implemented to protect this colony from possible disturbance from humans and/or predators. If management efforts are implemented, we expect the size of this colony could grow to somewhere within the range of historic colony sizes observed on the Washington Coast (100 to 3,500 breeding pairs). Larger colonies (e.g., more than 2,000 pairs) in Washington only occurred under ideal conditions (e.g., isolated islands and favorable ocean conditions) and were not sustained over time. Thus, under this alternative, we expect the number of nesting terns at Dungeness NWR to be in the lower- to mid-range of the historic numbers found on the coast. Similar to Alternatives A and B, there is a potential for establishment of new colonies or enlargement of existing sites in eastern Washington (e.g., Potholes Reservoir). The likelihood of this occurring however, would be lower than in Alternatives A and B because proposed management at alternate sites (Table 2.1) is expected to attract the majority of displaced terns. Additionally, as described in Alternative A, most of these sites are limited by size of available nesting area (e.g., Crescent Island), disturbances to the colony (e.g. human access to the nesting islands in Potholes Reservoir, fluctuating water levels), or prey availability (e.g. at Sprague Lake, Seto et al. 2003). Thus, even if some displaced terns nest at these sites, we do not expect the size of these colonies to increase substantially, limiting potential increases in consumption of Columbia River juvenile salmonids. As with Alternatives A and B, if nesting tern numbers increase substantially in these upper Columbia River sites, Federal, Tribal, and State partners, including appropriate land owners and managers, may initiate discussions as part of an adaptive management approach proposed in this FEIS, to ensure that impacts to Columbia River salmonids are minimized.

Table 4.3 Productivity of Caspian terns at various sites in Pacific Coast Region.

Site	Year (s)	Average Productivity (fledglings/pair)
Crescent Island, WA[a]	2000 – 2003	0.49 – 1.07
Solstice Island, WA[b]	2001, 2003	0.23 – 1.88
Rice Island, OR[c]	1997 – 2000	0.06 – 0.55
East Sand Island, OR[c]	1999 – 2003	0.57 – 1.39
Crump Lake, OR[d]	2003	0.63
Summer Lake, OR[d]	2003	0.40
Brooks Island, CA[d]	2003	0.62
Knight Island, CA[d]	2003	0.62
Baumberg Pond, CA[d]	2003	0.43
A-7 Pond, CA[d]	2003	0.08
Agua Vista, CA[d]	2003	0.42

[a] Data from Antolos 2002 and Collis et al. 2003a, b
[b] Data from Antolos 2002, C. Maranto pers. comm.
[c] Data from Collis et al. 2003a and b; Roby et al. 1998 and 2002
[d] Data from Roby et al. 2003a

Oregon. Based on the range of known nesting densities in the estuary, we expect that the tern colony on East Sand Island would decrease to approximately 2,500 to 3,125 breeding pairs when nesting habitat is reduced to approximately 1 to 1.5 acres. This would be a 60 to 70 percent decline from the 2003 colony size, a substantial decrease for this colony. Terns displaced from East Sand Island would most likely find nesting sites elsewhere in the region, especially since this alternative proposes to manage approximately 8 acres of habitat specifically for terns. However, other nesting sites in the region have not been observed to be as productive as in the Columbia River estuary (except for one year at Solstice Island, see Table 4.3). Thus, displaced terns may experience an overall decrease in productivity compared to that observed on East Sand Island. Productivity is likely to stabilize at levels more similar to those typically observed in the region (e.g., 0.08 to 1.88 fledgling/pair). See *Regional Population* section below for description of anticipated effects to the regional population.

The active measures (e.g., hazing, egg take, etc.) that would be implemented to prevent terns from nesting on the upper estuary islands would result in effects similar to that described in Alternative A and B. Although this alternative proposes to provide suitable tern nesting habitat on East Sand Island, Caspian terns may choose to nest elsewhere on their own accord.

Some of the displaced terns could be attracted to nest on managed habitat at Summer, Crump, and Fern Ridge lakes. The expected colony sizes at each of these sites would depend on the success of the social attraction techniques and available prey resources. Social attractants (e.g., decoys and sound recordings) have proven successful in attracting terns to nest at targeted locations (Kress 1983, Collis et al. 2002c, Roby et al. 2002). Although other colonial nesting birds occur Summer Lake, we expect that the majority of the three half-acre nesting islands could be used by Caspian terns. We expect that nesting tern numbers at this site could range between 5 to 300 breeding pairs if displaced terns respond to management actions under this alternative (based on historical numbers observed in interior Oregon). The number of nesting terns could be larger since a large number of terns would be displaced from East Sand Island, but would remain dependent upon annual availability of nesting habitat and prey resources. Human and/or predator disturbance at this site should be minimal, but may be managed, if necessary, to protect nesting terns.

At Crump Lake, the newly created 1-acre island would likely be shared with other colonial nesting birds. Anticipated numbers of terns is similar to that expected at Summer Lake (5 to 300 breeding pairs). Since this island would be located far from the shoreline, and public use in the lake is limited, we expect minimal human or predator disturbance. Similar to Summer Lake, the number of nesting terns could be larger because of the large number of displaced terns from East Sand Island. On the other hand, since prey base may be limiting at these two sites, the actual number of terns that can successfully nest at Summer and Crump lakes may not be as high as the nesting habitat could accommodate. Prey availability in both Summer and Crump lakes will vary annually, based on water levels, and thus would affect tern nesting success in these locations.

At Fern Ridge Lake, we expect other bird species to nest on the newly created island. We expect the number of nesting terns at this site to be from 5 to 300 breeding pairs. However, since this is not a historic nesting site, social attraction efforts may need to extend over a number of years before terns initiate nesting at this site. Since the nesting island would be located in shallow waters, human disturbance from boat use that occurs in the deeper portions of the lake is expected to be minimal. Other historically used nesting locations in Oregon (e.g., Malheur Lake) may also receive additional tern use under this alternative when environmental conditions allow for tern nesting; however, since terns would be actively attracted to sites specifically managed for terns (Table 2.1), the likelihood that displaced terns would select other sites would be lower than that expected in Alternative B.

California. The number of terns nesting in California would most likely increase from the immigration of terns displaced from the Columbia River estuary. Although these sites are some distance from East Sand Island, we expect displaced terns to nest at the San Francisco Bay sites because they fall within the tern's traditional breeding range along the coast. Active development or enhancement of nesting habitat at San Francisco Bay would most likely attract the majority of the displaced terns because these coastal sites are similar to habitat found in the Columbia River estuary and terns

already nest in the bay. Additionally, terns probably follow a coastal migration route to and from wintering grounds. Thus, it would be more likely that terns would discover these alternate sites on the coast, in contrast to interior sites.

In San Francisco Bay, the tern nesting site on Brooks Island would be enlarged to at least 2 acres through hand-pulling of vegetation (e.g., non-native ice plant and aster) or placement of additional substrate. If adjacent gulls do not encroach into the tern nesting area, the current colony could grow to at least 1,500 breeding pairs (average colony size of terns in coastal California) but could grow larger if conditions (e.g., prey abundance or predators) are suitable. At the two remaining sites in San Francisco Bay (Hayward Regional Shoreline and Ponds N1-N9), colony sizes are expected to range between 100 to 1,500 breeding pairs (at each site) once habitat is created.

Success of San Francisco Bay sites would be dependent on management of human and predator disturbances. Human activities are restricted at all three sites but a variety of avian or mammalian predators are present. Thus, predator management would most likely be necessary to protect nesting terns. Predator management programs are already in place at these locations and predator management for terns would fall within the current program design.

Terns nesting in San Francisco Bay are exposed to contaminants. Preliminary studies have shown that mercury, selenium, and brominated fire retardant (PBDE) concentrations are present in Caspian tern eggs (T. Adelsbach pers. comm., Schwarzbach and Adelsbach 2004). Mercury concentrations in the eggs of Caspian terns were above 0.5 parts per million and within the range found to affect reproduction in common terns (T. Adelsbach pers. comm.). However, current monitoring efforts in San Francisco Bay have shown that tern reproductive success (range from 0.42 to 0.62 fledglings/pair), with the exception of one site, is within the range of that observed in the region (see Table 4.3).

Region. *Regional population.* We expect a substantial effect to the distribution and initial reproductive success of the tern regional population under this alternative. An estimated 6,000 to 6,675 breeding pairs of terns would be displaced from East Sand Island as tern nesting habitat is reduced to 1 to 1.5 acres under this alternative. The dispersal of this large concentrated colony would be a benefit to the regional population because the potential risk of exposing this large segment of the population to catastrophic events (e.g., predators, storms, and disease, see section 3.2.1) would be removed. Additionally, increasing the network of nesting sites in both coastal and interior locations with varying conditions offers a better potential for maintaining a stable regional population over time in comparison to a network comprised of larger concentrations of terns at fewer individual colonies.

We expect that the managed sites would be able to provide suitable habitat to accommodate displaced terns, particularly when combined with underutilized habitat available at existing sites. However, we still would expect an initial decrease in reproductive success because displaced terns from East Sand Island may not be able to breed for a year or two before they find new nesting sites or breed successfully. In addition, this alternative could also result in a decrease in the overall regional population since adult birds could be lost if they cannot find new sites in the region or because displaced terns are expected to have lower productivity (see section 4.2.1.2). In the long-term, we expect the regional population to stabilize, possibly at a lower number than currently observed, but well above numbers documented in late 1970s and early 1980s (approximately 6,200 nesting pairs, Figure 3.3). The exponential growth that this regional population experienced since the 1960s is not expected to continue indefinitely. The variety of factors that influence population growth (e.g., prey resources, stable nesting habitat, and conflicts with other resources) vary considerably over time and would most likely preclude a long-term exponential growth trend. If the regional population trend declines toward a 50 percent decrease from the current size, management of tern nesting sites in the region would be reevaluated as part of the adaptive management approach proposed in this FEIS.

Regional habitat. Similar to Alternatives A and B, current nesting sites (Table F.1 and F.2) throughout the region would continue to provide a suite of locations suitable for supporting terns on a regional scale. However, unlike Alternatives A and B, the development of approximately 8 acres of nesting habitat (Table 2.1) proposed under this alternative would ensure that an enhanced network of nesting sites, dispersed throughout the Pacific

Coast region, would be available for terns displaced from East Sand Island. Displaced terns would be able to select from these managed sites as well as under utilized existing habitat throughout the region (Table F.1). Based on observed colony sizes in the region (Table F.2), we expect colony sizes at these managed locations may increase but would remain substantially smaller than the colony in the Columbia River estuary. Predictable nesting habitat (dredge material islands) and concentrated food resources (e.g., barged and released hatchery-reared salmonids) in the Columbia River estuary represent a unique combination that facilitated the rapid growth and atypical size of the estuary colony. This same combination of factors is not characteristic of any other site within the region.

Even though habitat would be developed for nesting terns, they are expected to nest opportunistically throughout the region based on various factors (e.g., food resources, proper nesting substrate, competition, or predation). Thus, specific colony locations and sizes throughout the region would change from year to year as is currently observed (Table F.2). Although nesting habitat in the Columbia River estuary and at alternate sites would be specifically managed for nesting terns, they may chose to nest elsewhere on their own accord.

4.2.1.4 Alternative D

Washington. If habitat reduction is successful in reducing the number of terns on East Sand Island, effects in Washington would be similar to that described in Alternative C. Unlike Alternative C, if lethal control is implemented, the number of displaced terns would be lower, reducing the potential increase in numbers of terns that could nest in Washington. However, if lethal control efforts result in the abandonment and dispersal of the entire colony from East Sand Island, effects would be similar to that described for Alternative B, resulting in unanticipated redistribution of terns throughout Washington.

Oregon. If habitat reduction is successful in reducing the number of terns on East Sand Island, effects in Oregon would be the same as that described in Alternative C. If a lethal control program is implemented, the decreased number of breeding terns in the Columbia River estuary would be a result of both the redistribution of terns due to habitat loss on East Sand Island and the direct loss of breeding birds through a lethal control program. The lethal control program would attempt to achieve the proposed range of nesting terns by killing up to 50 percent of breeding adult terns each year. The actual number of terns that would be killed under this alternative would depend on the success of redistributing majority of the colony to other sites in the region. If the entire colony continued to nest on the reduced acreage on East Sand Island, a substantial number of terns would need to be killed (see scenario 1 in Table 4.4). If the colony was partially reduced (e.g., by 50 percent) through habitat reduction, fewer terns would be killed with the implementation program proposed in this alternative (see scenario 2 in Table 4.4, below). For each scenario, we used the same population model used in Alternative A (see section 4.2.1.1) to estimate the number of terns that could potentially be killed from 2008 to 2012 (see Table 4.4). The model projects that if 50 percent of the tern colony is killed every year in scenario 1 (entire colony continues to nest on East Sand Island), the number of terns killed every year would range from approximately 4,300 to 11,000 terns (Table 4.4). Under scenario 2 (colony size decreases 50 percent), killing 50 percent of the annual tern colony would result in approximately 3,200 to 6,000 terns killed a year. This model, however, may not be accurate after a control program has been implemented, as population parameters have been observed to change (e.g., reduction in nesting density, decreased age of recruitment, etc.) in response to population control programs (Coulson et al. 1982). Killing of adults rather than juveniles or the take of eggs, has proven to be the most effective in reducing populations (Smith and Carlile 1993, Bedard et al. 1995). Table 4.4 summarizes the estimated number of terns that would need to be killed each year if a lethal control program was implemented in 2008.

Although the intention would be to kill a specific number of terns every year to maintain a colony within the target range, the control methods and associated activities (e.g., rocket nets, shot guns, human activity in the colony) themselves may be disturbing to the entire colony. This may result in complete abandonment of the site and dispersal of these birds back to upper estuary islands or other locations in the region.

Similar to Alternative C, we expect small colonies (5 to 300 breeding pairs) at Summer, Crump, and Fern Ridge lakes as a result of habitat enhancement activities at these sites.

TABLE 4.4 Estimated colony size and number of terns killed in the Columbia River estuary with implementation of a lethal control program under two colony size scenarios.

	Colony Size Scenario			
	Scenario 1[a]		Scenario 2[b]	
Year	Approximate No. of Terns Killed (individual no. of terns, not no. of pairs)	Post–Implementation Projected Colony Size (no. of breeding pairs)	Approximate No. of Terns Killed (individual no. of terns, not no. of pairs)	Post–Implementation Projected Colony Size (no. of breeding pairs)
2008	10,995	5,498	5,497	2,749
2009	8,514	4,257	6,013	3,006
2010	6,971	3,486	5,833	2,916
2011	5,872	2,936	5,354	2,677
2012	4,294	2,147	3,247	1,624

[a] No terns displaced by habitat reduction on East Sand Island (colony size projected to be 10,995 pairs in 2008 prior to implementation of lethal control)

[b] Projected 50 percent decrease in terns by habitat reduction on East Sand Island (colony size projected to be 5,498 pairs in 2008 prior to implementation of lethal control)

California. If habitat reduction is successful in reducing the number of terns on East Sand Island, effects in California would be similar to that described in Alternative C. However, if lethal control is implemented, then the actual number of displaced terns would be less than Alternative C, reducing the possibility of an increased number of terns in California. On the other hand, if a lethal control program is implemented but causes the entire colony on East Sand Island to abandon the site, a higher number of terns would be looking for alternate nesting sites, similar to that anticipated in Alternative C.

Region. *Regional population.* If habitat reduction is successful in redistributing terns from East Sand Island to elsewhere in the region, effects to the regional tern population would be similar to that described in Alternative C. It would result in a regional population that could initially decline but eventually stabilize, most likely at levels higher than documented in the late 1970s and early 1980s. However, if a lethal control program is implemented, this alternative, unlike all remaining alternatives, would result in a population control program for terns. The level of lethal take, however, cannot be specifically estimated because it would be dependent upon the level of dispersal of terns to sites elsewhere in the region. If habitat reduction on East Sand Island is successful in dispersing birds outside of the estuary, lethal take would be minimal. Should terns persist in attempting to nest on East Sand Island in excess of the proposed range of breeding pairs, then lethal take could be substantial (as described in Table 4.4) because as many as 50 percent of the current breeding population would be removed. This would result in a substantial decline in the regional tern population.

Regional habitat. Similar to Alternative C, the development of approximately 8 acres of nesting habitat, in addition to current nesting sites (Table F.1 and F.2) would provide an enhanced suite of locations suitable for supporting terns on a regional scale (as compared to Alternatives A and B). Displaced terns would be able to select from sites managed specifically for nesting terns as well as under utilized existing habitat throughout the region (Table F.1 and F.2). Even though habitat would be developed for nesting terns, they are expected to nest opportunistically throughout the region based on various factors (e.g., food resources, proper nesting substrate, competition, or predation). Thus, specific colony locations and sizes throughout the region are expected to change from year to year as is currently observed (Table F.2).

4.2.2 Effects to Fish

4.2.2.1 Alternative A

Washington. Current effects at Dungeness NWR of this No Action alternative to non-ESA-listed salmonids and other fish are not expected to change from current conditions (see section 4.2.3 below for

description of effects to ESA-listed salmonids). In 2004, Roby et al. (2004) determined that juvenile salmonids (non-ESA and/or ESA-listed) comprised 31 percent of the terns diet at the Dungeness NWR colony; surfperch (32 percent) were slightly more important in their diet. Five non-listed-ESA salmonid ESUs and two ESA-listed salmonids occur in Dungeness Bay. The study was unable to identify the specific ESUs or salmonid species consumed by terns at Dungeness Bay. However, current effects are not considered to be substantial given the tern nesting colony is less than 300 pairs.

Terns in eastern Washington also consume non-ESA-listed salmonids and other fish, but similar to Dungeness NWR, effects are not considered to be substantial because these colonies are all relatively small (average size of 18 to 545 breeding pairs). The number of terns may increase at all current nesting sites in Washington if nesting habitat in the estuary becomes fully occupied (projected in 2009). However, most of these sites are limited by size of available nesting area (e.g., Crescent Island), disturbances to the colony (e.g., human access to the nesting islands, predators, or fluctuating water levels in Potholes Reservoir), or prey availability (e.g., at Sprague Lake, Seto et al. 2003). Thus, these colonies are not expected to increase substantially, limiting effects to non-ESA-listed salmonids and other fish.

Some non-ESA-listed salmonids that originate in part in Washington are consumed by terns as they outmigrate through the Columbia River system (see section below). A continued increase in tern numbers at East Sand Island would result in increased consumption of those juvenile salmonids.

Oregon. Non-ESA-listed juvenile salmonids and other fish would continue to comprise a portion of the tern diet in the Columbia River estuary. If the tern colony continues to increase, then consumption of these fish in the Columbia River by terns would also increase under this alternative, but there has been no demonstrated effect on the populations of these species. Fluctuations in fish consumption levels by terns would be expected to vary across fish species as research efforts to date have documented. For example, in recent years, the number of juvenile salmonids in the tern diet has declined and the percent of marine/estuarine fish species (e.g., herring, anchovies) has increased through time (both annually and within years, Collis et al. 2003b). These fluctuations in fish consumption are influenced by a variety of factors such as good ocean conditions (e.g., ocean upwelling resulting in high marine fish productivity).

Herbicides would be used in upland areas on East Sand Island to control vegetation growth in the tern nesting area. These herbicides have a limited likelihood of negatively affecting, directly or indirectly, salmonids and other fish species. Rodeo, an EPA-registered chemical approved for over-water application, would be used in conjunction with mechanical control measures. The Rodeo formulation is comprised of glyphosate and water as the carrier agent. Glyphosate is slightly toxic to fish and practically non-toxic to aquatic invertebrates. The glyphosate formulation proposed for use under this action was selected for its low relative toxicity compared to other available formulations (U.S. Department of Agriculture 2004).

Currently, tern colonies at Summer and Crump lakes are small (less than 50 pairs). Salmonids are not found in these lakes, thus, no effects to non-listed salmonids are expected. Terns were observed to primarily eat non-native tui chubs in 2003 (Roby et al. 2003a) and since tui chubs are abundant, effects on local fish populations are considered to be negligible. Increases in fish consumption could occur at these two sites if the tern nesting site on East Sand Island is maximized and breeding terns seek new nesting sites at these locations. However, given the fact that these sites have limited nesting habitat and prey numbers may be limiting, the increase in number of terns would be small. Thus, effects to fish are expected to remain at negligible levels. No effects to fish at Fern Ridge Lake are expected as there currently is no nesting tern colony at this site.

California. Similar to Washington, effects to non-ESA-listed salmonids and other fish are not expected to change from current conditions and are not considered to be substantial since tern colonies are relatively small (range between 50 to less than 1000 pairs), distributed throughout San Francisco Bay, and have been documented to have a varied diet. Diet studies conducted in 2003 and 2004 found that the primary prey species in the tern diet were anchovy, surf perch, silversides, herring, sunfish, gobies, and toadfish (Roby et al. 2003a and 2004). Tern consumption of these fish may increase if terns from the Columbia River estuary are displaced when nesting habitat is maximized (anticipated in 2009).

4.2.2.2 Alternative B

Washington. Tern numbers at existing colony locations in Washington (Table F.2) may increase with implementation of this alternative. Loss of nesting habitat at East Sand Island would result in approximately 8,000 to 10,000 nesting pairs moving to alternative locations, possibly in Washington. Pioneering of terns onto new locations, including former coastal nesting locations and urband areas (e.g., rooftops, airports), may occur but specific location and future size of colonies cannot be predicted. Terns would more likely attempt to nest at existing sites (e.g., Dungeness NWR, Banks Lake, Potholes Reservoir and Sprague Lake), provided site conditions are suitable. However, as described in Alternative A, although fish consumption might increase, tern colony sizes are expected to remain small because of various limiting factors, thus, effects to non-ESA-listed salmonids and other fish are not considered to be substantial.

Unlike Alternative A, effects to non-ESA-listed salmonids that originate in part in Washington would be substantially reduced in the Columbia River estuary as the tern habitat would be lost (see section below).

Oregon. We expect the lack of management on East Sand Island would result in an elimination of tern nesting habitat within 3 years, causing Caspian terns to seek new nesting habitat elsewhere. The initial location where Caspian terns can be expected to seek new nesting sites would be at the upper estuary islands – Miller Sands, Rice and Pillar Rock islands. However, implementation of the measures (i.e., hazing, egg take) common to all alternatives in this FEIS is intended to preclude their use of these islands. Since there are no other locations in the estuary suitable for nesting terns, the loss of a tern breeding colony in the Columbia River estuary would substantially reduce juvenile salmonid consumption levels from that observed from 2000 to 2003 (average of 5.5 million juvenile salmonids, Collis et al. 2002a, 2002b, 2003a, 2003b, K. Collis pers. comm.). Consumption of various marine fishes in the estuary (e.g., northern anchovy, sardines, herring, smelt) would also be substantially reduced with implementation of this alternative. However, terns are likely to continue to loaf and roost on the islands or exposed shorelines of the estuary, thus, some continued consumption of non-ESA-listed salmonids and other fish can be anticipated.

As no management actions would occur at Summer and Crump lakes, effects to fish would be negligible, similar to that described in Alternative A. Also similar to Alternative A, no effects would occur in Fern Ridge lake as no habitat currently exists for nesting terns.

California. Tern numbers at existing colony locations in California (Table F.2) may increase with implementation of this alternative. Loss of nesting habitat at East Sand Island would result in approximately 8,000 to 10,000 nesting pairs moving to alternative locations, possibly in California. Pioneering of terns onto new locations, including former coastal nesting locations, may occur but specific location and future size of colonies cannot be predicted. Terns would most likely attempt to nest at existing sites (e.g., colonies in San Francisco Bay), provided site conditions are suitable. Although fish consumption might increase (as described in Alternative A), tern colony sizes in California are expected to remain relatively small (50 to less than 1000 breeding pairs) because of various limiting factors. Additionally, diet studies in San Francisco Bay conducted in 2003 found tern diet's to be variable and diverse, including a wide range of non-listed fish species (e.g. anchovey, surf perch, silversides, sun fish, gobies, toad fish, and salmonids), thus, effects to non-ESA-listed salmonids and other fish are not considered to be substantial.

4.2.2.3 Alternative C

Washington. Effects to fish (non-ESA-listed salmonids and other fish) would be similar to that described in Alternative B, except that effects would most likely not change from current conditions at eastern Washington sites (e.g., Banks Lake, Potholes Reservoir and Sprague Lake) because managed alternate sites at Dungeness NWR and in Oregon and California are expected to provide habitat for displaced terns from the Columbia River estuary. Effects to non-ESA-listed Columbia River salmonids that originate in Washington would continue to occur, although less than that described in Alternative A.

Oregon. Effects in the Columbia River estuary would be similar to that described for Alternative B, except that some consumption of non-ESA-listed fishes would still occur since some terns (2,500 to 3,125 breeding pairs) would remain to nest in the

estuary. Under this alternative, the tern colony in the Columbia River estuary would be reduced by 60 to 70 percent. The consumption of juvenile non-ESA-listed Columbia River salmonids and other fish would be reduced substantially (compared to current conditions).

Although habitat would be created for terns at Summer, Crump, and Fern Ridge lakes, we expect effects to the local fish populations at these sites to be negligible because expected tern colonies would be relatively small (e.g., 5 to 300 breeding pairs) and resident fish species are abundant. Additionally, terns nesting at Fern Ridge Lake may travel to feed on salmonids in the nearby Willamette and McKenzie rivers. If this occurs, effects are not expected to be substantial because the anticipated size of this new colony would remain relatively small (5 to 300 breeding pairs).

Short-term effects to fish may occur at all three of these sites associated with an increase in sedimentation or siltation caused by island construction activities. These effects are expected to be temporary, subsiding once construction activities have ceased.

California. Effects to non-ESA-listed fish in California are expected to be similar to that described in Alternative B except that fewer terns would be displaced from East Sand Island and prospecting for habitat at alternate sites. We expect tern numbers in San Francisco Bay to increase but individual colony sizes are expected to remain substantially smaller (100 to 1,500 pairs) than that observed in the Columbia River estuary. Additionally, the diet of terns in the Bay is very diverse and effects to individual species of non-ESA-listed fish are not considered to be substantial.

4.2.2.4 Alternative D

Since Caspian tern numbers in Washington, Oregon, and California are expected to be similar to Alternative C, effects to non-ESA-listed fishes are similar to that described in Alternative C. However, if lethal control is implemented to reduce the tern colony size on East Sand Island, fewer terns will seek habitat at alternate sites. Thus, effects to non-ESA-listed fish populations would be lower than that expected in Alternative C and all other alternatives.

4.2.3 Effects to Federally Endangered and Threatened Fish

4.2.3.1. Alternative A

Washington. The primary outmigration periods for ESA-listed salmonids in Puget Sound occur between February and July (Tynan 1997), which partly coincides with the tern breeding season (April to July). Current effects at Dungeness NWR of this No Action alternative to ESA-listed Puget Sound Chinook, Hood Canal summer-run chum, salmon, and bull trout have not been quantified. In 2004, Roby et al. (2004) determined that juvenile salmonids comprised 31 percent of the tern's diet at the Dungeness NWR colony (Table 4.5). However, all five salmonid ESUs (only two of which are ESA-listed), bull trout, and cutthroat trout fall within the "salmonid" category reported in this study. Considering the above, the variety of alternate prey available in the bay, and the relatively small tern colony size (less than 300 pairs, Roby et al. 2004), we expect a limited number of ESA-listed salmonids and bull trout are consumed by terns and effects on ESA-listed fish to be limited.

TABLE 4.5 Range of Salmonid Composition (percent) of Caspian Tern Diets observed at Coastal Sites in the Pacific Coast region.

Site	Salmonid Composition (percent)
Dungeness Bay (WA) (2004) [a]	31.3 %
Grays Harbor (WA) (1975-1976) [b]	3.5 – 21 %
Commencement Bay (WA) (2000) [c]	52%
East Sand Island (OR) (2000-2003) [d]	24 – 47 %
San Francisco (CA) (2003 and 2004) [e]	0.17 – 26.1 %

[a] Roby et al. 2004
[b] Penland 1976
[c] Thompson et al. 2002
[d] Collis et al. 2002b. and Roby et al. 2002.
[e] Roby et al. 2003a and 2004

Six ESA-listed stocks that originate at least in part in Washington would continue to be affected by tern consumption in the Columbia River estuary under this alternative since the tern colony on East Sand Island would continue to increase. These include Lower Columbia River Chinook, Upper Columbia River Chinook, Columbia River chum, Upper Columbia River steelhead, Mid-Columbia River steelhead and Snake River Basin steelhead. A more detailed description of effects to ESA-listed Columbia River Basin stocks is presented below, in the Oregon section.

Effects to other ESA-listed ESUs in Washington could occur if nesting habitat on East Sand Island is maximized in 2009, causing breeding terns to seek nesting habitat elsewhere. However, we expect effects at new or enlarged nesting sites in Washington to be limited since habitat is currently limited in the State (see section 4.2.1.1).

Oregon. Continued effects to ESA-listed salmonids, traveling through and/or rearing in the Columbia River estuary are expected under this alternative. There would be a continued and projected increase in predation of ESA-listed juvenile salmonids by terns as the East Sand Island colony continues to increase in size. Under this alternative, terns would continue to consume approximately 5.5 million (or higher as the number of terns increase) juvenile salmonids annually. This is the average number of juvenile salmonids consumed by terns nesting on East Sand Island from 2000 to 2004 (Collis et al. 2002a, 2002b, 2003a, and 2003b, K. Collis pers. comm.). If numbers increase to nearly 20,000 tern pairs, consumption of juvenile salmonids is expected to be comparable to what was observed at the Rice Island colony in 1998 (approximately 12.4 million smolts, Roby et al. 2002). The benefits gained from the relocation of terns from Rice Island to East Sand Island would be substantially lost as the tern colony continues to grow.

More importantly, Alternative A would not result in any appreciable improvement in population growth rate (λ) for four ESA-listed steelhead ESUs (Table 2.2 or see Table 5 in NOAA Fisheries 2004a, Appendix C). The larger tern colony size and/or predation levels could suppress the population growth rate for ESA-listed steelhead. In addition, if present good ocean upwelling conditions reverse, alternative marine prey resources would diminish and the tern's diet would likely shift towards more salmonids. This would also increase the consumption of ESA-listed juvenile salmonids in the estuary.

No substantial effects to Warner suckers are anticipated at Crump Lake as suckers comprised less than 0.3 percent of the tern diet; terns were observed to feed primarily on tui chubs in 2003 (Roby et al. 2003a). No nesting habitat currently exists at Fern Ridge Lake, thus effects to ESA-listed fish species at this site are not anticipated.

California. In San Francisco Bay, outmigration periods for juvenile Sacramento River winter-run Chinook (January to May), Central Valley spring-run Chinook (March to mid-June or November to April), and Central Valley steelhead (February through mid-May) overlaps with the tern breeding season (early April through early August, G. Stern pers. comm.). Despite this overlap, a study in 2003 and 2004 demonstrated that in all but one site, juvenile salmonids comprise less than 5 percent of the tern diet in San Francisco Bay (see below for more details, Roby et al. 2003a and 2004). Additionally, Roby et al. (2004) determined that the salmonids consumed by terns are not ESA-listed salmonids. Thus, effects to ESA-listed salmonids are considered to be limited.

Specifically, in 2003, salmonids were found in the tern diets of four out of five nesting colonies, ranging from 0.17 (Pond A7) to 8.7 (Knight Island) percent of prey items (Roby et al. 2003a). In 2004, juvenile salmonids were more prevalent in the tern diets, ranging from 1.4 (Agua Vista Park) to 26.1 (Knight Island) percent (Roby et al. 2004). The higher prevalence of salmonids in the tern diet was apparently due to a lower availability of marine fish (e.g., northern anchovy and surfperch, Roby et al. 2004). Although the percentage of salmonids increased to 26.1 percent in 2004 for terns nesting at Knight Island, this salmonid portion consisted primarily of juvenile Central Valley fall-run Chinook salmon (a non-ESA-listed ESU). Thus, effects to ESA-listed salmonids remain limited.

As in Washington, if nesting habitat on East Sand Island is maximized in 2009 and breeding terns seek nesting habitat elsewhere in the region, the number of nesting terns in San Francisco Bay may increase. However, we expect effects to remain limited since tern colonies are not predicted to increase substantially and their diets would remain comprised primarily of non-salmonids and non-ESA-listed salmonids.

4.2.3.2 Alternative B

Washington. If Dungeness NWR is colonized by higher numbers of terns as a result of the loss of habitat in the Columbia River estuary, it is probable that an increase in consumption of ESA-listed salmonids (Puget Sound Chinook and Hood Canal summer-run chum) and bull trout could occur. Timing of juvenile salmonid outmigration (from late February to late July, peaking from May to June, Bax et al. 1980, Bax 1983a and b, Tynan 1997) generally coincides with the tern's nesting season. However, because this colony would likely range somewhere near the lower end of the range of historic colony sizes observed in coastal Washington (e.g., 100 to 3,500 nesting pairs) and alternative prey are abundant, effects to ESA-listed salmonids and bulltrout are expected to remain limited.

Oregon. Within the Columbia River estuary, implementation of Alternative B would initially reduce and ultimately preclude tern nesting on East Sand Island in approximately 3 years. In conjunction with implementation measures common to all alternatives (prevention of tern nesting at upper estuary islands), terns would be precluded from nesting in the estuary, seeking alternate nesting habitat elsewhere in the region. This would result in a substantial reduction and possibly the elimination of tern predation on ESA-listed salmonids in the estuary. However, although nesting habitat would be unavailable within 3 years, displaced terns from East Sand Island may still attempt to nest in the estuary for several years. Terns displaced from East Sand Island are also likely to roost, loaf, and continue to forage in the estuary even if breeding does not occur. Thus, there would still be some consumption of ESA-listed salmonids in the Columbia River estuary during the initial breeding seasons following implementation of this alternative.

Implementation of this alternative could result in a positive change in population growth rate (a maximum of 1.6 to 4.9 percent increase for four steelhead ESUs) that could be realized within 6 to 7 years after implementation of this alternative (NOAA Fisheries 2004a, Table 5). Additionally, realized improvements from the reduction of tern predation would likely be lower than estimated because the model assumes that there is no compensatory mortality (e.g., mortality from other sources). It is also important to note that population growth rate calculations presented in NOAA Fisheries 2004a are based on tern predation of juvenile steelhead because they are the most affected of outmigrating juvenile salmonids (because they are consumed by terns at the highest rate, Ryan et al. 2003 and Roby et al. 2003b). Therefore, estimates of the potential benefit of reducing tern predation are the greatest for steelhead and thus, serves as a surrogate species for potential benefits to other salmonid species. The use of steelhead data in this analysis is especially important for Upper Columbia River steelhead because this ESU is among the most endangered of all ESA-listed stocks.

Similar to Alternative A, terns nesting at Crump Lake have not been documented to consume large numbers of Warner suckers (Roby et al. 2003a). Thus, although tern numbers may increase slightly under this alternative, effects to this ESA-listed species are expected to be limited. No effects are expected in the Fern Ridge Lake area because nesting habitat for terns does not currently exist.

California. The loss of nesting habitat at East Sand Island would most likely result in terns seeking alternative nesting locations elsewhere in the region. However, specific location and future size of colonies of pioneering of Caspian terns cannot be predicted. In San Francisco Bay, terns feed primarily on non-ESA-listed salmonids (Roby et al. 2004), therefore, an increase in predation on ESA-listed salmonids is not expected even if terns displaced from the Columbia River estuary select to nest in the bay. Additionally, as described in Alternative A, potential effects to ESA-listed salmonids are expected to be limited as tern numbers are not expected to grow substantially and ESA-listed salmonids were not observed to be the primary prey for terns in San Francisco Bay in 2003 and 2004 (Roby et al. 2003a and 2004).

4.2.3.3 Alternative C

Effects to ESA-listed salmonids at alternate nesting sites analyzed as part of this FEIS would depend on the number of birds and/or nesting pairs at each location and the percentage of ESA-listed salmonids in their diet (which is expected to change annually).

Washington. Effects to Puget Sound Chinook, Hood Canal summer-run chum, and bull trout would be similar to that described in Alternative B with the exception that any management actions implemented to further protect the tern colony on Dungeness NWR could result in an increased number of terns. As described in Alternative B, an increase in terns would probably result in an

increase in consumption of ESA-listed juvenile salmonids since the primary outmigration period for these salmonids partly coincides with the tern nesting season. However, effects to ESA-listed salmonids are anticipated to remain limited because of two factors. These factors include: (1) the predicted colony size is relatively small (on the lower to mid-end of the historic colony sizes documented on the Washington coast, e.g., 100 to 3,500 nesting pairs); and (2) consumption of juvenile ESA-listed salmonids and bull trout is not expected to be high because the 31 percent of salmonids observed in the tern's diet in 2004 could include a variety of species in addition to Puget Sound Chinook, Hood Canal summer chum, and bull trout (see description in Alternative A). We do not expect large numbers of displaced terns to nest in eastern Washington sites because alternate sites would be managed to attract the majority displaced terns. Thus, effects to other ESA-listed salmonids at these locations would be the same as described in Alternative A.

We have initiated ESA-consultation with the Service and NOAA Fisheries for the above ESA-listed species at Dungeness NWR and would complete the consultation prior to implementation of the preferred alternative. Based on initial discussions, the proposed action is likely to result in effects to these species (since there is a potential for an increased consumption of these species by terns). However, these effects are not considered to be substantial.

Oregon. Based on the NOAA Fisheries (2004a) report (Appendix C), population growth rate increases for four steelhead ESUs could occur within one generation (4 to 5 years). We expect the reduction in size of the tern colony on East Sand Island (2,500 to 3,125 breeding pairs) to occur by 2010. Thus, we could see initial benefits to ESA-listed salmonids no later than 2014 (given the 4 to 5 years of a salmon generation time). The NOAA Fisheries report also indicated that a potential for a positive population growth rate change (a maximum of 1.082 to 3.704 percent) could be achieved for the Snake River, Upper Columbia River, Middle Columbia River, and Lower Columbia River steelhead (see Table 2.2 or Table 5, NOAA Fisheries 2004a). However, we expect the actual realized improvement in lambda would most likely be below the projected change because the model used in the NOAA Fisheries analysis assumes no compensatory mortality. Although some level of compensatory mortality is likely to occur, there are no existing data from which to estimate the appropriate value or range (Roby et al. 2003b). Estimates for benefits gained from hydropower improvements are subject to these same compensatory mortality factors, thus comparisons among both of these actions can be made. The projected improvement in population growth rate from reduction in tern predation is similar in magnitude to that of increases in population growth rate that could result from hydropower improvements (0 to 4 percent increase). Benefits from both of these management actions are well below improvements that have been largely realized by harvest reductions (4 to 8 percent increase, see Table 6, NOAA Fisheries 2004a, Appendix C).

Ultimately, long-term benefits to ESA-listed salmonids in the Columbia River estuary from proposed management actions would depend on maintaining a range of nesting terns (2,500 to 3,125 pairs) in the estuary. However, long-term success of efforts intended to increase population growth rates of ESA-listed salmonids must be placed in context with other sources of mortality subject to human intervention. Hydropower operations, harvest impacts, habitat conditions, hatchery operations, and introduced species all have the potential to affect population growth rates of ESA-listed salmonids, and are subject in various degrees to management efforts to alleviate detrimental effects. Many actions to address these impacts have been implemented, and others have been proposed and may be developed in the future. Cumulatively, these actions have the potential to influence population growth rate to a substantially greater degree than could be realized from solely reducing predation from avian predators in the Columbia River estuary (Kareiva et al. 2000, Wilson 2003).

An increase in nesting terns at Crump Lake is not expected to substantially affect the threatened Warner sucker since they were observed to be only 0.3 percent of the tern's diet in 2003 (Roby et al. 2003a). Proposed activities to build up the existing island could result in temporary adverse effects to Warner suckers through siltation or increases in sedimentation with effects subsiding once construction activities are completed. We have initiated ESA-consultation with the Service for the sucker and would complete the consultation prior to implementation of the preferred alternative. Based on initial discussions, the proposed action is likely

to result in an unavoidable adverse effect to the sucker. However, these effects are considered to be at a level that will not jeopardize the recovery of the species.

If terns initiated nesting at Fern Ridge Lake, there is a possibility that terns could forage in the nearby Willamette and McKenzie rivers. Studies on terns in the Columbia River estuary indicate that about 65 percent of the terns foraged up to 6 miles away, while about 30 percent foraged as far as 15 miles (Collis et al. 2000). A 15 mile radius around Fern Ridge Lake includes the mainstem Willlamette River downstream to Harrisburg, Middle Fork and Coast Fork Willamette River to Mt. Pisgah, and the McKenzie River to its confluence with the Mohawk. If terns successfully nested at Fern Ridge Lake, they would occur in the general area during the mid- to latter stages of the outmigration period for the Upper Willamette River Chinook, thus, terns could potentially consume juvenile Chinook if they forage in the Willamette and McKenzie rivers. Effects are expected to be limited because the number of nesting terns are expected to be small (5 to 300 pairs). We have initiated ESA-consultation with NOAA Fisheries for the Upper Willamette River Chinook and would complete the consultation prior to implementation of the preferred alternative. Based on initial discussions, the proposed action is likely to result in effects to these species (since there is a potential for an increased consumption of these species by terns). However, these effects are not considered to be substantial. Juvenile steelhead from the Upper Willamette ESU do not outmigrate in portions of the watershed within foraging range of the terns. Thus, this ESU would not be affected.

California. Effects to ESA-listed salmonids are not expected to increase substantially under this alternative because current data suggest that terns primarily consume non-ESA-listed salmonids (Roby et al. 2004). In addition, individual colony sizes (100 to 1,500 pairs) are predicted to remain small in comparison to that observed in the Columbia River estuary and alternative prey (e.g. marine fishes) are typically abundant and available to nesting terns, reducing the potential for terns to prey on salmonids. However, as described in Alternatives A and B, there is some overlap with the outmigration periods of ESA-listed salmonid species during the tern breeding season. Thus, although ESA-listed salmonids were not the primary salmonid species consumed by terns, there is a potential that some are consumed and thus, an increase in consumption could occur with an increase in the number of terns. We have initiated ESA-consultation with NOAA Fisheries for the above ESA-listed salmonids and would complete the consultation prior to implementation of the preferred alternative. Based on initial discussions, the proposed action is likely to result in effects to these species (since there is a potential for an increased consumption of these species by terns). However, these effects are not considered to be substantial.

The foraging range of terns overlap with the southern end of the range of the delta smelt. The adult size class of the delta smelt that could be captured by terns is not expected to be present until after August, a time when terns are beginning to leave the area. Thus, it is unlikely predation on smelts would occur. We have initiated ESA-consultation with the Service for the delta smelt and would complete the consultation prior to implementation of the preferred alternative. Based on initial discussions, we are requesting concurrence from the Service that the above species may be affected but is not likely to be adversely affected under the preferred alternative.

4.2.3.4 Alternative D

Effects to ESA-listed salmonids and other fish in Washington, Oregon, and California are similar to that described in Alternative C, with the exception that if lethal control is implemented, the overall number of birds that may be displaced from the Columbia River estuary may be lower than expected in Alternative C. Thus, effects from displaced birds would be lower than anticipated in Alternative C. However, if the entire tern colony abandons as a result of the lethal control program, there is a potential for effects to other ESA-listed fish to increase substantially as a much larger number of terns would be displaced from East Sand Island.

4.2.4 Effects to Other Birds

4.2.4.1 Alternative A

Washington. Under this alternative, effects to other bird species at Dungeness NWR are expected to be absent or negligible because nesting terns currently use an area not used by many other bird species. The black oystercatcher is on the Service's Birds of Conservation Concern list (U.S. Fish and Wildlife Service 2002b). One to three pairs of oystercatchers currently nesting on Dungeness

NWR, use the same general location as the terns but no negative interactions have been observed. A larger tern colony may potentially cause the black oystercatchers to move their nest site away from nesting terns. It is also possible that a larger tern colony may attract more mammalian predators onto the spit, potentially increasing predation risks to the black oystercatchers. Despite the potential for effects to these nesting oystercatchers, we do not expect effects to the overall regional population of black oystercatchers. No specific effects to other colonial nesting bird species have been identified at known tern colony sites in eastern Washington. Thus, effects to other birds are expected to be absent or negligible in Washington.

Oregon. Effects to gulls nesting on East Sand Island are not expected since the amount of nesting habitat available to terns would not change from the current situation. Double-crested cormorants would probably not be affected by an increased number of nesting terns on East Sand Island since the cormorants nest on the opposite end of the island. Activities associated with the small colonies of terns on Summer and Crump lakes are not expected to affect other bird species found in these locations.

California. As no management actions would be implemented in California and the number of nesting terns is not expected to increase, no effects are anticipated on other bird species in California under this alternative.

4.2.4.2 Alternative B

We expect approximately 12,000 breeding pairs of terns (based on estimated colony size in 2005, Table 4.2) would be displaced from the Columbia River estuary. These terns may potentially affect other colonial nesting waterbirds that also prefer to nest in similar habitats as they seek new nesting habitat in the region. However, we expect these effects would be dispersed throughout the region and thus, would be limited.

Washington. Similar to Alternative A, effects to other bird species in Washington are expected to be negligible, even with potentially increased tern numbers.

Oregon. Nesting gulls may benefit from the vegetation growth in the tern nesting area on East Sand Island because gulls prefer to nest in vegetated areas. However, as this area continues to become vegetated, it would most likely be covered with dense, thick vegetation and could potentially displace nesting gulls as well. Effects to other colonial nesting bird species found on East Sand Island are not expected. Songbirds and some waterfowl species that nest on East Sand Island would benefit from the additional acres of vegetated habitat.

Effects to other bird species at Summer and Crump lakes are expected to be negligible because existing nesting habitat, without management efforts, cannot accommodate a large number of displaced terns from the Columbia River estuary. There is no suitable nesting habitat at Fern Ridge Lake, thus, effects to other bird species are not expected under this alternative.

California. Displaced terns may nest at sites within San Francisco Bay, northeastern California, and southern California and thus, could compete with other colonial nesting birds. Effects are expected to not be substantial. In southern California, nesting habitat is very limited and there is a potential that the larger Caspian tern could displace smaller Forster's or California least terns. However, effects are expected to be limited since Caspian tern colony sizes are not anticipated to be similar to those observed in the Columbia River estuary.

4.2.4.3 Alternative C

Washington. Effects to other bird species at Dungeness NWR are similar to that described for Alternative A and B, except that any management actions to protect the tern colony from human disturbance and/or predators would most likely also benefit other birds nesting near the terns.

Oregon. Adverse effects to other bird species found on East Sand Island are not expected. Nesting gulls would benefit from the increased vegetated nesting area. Songbirds would also benefit from the development of densely vegetated habitat. Canada geese and mallards would also be expected to nest in the newly created habitat.

Since this alternative would create more island nesting habitat at Summer and Crump lakes, other colonial nesting birds, such as American white pelicans, Forster's terns and double-crested

cormorants may also benefit by having more nesting habitat available. The creation of a nesting island at Fern Ridge Lake would also benefit other colonial nesting birds that may select to nest at that site since we do not expect terns to use the entire island.

California. In San Francisco Bay, the projected increased number of terns is not expected to effect other bird species or result in competition for nesting habitat because sufficient habitat is proposed to accommodate the projected increase in tern numbers. In fact, we expect that there would be an excess of nesting habitat that could be used by other colonial waterbirds (e.g., Forster's tern). Displaced terns may choose to nest on their own accord in southern California and could compete with other colonial nesting birds since habitat is very limited here. However, since habitat would be created in San Francisco Bay, it is unlikely that a large number of terns would select nest sites in southern California.

4.2.4.4 Alternative D

Effects to other birds would be similar to that described in Alternative C for Washington, Oregon, and California with the exception that if a lethal control program was implemented, it would most likely disturb nesting gulls, cormorants, and other bird species on East Sand Island, potentially causing colony abandonment.

4.2.5 Effects to Mammals

4.2.5.1 Alternative A

No effects to mammals are expected in Washington, Oregon, and California under this alternative as no management actions are proposed.

4.2.5.2 Alternative B

No effects are expected to mammals in Washington, Oregon, and California under this alternative beyond habitat improvement for small mammals on East Sand Island.

4.2.5.3 Alternative C

Washington. If mammalian predators become an issue on Dungeness NWR, a predator management program (e.g., fences) may be necessary. It is unlikely that large numbers of mammals would wander onto the spit to become a problem. Thus, if a predator management program was implemented, we expect that it could potentially affect a small number of individuals. Effects to mammal populations near Dungeness NWR are expected to be negligible. The expected larger tern colony should have no effects to harbor seals that frequently haul out on the spit.

Oregon. No effects to mammals are expected on East Sand Island. If predation from mammals on nesting terns occurs in Summer and Crump lakes, a predator management program may be necessary. Similar to that described for Dungeness NWR, effects to mammals are expected to be negligible. No mammalian predators are expected to access the tern nesting island in Fern Ridge Lake. Thus, no affects are expected.

California. The red fox, a non-native species, is a known predator on nesting terns in San Francisco Bay. Predator management may be necessary at all three sites in San Francisco Bay. If implemented, management actions would fall within predator management programs currently implemented at the Brooks Island, Hayward Regional Shoreline, and Don Edwards NWR. Similar to that described in Washington and Oregon, effects to the red fox population or other mammalian predators are expected to be negligible.

4.2.5.4 Alternative D

As management programs would be the same as proposed in Alternative C, effects to mammals would be similar to that described in Alternative C for Washington, Oregon, and California.

4.2.6. Effects to Federally Endangered and Threatened Wildlife

4.2.6.1 Alternative A

Washington. Effects to bald eagles and marbled murrelets, which occur in Dungeness Bay are not considered substantial since the current tern colony is small (e.g., less than 300 pairs), resulting in minimal conflicts (e.g., prey competition).

Oregon. Under this status-quo alternative, construction activities associated with development of the tern nesting area would occur during a period when brown pelicans are not on the island. Additionally, during the tern nesting season, pelicans roost on the shoreline or the upstream beaches; areas outside the tern nesting site. Thus, no effects to the threatened brown pelican are expected. Bald eagle use of the island would

continue under this alternative and no adverse effect for this species is expected from tern habitat enhancement activities. Bald eagles are expected to continue to benefit from the additional food resource that the tern colony potentially provides. The current tern nesting colonies at Summer and Crump lakes are extremely small, resulting in no effects to bald eagles in the area.

California. Under this alternative, current effects to bald eagle, brown pelicans, western snowy plovers and California least terns in San Francisco Bay are expected to continue. No effects to bald eagles, brown pelicans, California clapper rail, and the salt marsh harvest mouse occurs because competition for prey, nesting, or roosting sites does not occur. Western snowy plovers and California least terns nest in similar habitats as Caspian terns, but adverse interactions between these species have not been observed in San Francisco Bay, thus, current effects are minimal or absent.

4.2.6.2 Alternative B

Washington. Although there is a potential for the Caspian tern colony to increase at Dungeness NWR under this alternative, expected effects are similar to that described in Alternative A.

Oregon. The loss of the current tern colony on East Sand Island is not expected to affect roosting brown pelicans which primarily occur along the shorelines or on the beaches of the island. These areas are not associated with the tern nesting site. Although bald eagles would lose a potential food resource, there are no indications that the tern colony is an important food resource for bald eagles. As with Alternative A, bald eagles at Summer and Crump lakes would not be affected.

California. The potential growth of existing tern colonies in San Francisco Bay are not expected to affect bald eagles, brown pelicans, California clapper rail, and the California salt marsh harvest mouse for the same reasons described in Alternative A. Effects to the western snowy plover and California least terns nesting in San Francisco Bay are also not expected as described in Alternative A. Even if tern numbers increase in the Bay, adverse effects are unlikely as prey and nest site competition would be minimal. For example, Caspian terns currently nest at sites that are at least 8 miles away from the current California least tern colony site at the proposed Alameda NWR. In addition, foraging competition is not expected because there is only a slight overlap in prey size preference for both species (California least terns feed on prey that are 2.0 to 9.0 cm long (Thompson et al. 1997) while Caspian terns feed on prey that is at least 5 cm long (Cuthbert and Wires 1999).

If Caspian tern colonies increase in size in southern California, the larger Caspian tern could compete for nesting substrate with the smaller California least tern since nesting habitat is already limiting for colonial nesting waterbirds in this highly urbanized coastline. However, effects are expected to be limited under this alternative because colony sizes are not expected grow to numbers similar to those observed in the Columbia River estuary.

4.2.6.3 Alternative C

Washington. Although there is a potential for the tern colony to increase at Dungeness NWR under this alternative, expected effects to bald eagles and marbled murrelets are similar to that described in Alternatives A and B. We have initiated ESA-consultation with the Service for ESA-listed species at this site and would complete the consultation prior to implementation of the preferred alternative. Based on initial discussions, we are requesting concurrence from the Service that the above species may be affected, but are not likely to be adversely affected under the preferred alternative.

Oregon. Similar to Alternatives A and B, the smaller tern colony on East Sand Island is not expected to affect roosting brown pelicans which primarily occur along the shorelines or on the beaches of the island. As described in Alternative B, bald eagles would lose a potential food resource, but effects are expected to be minimal. Conversely, increased numbers of nesting terns may benefit bald eagles at Summer, Crump, and/or Fern Ridge lakes by providing an additional food resource.

We have initiated ESA-consultation with the Service for ESA-listed species at these locations and would complete the consultation prior to implementation of the preferred alternative. Based on initial discussions, we are requesting concurrence from the Service that the above species may be affected, but are not likely to be adversely affected under the preferred alternative.

California. The potential growth of existing and the establishment of new tern colonies in San Francisco Bay are not expected to affect bald eagles and brown pelicans (as described in Alternative A). Effects to western snowy plovers may occur but are expected to be limited. There has been no occurrences of the western snowy plover on Brooks Island, thus, no effects are expected at this site. The plover is known to nest in the vicinity of the Hayward Regional Shoreline and Ponds N1-N9 sites. Effects to plovers could occur through nest site competition, attraction of predators, or trampling of nests. Roosting Caspian terns have been observed to "trample" young snowy plover chicks (i.e., Salinas River NWR, I. Loredo pers. comm.), however, we do not expect this to occur frequently at these two sites because there are numerous roosting site available to the Caspian terns. Additionally, planning efforts for the tern nesting site at Ponds N1-N9 would aim at maximizing distance of the managed tern nesting site from known plover nesting areas. There is also the potential that habitat enhancement for terns could benefit snowy plovers by providing additional plover nesting habitat. Interactions between terns and plovers at tern enhancement sites would be monitored.

We have initiated ESA-consultation with the Service for the plover and would complete the consultation prior to implementation of the preferred alternative. Based on initial discussions, the proposed action is expected to adversely affect the plover. However, we do not expect effects to jeopardize the recovery of the species.

As in Alternative B, larger nesting colonies of terns are not expected to affect the California least tern colony nesting at the proposed Alameda NWR in San Francisco Bay. Social facilitation efforts to attract Caspian terns to the managed alternate sites in the Bay would reduce the likelihood that Caspian terns would attempt to nest close to the California least tern colony site. Additionally, foraging competition is unlikely because all of the proposed tern management sites are 8 to 20 miles from the California least tern nesting site and the sizes of prey consumed by the two species have a very slight overlap (e.g., Caspian tern consumes prey 5 to 25 cm in size and the California least tern consumes prey 2 to 9 cm in size, Shuford and Craig 2002, Thompson et al. 1997). Monitoring of interactions between both tern species would be conducted to ensure effects to the California least tern are minimal.

Effects to the California clapper rail and California salt marsh harvest mouse could occur during habitat enhancement activities at the Hayward Regional Shoreline and Ponds N1-N9 sites especially if they entail helicopter use, but conservation measures would be employed to limit the potential for impacts to these species, including avoidance through timing, distance, and area closures.

We have initiated ESA-consultation with the Service for the California least tern, California clapper rail, and salt marsh harvest mouse and would complete the consultation prior to implementation of the preferred alternative. Based on initial discussions, we are requesting concurrence from the Service that the above species may be affected, but are not likely to be adversely affected under the preferred alternative.

4.2.6.4 Alternative D

Effects to threatened and endangered wildlife would be similar to that described in Alternative C for Washington, Oregon, and California. The only difference is if a lethal control program is implemented on East Sand Island, removal of an undetermined number of terns would occur on an annual basis until the target colony size is attained. This program may disturb to roosting brown pelicans and bald eagles on the island.

4.3 Effects to Socioeconomic Environment

4.3.1 Effects to Commercial and Recreational Fisheries

4.3.1.1 Alternative A

Washington. Terns consume commercially and recreationally harvested fish species (e.g., salmonids, herring) that occur in Dungeness Bay and the Strait of Juan de Fuca (see section 4.2.2 and 4.2.3). However, effects to most of these species are not considered to be substantial because the current colony at Dungeness NWR was estimated at less than 300 breeding pairs in 2004 and their consumption of herring (6.5 percent) and northern anchovy (less than 1 percent) were small (Roby et al. 2004). Juvenile salmonids were the second most important prey species (31 percent) and are considered to represent a cross section of the

salmonid species that originate in the watersheds and rear in the waters of Puget Sound and the Strait of Juan de Fuca. Consequently, effects from terns are spread among a mixture of species and stocks and probably represents a limited effect on any given species or stock. Additionally, NOAA Fisheries acknowledges that tern predation may not be 100 percent additive and thus, a direct link with fisheries stocks is difficult to assess. Salmonid stocks that originate in Washington and associated with the Columbia River Basin would also be consumed by terns nesting in the Columbia River (see Oregon section below).

The current tern colony probably does not contribute to fecal coliform levels that have been observed in Dungeness Bay (causing shellfish harvest closures) because the number of nesting terns is small and their nesting area is located on an upland site, reducing the possible contamination of bay waters.

Oregon. Consumption of juvenile salmonids and pelagic fisheries species by terns in the Columbia River would increase under this alternative. This increased consumption could potentially affect commercial and recreational salmonid fisheries if increased tern predation continues to affect ESA-listed stocks. Failure to attain management objectives for survival and recovery of ESA-listed stocks would most likely continue to result in restricted commercial and recreational fisheries for salmon stocks.

Since no commercial fisheries occur at Summer, Crump, or Fern Ridge lakes, no effects to commercial and recreational fisheries are expected.

California. In San Francisco Bay, tern colonies are predicted to remain similar to current numbers and effects to fisheries in the bay are not considered to be substantial.

4.3.1.2 Alternative B

Washington. Effects would be similar as described in Alternative A, except that there would be an increased likelihood that tern numbers could increase in Washington as tern nesting habitat is lost on East Sand Island. However, colonies are not expected to grow to the sizes observed in the Columbia River estuary, thus, effects are expected to be similar to current conditions.

Oregon. Consumption of juvenile salmonids by terns would decrease substantially and eventually be eliminated under this alternative, potentially resulting in beneficial effects to commercial and recreational salmonid fisheries if reduction of tern predation aids salmon recovery in the Columbia River Basin.

Since no commercial fisheries occur at Summer, Crump, and Fern Ridge lakes, no effects are expected. Since there is a potential for the number of nesting terns to increase, predation on recreational fish may also increase at Crump Lake. However, since nesting habitat is limiting, this increase is expected to be negligible.

California. Effects would be similar as described in Alternative A, except that the likelihood that tern numbers could increase in California would be greater as habitat is lost on East Sand Island. Effects are expected to be similar to current conditions (see above).

4.3.1.3 Alternative C

Washington. Effects would be similar or increased from the current conditions described in Alternatives A. However, we expect effects to remain limited because the colony size is expected to be in the lower to mid-end of historic colony sizes (e.g., 100 to 3,500 pairs). In addition, as described in section 4.2.2 and 4.2.3, we expect the diet of terns nesting in Dungeness NWR to remain similar to that observed in 2004 (e.g., less than 40 percent salmonids, Roby et al. 2004). Additionally, NOAA Fisheries acknowledges that tern predation may not be 100 percent additive and thus, a direct link with fisheries stocks is difficult to assess. Effects to herring fisheries in Washington are not expected and a large tern colony would not contribute to fecal coliform levels that have been observed in Dungeness Bay because their nesting area is located in an upland site, reducing the possible contamination of bay waters.

Oregon. Effects would be similar to Alternative B, except that there would still be some amount of predation on smolts of commercially harvested salmonids in the Columbia River. However, consumption of juvenile salmonids by terns would decrease by an estimated 3.5 to 3.9 million juvenile salmonids annually under this alternative, potentially resulting in beneficial effects to commercial and recreational salmonid fisheries if

reduction of tern predation aids salmon recovery in the Columbia River Basin. We expect a possible increase in tern predation on recreational fish at Summer and Crump lakes if Caspian terns eventually relocate to these sites. These colonies would be small (5 to 300 pairs) and resident fish populations are healthy and abundant. Thus, effects are expected to be negligible.

California. Similar to Alternative B, we expect possible increases in tern predation on commercially important species if terns relocate from the Columbia River estuary to San Francisco Bay. Effects in San Francisco Bay are similar to that described in Alternative B.

4.3.1.4 Alternative D

Effects to commercial and recreational fisheries in Washington, Oregon, and California are similar to that described in Alternative C.

4.4 Effects to Tribal Fisheries

4.4.1 Alternative A

Washington. Effects are expected to be similar to that described above in the Effects to Commercial and Recreational Fisheries section. Terns most likely do consume some smolts of Tribal harvested salmonids that occur in Dungeness Bay. However, effects are not considered to be substantial because the current colony is relatively small (less than 300 breeding pairs), resulting in low consumption levels. Consumption could increase if the number of terns nesting at Dungeness NWR increases when the nesting habitat on East Sand Island is maximized in 2009. However, we expect this increase would not be substantial. As described in section 4.2.2 and 4.2.3, we expect the diet of terns nesting in Dungeness NWR to remain similar to that observed in 2004 (e.g., less than 40 percent salmonids, Roby et al. 2004). Additionally, NOAA Fisheries acknowledges that tern predation may not be 100 percent additive and thus, a direct link with fisheries stocks is difficult to assess. Tribal fisheries associated with salmonid stocks that originate in Washington in the Columbia River Basin would be affected by continued tern predation occurring in the Columbia River (see Oregon section below).

Oregon. Similar to the description of effects to commercial and recreational fisheries, consumption of juvenile salmonids by terns in the Columbia River would increase under this alternative. This increased consumption could potentially affect Tribal salmonid fisheries if increased tern predation continues to affect depressed or ESA-listed stocks. Failure to attain management objectives for survival and recovery of ESA-listed stocks would most likely continue to result in restricted Tribal fisheries for salmon stocks.

California. No Tribal fisheries occur within the affected environment. Thus, no affects are expected.

4.4.2 Alternative B

Washington. Effects would be similar to those described in Alternative A, except that the likelihood that tern numbers could increase in Washington would be greater. However, effects to salmonid fisheries are expected to similar to current conditions.

Oregon. Consumption of juvenile salmonids by terns would decrease under this alternative, potentially resulting in beneficial effects to Tribal fisheries if reduction of tern predation aids salmon recovery in the Columbia River Basin.

California. No Tribal fisheries occur within the affected environment. Thus, no affects are expected.

4.4.3 Alternative C

Washington. Although the number of nesting terns would most likely increase on Dungeness, we expect effects to Tribal fisheries to be similar or slightly increased to those described in Alternatives A.

Oregon. Effects would be similar to Alternative B, except that there would still be some amount of predation on Tribal harvested salmonids in the Columbia River. However, consumption of juvenile salmonids by terns would substantially decrease under this alternative, potentially resulting in beneficial effects to commercial and recreational salmonid fisheries if reduction of tern predation aids salmon recovery in the Columbia River Basin.

California. No Tribal fisheries occur within the affected environment. Thus, no affects are expected.

4.4.4 Alternative D

Effects to Tribal fisheries in Washington, Oregon, and California are similar to that described in Alternative C.

4.5 Effects to Cultural Resources

4.5.1 Alternative A

Since this alternative does not propose any habitat manipulations and actions, other than ongoing actions on East Sand Island, no effects to cultural resources are expected under this alternative in Washington, Oregon, and California.

4.5.2 Alternative B

Similar to Alternative A, since this alternative does not propose any habitat manipulations and actions, there are no anticipated effects to cultural resources under this alternative in Washington, Oregon, and California.

4.5.3 Alternative C

Washington. There are no anticipated effects to cultural resources under this alternative in Washington.

Oregon. There are no anticipated effects to cultural resources under this alternative on East Sand Island. However, since cultural resources are present in Summer, Crump, and Fern Ridge lakes, activities associated with the creation of the proposed islands in each lake could potentially affect cultural resources. Coordination with associated Tribes and archeologists would be required.

California. There are no anticipated effects to cultural resources under this alternative in San Francisco Bay. Hand-pulling of vegetation on Brooks Island would be the management measure to develop additional nesting habitat for Caspian terns. This low impact method would preclude effects to cultural resources at this site.

4.5.4 Alternative D

Effects to cultural resources are similar to that described in Alternative C for Washington, Oregon, and California.

4.6 Summary of Effects

Table 4.6 summarizes potential effects to Caspian terns and ESA-listed salmonids for each of the four alternatives.

4.7 Cumulative Effects

This section addresses the potential cumulative effects for all of the alternatives and is intended to consider the proposed action in the context of other actions on a larger temporal and spatial scale.

Natural and human-caused events have reduced or eliminated tern nesting habitat throughout the region. This has apparently led to the concentration of terns on the few remaining suitable sites or the colonizing of new sites in conflict with human interests (Shuford and Craig 2002). The large breeding concentration of terns in the Columbia River estuary is more vulnerable to stochastic events (e.g., storms, predators) and disease as compared to a similar population that is dispersed among many smaller colonies (Roby et al. 2002, Shuford and Craig 2002). Thus, dispersal of the large and concentrated tern colony on East Sand Island would result in a benefit to the regional population because the potential risk of this large segment (approximately 70 percent) of the population to catastrophic events would be removed.

Additionally, increasing the network of nesting sites in both coastal and interior locations with varying conditions offers a better potential for maintaining a stable regional population over time in comparison to a network comprised of fewer sites with larger concentrations of nesting terns. The proposed enhanced suite of nesting locations would provide more suitable habitat for supporting terns on a regional scale as well as help support other management actions to decrease the loss of juvenile salmonids in the Columbia River estuary.

Tern predation should be considered in context with other efforts to improve juvenile salmonid survival. Many of the measures taken to restore salmonids in the Columbia River Basin have focused on improving survival of juvenile salmonids through the mainstem dams. These measures are associated with the operation and management of the Federal Columbia River Power System (FCRPS) and include research, development, and construction of measures under the Columbia River Fish Mitigation (CRFM) program of the Corps. Costs associated with the implementation of the 2000 FCRPS Biological Opinion, including aggressive hydropower measures (NOAA Fisheries 2000), CRFM, and other salmon recovery efforts are substantial and are reported

in the Endangered Species Act 2003 Check-In Report (U.S. Bureau of Reclamation et al. 2003). The reduction in Caspian tern predation on juvenile salmonids would complement and protect benefits associated with upstream efforts to increase the number of juvenile salmonids reaching the ocean.

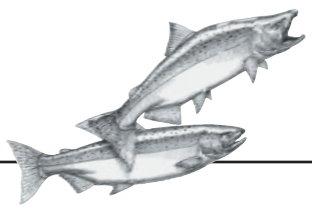
Reducing tern predation in the estuary is one additional mechanism that can be used to improve juvenile salmonid survival, thereby increasing population growth rates of ESA-listed salmonids in the Columbia River Basin (NOAA Fisheries 2004a, Appendix C). Ultimately, long-term benefits to ESA-listed salmonids in the Columbia River estuary would depend on the ability to maintain nesting habitat to support the proposed range of terns (2,500 to 3,125 pairs). If a more stable, dispersed regional tern population resulted in less predation of juvenile salmonids then conditions may improve for some Columbia River estuary ESUs.
However, long-term success of efforts intended to increase population growth rates of ESA-listed salmonids must be placed in context with other sources of mortality subject to human intervention. Hydropower operations, harvest impacts, habitat conditions, hatchery operations, and introduced species all have the potential to affect population growth rates of ESA-listed salmonids, and are subject in various degrees to management efforts to alleviate detrimental effects. Actions to address these impacts have been implemented or proposed, and others may be developed in the future. Cumulatively, these actions have the potential to influence population growth rate to a substantially greater degree than would be realized from solely reducing predation from avian predators in the Columbia River estuary (e.g., Kareiva et al. 2000, Wilson 2003).

TABLE 4.6 Summary and comparison of potential effects of Alternatives A, B, C, and D.

RESOURCE	ALTERNATIVE A No Action-Current Management Program	ALTERNATIVE B No Management	ALTERNATIVE C Redistribution of ESI Tern Colony **PREFERRED ALTERNATIVE**	ALTERNATIVE D Redistribution and Lethal Control of ESI Tern Colony
PHYSICAL ENVIRONMENT	WA: No effects OR: No effects, continued removal of vegetation on 6 acres on East Sand Island CA: No effects	WA: No effects OR: Substantial effects, complete revegetation of 6 acres on East Sand Island CA: No effects	WA: No effects OR: Revegetation of 4.5 to 5 acres on East Sand Island; minimal short-term construction associated effects elsewhere CA: Minimal short term effects (removal of vegetation and addition of substrate material)	Same as Alternative C
CASPIAN TERNS				
Nesting Habitat on East Sand Island (ESI)	No effects, maintain 6-acre nesting area	Substantial effects with loss of 6-acre nesting area within 3 years	Colony site reduced from 6 acres to 1 - 1.5	Same as Alternative C
Nesting Habitat in Region	No effects to existing network of nesting sites	No effects to existing network of nesting sites	8 acres of enhanced and managed habitat in addition to existing network of nesting sites	Same as Alternative C
East Sand Island Colony Size	Stabilized with a potential for increase (predicted size of 18,500 pairs in 2009)	Substantial effect, colony elimination, 0 pairs within 3 years	Substantial effect: colony reduced to about 2,500 to 3,125 pairs at full implementation	Same as Alternative C
Regional Tern Population Trend	Stabilized with a potential for increase	Stabilize (possibly lower than current numbers) or potential decline if terns unable to find alternative nesting sites	Stabilize (possibly lower than current numbers)	Stabilize (possibly lower than current numbers but declining if lethal control is implemented
ESA-LISTED FISH (SALMONIDS AND OTHER FISH)				
ESA-listed Fish in the Columbia River Estuary (CRE)	Continued or potential increase in consumption of ESA-listed salmonids; no improvement in lambda	Substantial decrease or eventual elimination of consumption of ESA-listed salmonids, predicted improvement in lambda	Substantial decrease of consumption of ESA-listed salmonids, predicted improvement in lambda	Same as Alternative C
ESA-listed Fish at Managed Alternate Sites	WA: No substantial effects OR: No effects CA: Not substantial effects	Possible increase in consumption of ESA-listed salmonids or bull trout; Effects may range from no effects to no substantial effects depending on where displaced terns relocate	Limited increase in consumption of ESA-listed salmonids, bull trout, and Warner sucker but no substantial effects	Same as Alternative C, but effects reduced if lethal control is implemented

TABLE 4.6 (con't) Summary and comparison of potential effects of Alternatives A, B, C, and D.

RESOURCE	ALTERNATIVE A No Action-Current Management Program	ALTERNATIVE B No Management	ALTERNATIVE C Redistribution of ESI Tern Colony **PREFERRED ALTERNATIVE**	ALTERNATIVE D Redistribution and Lethal Control of ESI Tern Colony
FISH (NON-ESA-LISTED)	No substantial effects	WA: No substantial effects OR: Moderate effects, decreased consumption as terns abandon ESI CA: No substantial effects	No substantial effects	Same as Alternative C, but effects reduced if lethal control is implemented
OTHER BIRDS	No effects	WA: No substantial effects OR: Gulls will benefit from vegetated tern nesting area on ESI CA: No substantial effects	WA: No substantial effects OR: Moderate beneficial effects from additional nesting islands created at Summer and Crump lakes CA: No substantial effects	Same as Alternative C, but immediate benefits in Oregon because fewer terns are expected to disperse if lethal control is implemented
MAMMALS	No effects	No effects	Minimal effect if predator management program implemented	Same as Alternative C
ESA-LISTED WILDLIFE AND PLANTS	Minimal effects	Effects may range from no effects to no substantial effects depending on where displaced terns relocate	WA: Minimal effects OR: Minimal effects CA: Potential effects to western snowy plover, but not substantial; minimal effects to other ESA-listed wildlife	Same as Alternative C, but effects reduced if lethal control is implemented
COMMERCIAL AND RECREATIONAL FISHERIES	No substantial effects (no change from current conditions)	No substantial effects, except potential benefits in the Columbia River estuary	Same as Alternative B	Same as Alternative B, but effects reduced if lethal control is implemented
TRIBAL FISHERIES	No substantial effects (no change from current conditions)	No substantial effects, except potential benefits in the Columbia River estuary	Same as Alternative B	Same as Alternative B, but effects reduced if lethal control is implemented
CULTURAL RESOURCES	No effects	No effects	WA: No effects OR: Potential minimal effects CA: No effects	Same as Alternative C



Chapter 5

Relationships to Federal, State, and Local Policies and Plans

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Chapter 5. Relationships to Federal, State, and Local Policies and Plans

This chapter contains an overview of the policies and plans used by public agencies within the jurisdiction of the affected environment of this FEIS. A summary is included for each relevant policy and plan, as well as a brief discussion of its relevancy to the proposed action. Land use plans associated with specific sites (e.g., National Wildlife Refuges, Wildlife Management Areas), have been considered in the development of the proposed action and will not be discussed in detail here.

5.1 Fish and Wildlife Service Plans, Policies, and Programs

Management and conservation measures for the Caspian tern are described in the *Status Assessment and Conservation Recommendations for the Caspian tern in North America* (Shuford and Craig 2002) and are intended for use by the Service and other partners interested in tern conservation. Caspian tern conservation needs are also included in the Seabird Conservation Plan, Pacific Region, USFWS (U.S. Fish and Wildlife Service 2005). The purpose of this plan is to identify the Service's goals and priorities for seabird conservation in the Pacific Region, including specific objectives and strategies to achieve these goals. The plan will serve to direct and coordinate Service activities towards seabird conservation in the future.

Service policies relevant to the development of a management plan for the Caspian tern are summarized in Appendix D.

5.2 Other Federal Agency Plans

The Corps is also responsible for implementation of many of the reasonable and prudent alternatives identified in the 2000 FCRPS BO (NOAA Fisheries 2000) for protection and improvement of juvenile salmonid survival at their four mainstem Columbia River and four Snake River dams. The 2004 FCRPS BO (NOAA Fisheries 2004b) assessed predator control actions, including tern management. The Action Agencies (the Corps is one of the Action Agencies) intend to carry out tern management actions as proposed in this FEIS, aimed to redistribute a portion of the terns in the Columbia River estuary in order to reduce tern predation of juvenile salmonids.

The Corps Columbia River Channel Operation and Maintenance Program (O&M Program) would be supported by implementation of a selected alternative associated with this FEIS. The NOAA Fisheries 1999 Biological Opinion for the O&M Program, under Terms and Conditions 1a, states: " The COE shall modify the habitat on Rice Island by April 1, 2000, so that it is no longer suitable as a nesting site for Caspian terns or provide for the hazing of terns off the island in a manner that will preclude their nesting. The COE shall ensure that any terns hazed off the island do not nest on any dredge spoil islands in the action area (other than East Sand Island). The COE shall continue to prevent nesting of Caspian terns on disposal islands within the action area for the life of the project." Thus, implementation of a measure to reduce the Caspian tern population in the Columbia River estuary would assist in achieving the prescribed Terms and Conditions.

Reconsultation is underway for the O&M Program. It is anticipated that the forthcoming BO will address Caspian tern management in the Columbia River estuary in a manner comparable to the existing Terms and Conditions. The future BO for the O&M Program will be merged with the Columbia River Channel Improvement Project (CRCIP) Biological Opinion to ensure a continuity of management practices relative to Caspian terns in the estuary. The CRCIP would entail a deepening of the existing 40-foot navigation channel to a 43-foot project depth plus implementation of a number of ecosystem restoration features.

The Corps has a number of environmental restoration programs in place authorized by Section 1135 of the 1986 Water Resources Development Act (WRDA), Section 206 of WRDA 1996 and Section 536 of WRDA 2000. Various projects are underway or have been completed under these authorities in the lower Columbia River and estuary. Restoration projects associated with these authorities and the CRCIP are principally intended to restore fish and wildlife habitat, to include tidal marshes and riparian forest, and to reconnect the Columbia River to floodplain and/or diked habitats.

The Northwest Power Act of 1980 directs the Northwest Power and Conservation Council

(formerly known as the Northwest Power Planning Council) to develop a program for the protection, mitigation, and enhancement of fish and wildlife of the Columbia River Basin and make annual funding recommendations to the Bonneville Power Administration for projects to implement the program. Sub-basin plans are being developed and contain strategies that will drive the implementation of the Council's Fish and Wildlife Program at the sub-basin level. The sub-basin plan for the lower Columbia River and Willamette River includes a discussion of management of Caspian terns. The Columbia River Fish Mitigation (CRFM) program is funding research efforts on salmon use of Columbia River estuarine habitats. The Lower Columbia River General Investigation Study has been established to investigate and recommend appropriate solutions to accomplish ecosystem restoration in the lower Columbia River and estuary, including wetland/riparian habitat restoration, stream and fisheries improvement, water quality, and water-related infrastructure improvements. The study area includes all areas west of Bonneville Dam on the Columbia River, including tidally influenced tributaries.

The U.S. Army Corps of Engineers 2002 Draft interim environmental assessment titled: Caspian Tern Interim Management Plan Fiscal Year 2003-2004 and Pile Dike Excluder Maintenance to Discourage Cormorant use Lower Columbia River, Oregon (U.S. Army Corps of Engineers 2002) describes management of terns in the Columbia River estuary and presents a plan (see description in Chapter 2, Alternative A) for managing Caspian terns in the Columbia River estuary until a proposed action resulting from this FEIS is implemented.

5.3 State, Local, and Tribal Plans

5.3.1 Washington

The State of Washington has various strategies and programs designed to improve the habitat of ESA-listed salmonids and assist in recovery planning. Washington's 1998 Salmon Recovery Planning Act provided the framework for developing watershed restoration projects and established a funding mechanism for local habitat restoration projects. It also created the Governor's Salmon Recovery Office to coordinate and assist in the development of salmon recovery plans. Washington's Department of Fish and Wildlife and Tribal co-managers have been implementing the Wild Stock Recovery Initiative since 1992. The co-managers are currently completing comprehensive species management plans that examine limiting factors and identify needed habitat activities. The plans also concentrate on actions in the harvest and hatchery areas, including comprehensive hatchery planning. The Department and some western Washington treaty Tribes have adopted a wild salmon policy to provide general policy guidance to managers on fish harvest, hatchery operations, and habitat protection and restoration measures to better protect wild salmon runs.

Washington State's Forest and Fish Plan were promulgated as administrative rules. The rules were designed to establish criteria for non-Federal and private forest activities that will improve environmental conditions for ESA-listed salmonids. The State of Washington also established the Lower Columbia Fish Recovery Board to begin drafting recovery plans for the lower Columbia region.

The Washington Shoreline Management Act (RCW 90.58), administered by the Washington Department of Ecology through Shoreline Master Programs adopted by each local jurisdiction, regulates the development of Washington shorelines.

5.3.2 Oregon

The Oregon Plan is designed to restore the healthy function of Oregon's natural aquatic systems. It represents commitments on behalf of governments, interest groups, and private citizens from all sectors of the State. While the plan originated as an effort to address declining populations of coho salmon, in the two years since its initiation, the plan has engaged new participants, addressed new fish species, attained regional significance and promoted unique approaches to natural resource issues on a State-wide basis (The Oregon Plan for Salmon and Watersheds 2004).

5.3.3 California

The Goals Project was undertaken in June 1995 to establish a long-term vision for a healthy and sustainable baylands ecosystem. The Goals Project used available scientific knowledge to identify the types, amounts, and distribution of wetlands and related habitats needed to sustain diverse and healthy communities of fish and wildlife resources in the San Francisco Bay Area. The Project provides a biological basis to guide regional wetlands planning processes for public and private interests seeking to preserve, enhance, and restore the ecological integrity of wetland communities (Goals Project 1999).

5.3.4 Local Governments

The Lower Columbia Fish Recovery Board (LCFRB) released their Lower Columbia Salmon

Recovery and Fish & Wildlife Subbasin Plan in December, 2004. The goal of the plan is to have Washington Lower Columbia salmon and steelhead recovered to healthy, harvestable levels that will sustain productive recreational, commercial, and tribal fisheries. The plan outlines an adaptive management approach over the next 25 years. It's designed to integrate new information on successes of recovery actions, and on threats to salmon and steelhead, so future efforts can be tailored to provide the best chances for recovery.

The Lower Columbia River Estuary Partnership's (LCREP) *Comprehensive Conservation and Management Plan* provides a broad framework for managing and protecting the lower Columbia River and estuary. It serves as a guide for preserving and enhancing water quality and habitat to be implemented by federal, state, local, and tribal governments; river users; environmental interests; and citizens of the region. LCREP is also completing a subbasin plan, the *Mainstem Lower Columbia River and Columbia River Estuary Subbasin Plan,* for the lower Columbia River and Oregon tributaries. The LCREP subbasin plan complements the LCFRB's document, providing strategies and recommendations for actions that result in fish and wildlife resources and their habitats being maintained at healthy levels and clean, safe water that is available for people, fish, and wildlife. This subbasin plan has potential for a comprehensive, cohesive, and sustained program for species recovery in the Lower Columbia River.

5.3.5 Tribal Governments

The Wy-Kan-Ush-Mi Wa-Kish-Wit, or "Spirit of the Salmon" plan is a joint restoration plan for anadromous fish in the Columbia River basin prepared by the Nez Perce, Umatilla, Warm Springs and Yakama Tribes. It provides a framework for restoring anadromous fish stocks, specifically salmonids, Pacific lamprey (eels), and white sturgeon in upriver areas above Bonneville Dam. Overall, future implementation of the Spirit of the Salmon plan should have positive cumulative effects on ESA-listed salmonids and their habitats. The Nez Perce, Warm Spring, Umatilla, and Yakama Tribal governments are now seeking to implement this plan and salmon restoration in conjunction with the States, other Tribes, and the Federal government, as well as in cooperation with their neighbors throughout the basin's local watersheds and with other citizens of the Northwest.