Chapter 4. Environmental Consequences

This chapter identifies the effects of the four alternatives (summarized in Table 4.1, above) 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.

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 disturbing birds) and/or egg take operations on upper estuary islands would not affect the physical environment. Dredged material placement at the downstream end of Rice Island, where the estuary tern colony was present from 1986 through 2000 would resume. This area is approximately 28 acres in size and vegetation development has precluded tern use.

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 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.

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

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

revegetation of the site used by nesting terns to occur immediately. European beachgrass and American dunegrass 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 includes 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.

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.

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, half acre islands) and Crump Lake (1 acre island). See Appendix G for a full description of construction of islands. Construction of the islands 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. A short-term increase in sedimentation or siltation would occur in the wetland impoundment and lake as a result of the construction activities. These effects, however, are expected to subside once construction activities are completed.

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 winter when this portion of the lake is exposed due to drawdown for winter flood control storage. Construction access would be on the portions of Royal Avenue and Gibson Island roadbeds within the boundaries of Fern Ridge Lake. 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.

California. Under this alternative, management actions that would affect the physical environment are proposed at San Francisco Bay.

Habitat management to provide tern nesting habitat would occur 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 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.

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, and improving the substrate with sand or oyster shells. 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, predator control measures, 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. Since no other actions are proposed that may disturb the levee substrate, negligible effects to the physical environment at these two locations are expected.

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 in subsequent years as birds are able to nest successfully and through immigration. Although nesting substrate is not limiting at this site, we do not expect this colony to grow substantially because of other 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.

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. The barging and release of large numbers of hatchery reared and wild juvenile salmonids into the Columbia River estuary 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 3.3.1 (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 remain below 1,000 nesting pairs because predators 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 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, would initiate discussions as part of an adaptive management approach proposed in this DEIS 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 (*in litt.*) 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 the Columbia River Avian Predation Project from 1997 through 2003 and other currently available data on tern breeding biology (Cuthbert and Wires 1999, Suryan et al. *In review*).

Simple Deterministic Population Model for Caspian Terns (D. Roby *in litt.*):

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. *In review*)
- 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. *In review*)
- 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)

TABLE 4.2 Actual and Projected Caspian tern colony size in the Columbia River estuary, 1997 to 2010.

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	-	~9,000
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).

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. 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 in 2009, terns would need to look for habitat elsewhere in the estuary (e.g., Rice Island, Miller Sands Spit, 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 immediately after initiation. 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 small number of eggs would be collected, thus, effects to the breeding birds 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 due to 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, thus, 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 is not expected to change substantially under this alternative. The stable 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 (four 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. Thus, 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 would initiate discussions to ensure that impacts to Columbia River salmonids are minimized.

Terns would probably continue to try to colonize new areas 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 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 terns from nesting on these islands. Effects 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 provide nesting locations for terns on a regional scale. As described above, whether these sites are sufficient to accomodate all of the displaced terns remains unclear. The majority of the sites that do not require habitat enhancement and are currently available to 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 would be considered 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 range somewhere within the historic colony sizes observed on the Washington Coast (100 to 3,500 breeding pairs).

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, would initiate discussions as part of an

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	1.04 – 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] data from Collis et al. 2003a and b; Roby et al. 1998 and 2002
[d] data from Roby et al. 2003a

adaptive management approach proposed in this DEIS, to ensure that impacts to Columbia River salmonids are minimized.

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 decrease 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 Solstice Island, see Table 4.3). Thus, displaced terns may experience an overall decrease in productivity to 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. Similar to Alternative A, 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 at Summer, Crump, and Fern Ridge lakes. The expected colony sizes at each of these sites would depend on the size of the islands created at each site, 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). At Summer Lake, since other colonial nesting birds occur at this site, we expect that majority of the three, half acre nesting islands could be used by Caspian terns. We expect that nesting tern numbers at Summer Lake could range between 5 to 300 breeding pairs if displaced terns are successfully attracted to this site (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 would 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 resulting in anticipated numbers of terns to be 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, since there are not many other colonial nesting birds at this site, it is expected that majority of the newly created island would be available for nesting terns. We expect the number of nesting terns at this site would also be similar to that of Summer and Crump lakes (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 the extensive boat use that occurs in 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 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 substantially 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 these sites because only a small number of sites would be managed for terns in Washington and Oregon. 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 could be enlarged to at least 2 acres through hand-pulling of vegetation (e.g., non-native ice plant and aster). 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), depending on the success in attracting terns to these new nesting sites.

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 be necessary to protect nesting terns.

Terns nesting in San Francisco Bay are exposed to contaminants and this may be an issue of concern. Some preliminary work has shown that mercury, selenium, and brominated fire retardant (PBDE) concentrations have been found in Caspian tern eggs (T. Adelsbach pers. comm., Schwarzbach and Adelsbach *In review*). 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 5,000 to 6,500 breeding pairs of terns would be displaced from East Sand Island as tern nesting habitat is reduced to one 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 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 fewer sites and larger concentrations of individual colonies.

We expect that the managed sites would be able to provide suitable habitat to accommodate displaced terns, particularly when combined with 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 incurred 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 declines to 50 percent of the current size, management of tern nesting sites in the region would be reevaluated as part of the adaptive management approach proposed in this DEIS.

Regional habitat. Similar to Alternatives A and B, current nesting sites (Table F.1 and F.2) throughout the region would most likely 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 underutilized 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 locations may increase but would not grow to

the level observed in the Columbia River estuary. Predictable nesting habitat (managed dredged 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 dispersal of the entire colony on East Sand Island, effects would be similar to that described for Alternative B.

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 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., by 50 percent) through habitat reduction, we can use a population model to estimate the number of terns that could potentially be killed (e.g., 1,000 to 6,000 terns very year in the first 5 years, see Table 4.4). 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.

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

Year	Pre-Implementation Estimated 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	3,200	3,000	2,700
2009	-	5,900	3,000
2010	-	3,000	2,500
2011	-	2,000	2,600
2012	-	1,000	2,700
2013	-	1,000	2,800
2014	-	1,000	2,800

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.

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 and is successful in killing terns, then the actual number of displaced terns would be less than Alternative C, decreasing the possible increase 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 underutilized 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. Effects to non-ESA-listed salmonids and other fish populations are not expected to change from current conditions (see section 4.2.3 below for description of effects to ESA-listed salmonids). Terns from Dungeness NWR consume these fish, however, effects are not considered substantial given that the tern nesting colony at Dungeness NWR is estimated to be less than 200 breeding 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 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 and 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.

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.

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, 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) and distributed throughout the State. In particular, a study in San Francisco Bay demonstrated that salmonids were a small component (0.17 to 8.7 percent, Roby et al. 2003a) of the tern diet. Effects may increase if terns from the Columbia River estuary are displaced when nesting habitat is maximized (anticipated in 2009). Since this alternative does not propose to implement management actions that would increase suitable nesting habitat for terns, effects are expected to remain the same.

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 nesting pairs moving to alternative locations, possibly in Washington. 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 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 consumption might increase, tern colony sizes are expected to remain small, 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 eliminated 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 DEIS 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 the tern colony in the Columbia River estuary would substantially reduce juvenile salmonid consumption levels from that observed from 2000 to 2003 (average of 5.9 million juvenile salmonids, Collis et al. 2002a, 2002b, 2003a, 2003b). 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.

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. Effects would be similar to that described in Alternative A. Effects to non-ESA-listed salmonids and other fish are not considered to be substantial since tern colonies in California are relatively small (50 to less than 1000 breeding pairs).

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 in the estuary. However, since the tern colony would be reduced by 60 to 70 percent on East Sand Island, the consumption of juvenile non-ESA-listed Columbia River salmonids and other fish would also reduce 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 to be negligible because expected tern colonies at these sites would be relatively small (e.g., 5 to 300 breeding pairs) and resident fish species are abundant. However, 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 if nesting habitat is managed for terns at identified sites (Table 2.1), effects to fish would primarily occur in San Francisco Bay. We expect tern colonies in the bay to grow but individual colony sizes are expected to remain substantially smaller (100 to 1,500 pairs) than that observed in the Columbia River estuary. Thus, effects to non-ESA-listed fish in San Francisco Bay 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, the potential increase in tern numbers at alternate sites would decrease because a number of terns would be removed from the regional population. Thus, effects to non-ESA-listed fish populations would be lower than that expected in Alternative C.

4.2.3 Effects to Federally Endangered and Threatened Fish

4.2.3.1. Alternative A

Washington. Current effects of this No Action alternative, to Puget Sound Chinook and Hood Canal summer-run chum salmon, steelhead, and bull trout have not been quantified. The primary outmigration periods for ESA-listed salmonids in the Puget Sound area occur between February and July (Tynan 1997), coinciding with the tern breeding season (April to July). Based on diet studies of terns nesting in similar habitats (i.e., highly marine coastal sites), we expect juvenile salmonids to comprise a small percent of their diet (Table 4.5). This colony is also relatively small (less than 200 breeding

TABLE 4.5 Range of Salmonid Composition (percent) of Caspian Tern Diets observed at Coastal Sites.

Site	Salmonid Composition (percent)
Grays Harbor (WA) (1975-1976) [a]	3.5 – 21 %
Commencement Bay (WA) (2000) [b]	52%
East Sand Island (OR) (2000-2003)[c]	24 – 47 %
San Francisco (CA) (2003)[d]	0.17 – 8.7 %

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

pairs), resulting in a low number of total salmonids consumed. Thus, we expect effects to ESA-listed salmonids to be limited.

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, under 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 colony continues to increase in size. Under this alternative, terns would continue to consume approximately 5.9 million (or higher as the number of terns increase) juvenile salmonids annually (the average number of juvenile salmonids consumed by terns from 2000 to 2003 when nesting on East Sand Island, Collis et al. 2002a, 2002b, 2003a, and 2003b). Although juvenile salmonids comprise a smaller portion of the diet of terns nesting on East Sand Island, overall consumption of juvenile salmonids may be comparable to what was observed of the Rice Island colony in 1998 (approximately 12. 4 million smolts consumed by terns, Roby et al. 2002) if numbers increase to nearly 20,000 tern pairs. 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 ESA-listed salmonids (Table 2.2 or see Table 5 in NOAA Fisheries 2004, Appendix C). The larger tern colony size and/or predation levels could suppress the population growth rate for ESA-listed salmonids. In addition, if present good ocean upwelling conditions reverse, alternative marine prey resources would diminish, potentially increasing the consumption of ESA-listed juvenile salmonids.

No substantial effects to Warner suckers are anticipated at Crump Lake as terns here were observed to feed primarily on tui chubs in 2003 (Roby et al. 2003a). No nesting habitat exists at Fern Ridge Lake, thus effects to ESA-listed fish species are not anticipated.

California. In San Francisco Bay, outmigration periods for juvenile Sacramento River winter-run Chinook (January to May), Central California Coast coho (mid-April or earlier to mid-June or later), Central Valley spring-run Chinook (March to mid-June or November to April), and Central Valley and Central California Coast 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 demonstrated that juvenile salmonids comprise a small portion of the tern diet in San Francisco Bay (Table 4.5, Roby et al. 2003a). Salmonids were found in the diets of three out of five nesting colonies, ranging from 0.17 (Pond A7) to 8.7 (Knight Island). Thus, effects to ESA-listed salmonids are considered to be 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.

4.2.3.2 Alternative B

Washington. If Dungeness NWR is colonized by higher numbers of Caspian 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) could occur. Timing of juvenile salmonid outmigration (from late February to late July, peaking from May to June, Bax et al. 1980, Bax 1983a, b, Tynan 1997) generally coincides with the tern's nesting season. However because this colony would likely range somewhere between 100 to 1,000 nesting pairs and alternative prey are abundant, effects are expected to remain limited.

Oregon. Within the Columbia River estuary, implementation of Alternative B would initially reduce and ultimately eliminate Caspian 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 eliminated from the estuary, seeking alternate nesting habitat elsewhere in the region. This would result in a substantial reduction and eventual elimination in the total number of ESA-listed salmonids consumed by terns 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 would result in a positive change in population growth rate (1.560 to 4.861 percent for steelhead) that would be realized within 6 to 7 years after implementation of this alternative (NOAA Fisheries 2004). It is important to note that population growth rate calculations presented in NOAA Fisheries 2004 are based on tern predation of juvenile steelhead because they are the most impacted of outmigrating juvenile salmonids (because they are consumed by terns in the highest numbers, 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 serve as a surrogate 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 negligible. 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, a probable increase of predation on ESA-listed salmonids would occur if terns displaced from the Columbia River estuary select to nest in the bay. However, as described in Alternative A, effects to ESA-listed salmonids are expected to be limited as tern numbers are not expected to grow substantially and salmonids were not observed to be primary prey for terns in San Francisco Bay in 2003 (Roby et al. 2003a).

4.2.3.3 Alternative C

Effects to ESA-listed salmonids at alternate nesting sites analyzed as part of this DEIS will depend on the number of birds and/or nesting pairs at each location.

Washington. Effects to Puget Sound Chinook and Hood Canal summer-run chum would be similar to that described in Alternative B with the exception that management actions that may be implemented to further protect the nesting site on Dungeness NWR for terns could result in an increased number of terns. As described in Alternative B, the potential increase in terns would probably result in an increase in consumption of ESA-listed juvenile salmonids. The primary outmigration period for these salmonids coincide with the tern nesting season, the predicted colony size would most likely remain relatively small (100 to 3,500 nesting pairs, based on historic colony sizes on the Washington coast) as compared to the colony in the Columbia River estuary. In addition, consumption of juvenile salmonids is not expected to be high if the terns' diet composition at Dungeness NWR is similar to terns nesting in highly marine areas (e.g., Grays Harbor, San Francisco Bay, and East Sand Island) in which salmonids have not been observed to be a primary component of their diets (Table 4.5). Thus, effects to ESA-listed salmonids are anticipated to remain limited. We do not expect large numbers of displaced terns to nest in eastern Washington sites because alternate sites would be managed to attract these terns. Thus, we expect effects to ESA-listed salmonids in these locations to remain limited.

Oregon. Based on the NOAA Fisheries (2004) report (Appendix C), population growth rate increases would 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) would occur within 3 to 5 years after implementation of this alternative. Thus, initial benefits for ESA-listed salmonids could be realized within 6 to 7 years after implementation of this alternative. The NOAA Fisheries report also indicated that a potential for a positive population growth rate change (1.082 to 3.704 percent) can 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 2004). This improvement in population growth rate is similar in magnitude to that of increases in population growth rate that would result from hydropower improvements (0 to 4 percent increase), but well below improvements that could be achieved by harvest reductions (4 to 8 percent increase, see Table 6, NOAA Fisheries 2004, 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 of 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. 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 (Kareiva et al. 2000, Wilson 2003).

An increase in nesting terns at Crump Lake is not expected to affect the threatened Warner sucker since they were not observed to be a primary prey species for terns in 2003 (Roby et al. 2003a). However, proposed activities to build up the existing island could result in temporary effects to Warner suckers through siltation or increase in sedimentation, with effects subsiding once construction activities are completed. Efforts would be made to minimize potential effects. No ESA-listed salmonids occur at Summer and Crump lakes, thus no effects are expected.

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 (East Sand Island in 2000) 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 ESA-listed salmonids. Thus, terns could potentially consume juvenile salmonids if they forage in the Willamette and McKenzie rivers. However, effects to these ESA-listed salmonids are expected to be limited because the number of nesting terns are expected to be small (5 to 300 pairs).

California. Effects to ESA-listed salmonids have the potential to increase under this alternative because specific sites in San Francisco Bay would be managed to attract displaced terns from the Columbia River estuary. Increased numbers of terns could increase consumption of ESA-listed salmonids in San Francisco Bay. However, as described in Alternatives A and B, although there is some overlap with the outmigration periods of these salmonid species during the tern breeding season, effects are expected to remain limited. In particular, a diet study conducted in 2003 indicated that salmonids comprise a small portion of the tern diet (Roby et al. 2003a) and individual colony sizes (100 to 1,500 pairs) are predicted to remain small in comparison to that observed in the Columbia River estuary. Additionally, alternative prey (e.g. marine fishes) are most likely abundant and available to nesting terns, reducing the potential for terns to prey on salmonids.

4.2.3.4 Alternative D

Effects to ESA-listed fish in Washington, Oregon, and California are similar to that described in Alternative C, with the exception that if lethal control is implemented to reduce the colony size on East Sand Island, 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.

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). The one

to three pairs of oystercatchers currently nesting on Dungeness NWR, use the same location as the terns but no negative interactions were 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 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 for 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) 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 that 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. Song birds 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 be negligible since nesting habitat is usually not limited, except in southern California. 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 the 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 decreased competition with nesting terns and 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, Forester's terns and double-crested cormorants would benefit by having more nesting

habitat available. The creation of a nesting island at Fern Ridge Lake could also benefit colonial nesting birds that may select to nest at that site if habitat was available.

California. In San Francisco Bay, increased tern numbers are not expected to affect other bird species because habitat is not limiting at these sites. 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 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 is a known predator on nesting terns in San Francisco Bay. Predator management would be necessary at all three sites in San Francisco Bay. Similar to that described in Washington and Oregon, effects to the red fox population 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. Implementation of Alternative A would have no effect to bald eagles, western snowy plovers, and marbled murrelets, which occur in Dungeness Bay because they do not compete with Caspian terns for nest sites or prey.

Oregon. Under this alternative we expect no effects to roosting brown pelicans that primarily occur on the western half of East Sand Island, along the shoreline or on the upstream beaches. These areas are outside the tern nesting site. Bald eagle use of the island would continue under this alternative and no effect for this species is expected. 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, we expect no effects to bald eagles, western snowy plovers, brown pelicans, and California least terns in California because no change in existing tern colony sizes are expected and competition with these species for nest sites or prey is 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 because terns do

not compete with the various ESA-listed species for nest sites or prey.

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, western snowy plovers, and brown pelicans for the same reasons described in Alternative A. Effects to California least terns nesting in San Francisco Bay are not expected because competition for nest sites at the proposed Alameda NWR is unlikely. Caspian terns currently nest at sites that are at least 8 miles away. 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). However, if Caspian tern colonies increase in size in southern California, the larger Caspian tern could compete for nesting habitat 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 to be 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 are similar to that described in Alternatives A and B.

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. Increased numbers of nesting terns may benefit bald eagles at Summer, Crump, and/or Fern Ridge lakes by providing an additional food resource.

California. The potential growth of existing and the establishment of new tern colonies in San Francisco Bay are not expected to affect bald eagles, western snowy plovers, and brown pelicans. Western snowy plovers primarily use dry salt pond beds, whereas, terns use nesting islands or abandoned levees. Thus, with the exception of the levees, terns would not be competing for nesting habitat with western snowy plovers. 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 because nest site and foraging competition is unlikely. Although displaced terns may nest in southern California under their own accord, we do not expect large numbers of terns selecting these sites since other sites in California would be actively managed to attract displaced terns. Thus, unlike Alternative B, we expect effects to California least terns to be negligible.

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 (see section 4.2.2 and 4.2.3). However, effects are not considered to be substantial because the current colony at Dungeness NWR is less than 200 breeding pairs, resulting in low consumption levels. In addition, as described in section 4.2.2 and 4.2.3, we expect the diet of terns nesting in Dungeness NWR would primarily consist of non-salmonids. Salmonid stocks that originate in Washington and associated with the Columbia River Basin would al be consumed by terns nesting in the Columbia River (see Oregon section below).

Effects to herring fisheries in Washington are not expected because these stocks are not depressed and should not be affected by the small tern colony. 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 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 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. Thus, effects to fisheries in the bay are not considered to be substantial. In particular, salmonids comprise a small portion of the tern diet in the bay (Roby et al. 2003a, Table 4.4).

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 to are expected to be similar to current conditions.

Oregon. Consumption of juvenile salmonids by terns would decrease subtantially 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 as described in Alternatives A and B. We expect effects to not be substantial because the colony size is expected to remail small, resulting in low consumption levels. In addition, as described in section 4.2.2 and 4.2.3, we expect the diet of terns nesting in Dungeness NWR would primarily consist of non-salmonids. Effects to herring fisheries in Washington are not expected and 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 commercially 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. 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. The current effect on Tribal harvested salmonids at Dungeness NWR is unknown since terns have been nesting at this site for just one year. 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 Tribal harvested salmonids that occur in Dungeness Bay. However, effects are not considered to be substantial because the current colony is less than 200 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 since tern numbers are not anticipated to be similar to that observed in the Columbia River estuary. In addition, as described in section 4.2.2 and 4.2.3, we expect the diet of terns nesting in Dungeness NWR would primarily consist of non-salmonids. 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. Effects would be similar to those described in Alternatives A and B.

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.

TABLE 4.6 Summary and comparison of potential effects of Alternatives to Caspian Terns and ESA-listed Salmonids in the Pacific Coast region.

RESOURCE	ALTERNATIVE A No Action-Current Management Program	ALTERNATIVE B No Management	ALTERNATIVE C Redistribution of ESI Tern Colony	ALTERNATIVE D Redistribution and Lethal Control of ESI Tern Colony
CASPIAN TERNS				
Nesting Habitat on East Sand Island (ESI)	6 acres	Anticipate nesting area completely vegetated within 3 years	1 - 1.5 acres	Same as Alternative C
Nesting Habitat in Region	Existing network of nesting sites throughout the region	Existing network of nesting sites throughout the region, except for the loss of ESI	Enhanced network of nesting sites throughout the region with approximately 8 acres of managed nesting habitat	Same as Alternative C
East Sand Island Colony Size	Would continue to increase until habitat is maximized	Anticipate colony elimination	2,500 and 3,125 pairs	Same as Alternative C
Regional Tern Population	Continue current increasing trend	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) or potential decline if lethal control is implemented
ESA-LISTED SALMONIDS				
Columbia River Estuary (CRE)	Increase in consumption of ESA-listed salmonids no improvement in lambda	Substantial decrease or eventual elimination of consumption of ESA-listed salmonids, improvement in lambda	Substantial decrease in consumption of ESA-listed salmonids, improvement in lambda	Same as Alternative C
Alternate Sites	No effects	Possible increase in consumption of local ESA-listed salmonid populations	Increase in consumption of local ESA-listed salmonid populations at managed alternate sites	Same as Alternative C, except if lethal control is implemented, lesser increase in consumption of ESA-listed salmonids
Region	No effects	Overall decrease in consumption of ESA-listed salmonids	Overall decrease in consumption of ESA-listed salmonids	Same as Alternative C, except if lethal control is implemented, less terns would be displaced, resulting in greater effects than Alternative C

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 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 and concentrations of larger individual colonies. 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 FCRPS Biological Opinion (aggressive hydropower measures, NOAA Fisheries 2000), CRFM, and other salmon recovery efforts are substantial and reported in the Endangered Species Act 2003 Check-In Report (U.S. Bureau of Reclamation et al. 2003). Thus, 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 2004, 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).