Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary

Draft Environmental Impact Statement

US Army Corps of Engineers ®
Portland District

Executive Summary

The Need for a Management Plan

In this Environmental Impact Statement the U.S. Army Corps of Engineers (Corps) is evaluating several alternatives to reduce predation-related losses of juvenile salmon (*Oncorhynchus* spp.) and steelhead (*O. mykiss*) from double-crested cormorants (*Phalacrocorax auritus*) nesting on East Sand Island in the Columbia River Estuary. Many of these juvenile salmon and steelhead (referred collectively hereafter as salmonids) are listed as threatened or endangered under the Endangered Species Act. Development and implementation of a management plan to reduce avian predation is a requirement under the Corps' consultation under the Endangered Species Act with the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration (NOAA Fisheries) for the operation of the hydropower dams that make up the Federal Columbia River Power System. Management of double-crested cormorants is necessary to increase survival of juvenile salmonids by reducing predation-related losses. Over the past 15 years, double-crested cormorants on East Sand Island consumed approximately 11 million juvenile salmon and steelhead per year. When compared to other known mortality factors, this predation is considered a significant source of mortality to juvenile salmonids.

The Corps is the lead agency of the Environmental Impact Statement under the National Environmental Policy Act. The U.S. Fish and Wildlife Service, U.S. Department of Agriculture's Animal and Plant Health Inspection Service, Oregon Department of Fish and Wildlife, and Washington Department of Fish and Wildlife are cooperating agencies to the Environmental Impact Statement. The preferred alternative is the Corps' proposed management plan to comply with the 2014 Supplemental Federal Columbia River Power System Biological Opinion. The analyses in this Environmental Impact Statement will also help support decision-making within the cooperating agencies and other agencies, which have connected actions as a result of the implementation of the Corps' action. Three action alternatives (management plans) are considered in detail in the Environmental Impact Statement. Each alternative contains a set of actions, monitoring efforts, and potential adaptive responses that make up a management plan. Each alternative integrates non-lethal and lethal methods to manage the colony, with focus on one method as the primary management strategy.

Double-crested cormorants are native to the Columbia River Estuary. The colony on East Sand Island near the mouth of the Columbia River has increased from 100 breeding pairs in 1989 to approximately 15,000 breeding pairs in 2013. With a typical foraging range of

25 kilometers (Figure ES-1), the diet of double-crested cormorants on East Sand Island is made up mostly of marine forage fish. However, as juvenile salmonids migrate through the Lower Columbia River Estuary and past East Sand Island, double-crested cormorants consume them at high rates. Double-crested cormorant consumption of juvenile salmonids is highest in early May, which coincides with the peak nesting season.

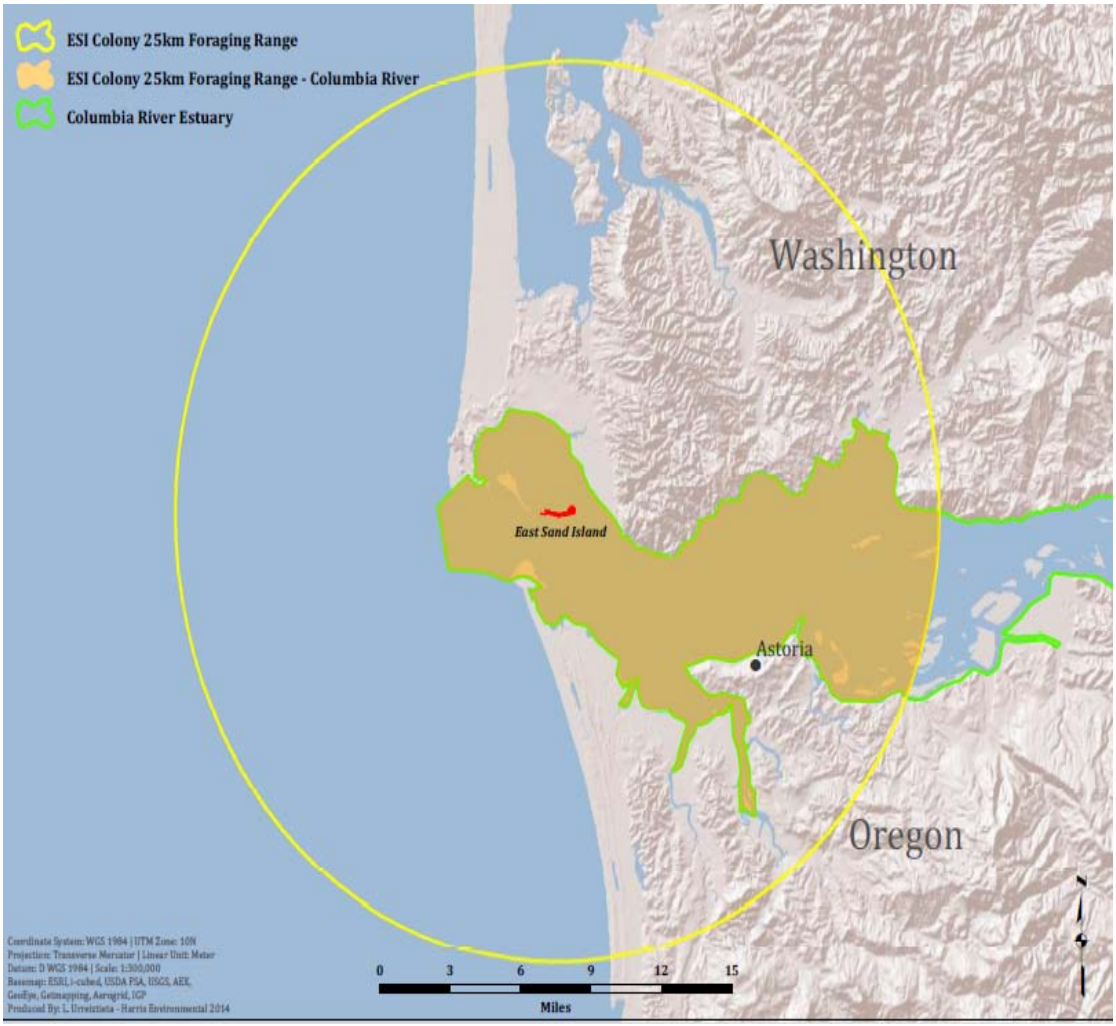

FIGURE ES-1. East Sand Island and the typical foraging range of nesting double-crested cormorants.

Management Objectives

Because of the documented adverse impacts to juvenile salmonids, management of the double-crested cormorant colony on East Sand Island was identified as a reasonable and prudent alternative action in the 2008 and associated 2010 and 2014 Supplements to

the Federal Columbia River Power System Biological Opinion issued by NOAA Fisheries. For the 2014 Supplemental, NOAA Fisheries presented a "survival gap" analysis, which evaluated the difference in double-crested cormorant predation on juvenile steelhead between the "base period" of 1983–2002 and the "current period" of 2003–2009. Because steelhead are more susceptible to double-crested cormorant predation (compared to other salmonid species and in the context of the Biological Opinion), they were used to describe survival improvement targets that could be achieved through management of the double-crested cormorant colony on East Sand Island. NOAA Fisheries analysis determined that mortality of juvenile steelhead from double-crested cormorant predation was approximately 3.6 percent higher in the "current period" than the "base period."

NOAA Fisheries then determined that a reduced double-crested cormorant breeding population of 5,380 to 5,939 breeding pairs on East Sand Island would restore juvenile steelhead survival to the environmental baseline or "base period" levels. Thus, reasonable and prudent alternative 46 in the 2014 Supplemental Federal Columbia River Power System Biological Opinion called for the Corps to "…*develop a cormorant management plan (including necessary monitoring and research) and implement warranted actions to reduce cormorant predation in the estuary to Base Period levels (no more than 5,380 to 5,939 nesting pairs on East Sand Island).*" Reasonable and prudent alternative 46 specified the primary management objective for this Environmental Impact Statement and was written into the purpose of and need for action. The time period associated for implementation and achievement of management objectives is tied to the Biological Opinion, which identifies actions to begin by spring of 2015 and overall objectives to be achieved by the end of 2018. Regardless of prescribed timeframes, there is a strong need to implement actions as soon as possible to alleviate the significant source of mortality to juvenile salmonids from double-crested cormorant predation.

Putting Predation Impacts in Context

There are many causes of mortality to juvenile salmonids (Figure ES-2) as they move through the Columbia River Basin to the Pacific Ocean. In the context of other identified point-sources of mortality, such as hydropower dams, the mortality from predation by double-crested cormorants for some salmonid groups in the Columbia River Estuary is significant. For example, dam passage survival of steelhead and spring Chinook salmon

at Bonneville Dam is required to be 96 percent (no more than 4 percent mortality). In 2011, estimated juvenile steelhead survival was higher than this, at 97.5 percent (or 2.5 percent mortality). This level of mortality from dam passage is approximately 2.7 times less than the 6.7 percent mortality for juvenile steelhead resulting from double-crested cormorant predation, as estimated in the NOAA Fisheries analysis in determining reasonable and prudent alternative 46. Higher mortality rates compared to the NOAA Fisheries analysis have been documented for some Columbia River salmonid groups in a given year (e.g., 11-17 percent; see Chapter 1, Section 1.2). Thus, for some salmonid groups, average double-crested cormorant predation impacts can be similar to or exceed the mortality experienced at a hydropower dam in the Federal Columbia River Power System, and, in some years, can be three to four times higher. Furthermore, recent research indicates juvenile salmonid mortality is highest in the lower 31 miles of the Columbia River (see Chapter 1, Section 1.2).

It is important to note that double-crested cormorant predation can differ dramatically within a given year and between years. During 2003–2013, when the colony size was relatively stable, estimates of total annual consumption ranged between 2.4 and 20.5 million. Factors that likely affect double-crested cormorant predation include environmental conditions that affect the timing, abundance, and availability of forage fish in the estuary (e.g., river discharge, tidal volume, sea surface temperature, upwelling timing, and strength), differences in double-crested cormorant abundance, nesting chronology, and nesting success, and large-scale climatic factors that influence both the prey and predator (e.g., El Niño Southern Oscillation, Pacific Decadal Oscillation, North Pacific Gyre Oscillation, and Pacific Northwest Index). These factors will be considered when predicting and interpreting the success of management actions on East Sand Island within a given year and over the long-term.

FIGURE ES-2. Juvenile salmon.

A Complex Issue

This Environmental Impact Statement proposes alternatives to manage the largest colony of double-crested cormorants in North America. Wildlife management is fundamentally a human concept. As the needs or goals of humans conflict with the needs of wildlife, there is an increasing "human dimension" to wildlife management. Individuals with an interest in the outcome of the management plan do not all share common values, nor will any one management action or alternative appease all stakeholders. The issues presented in this Environmental Impact Statement compose a complex problem, and the importance and relevance of the "human dimension" to finding an adequate solution cannot be overstated.

The differences in values held by the various stakeholders interested in the Corps' double-crested cormorant management plan were identified to some degree in the public scoping comments received. Many fisheries groups expressed concern that the problem has been left unaddressed for too long, that double-crested cormorant predation will only continue to increase, and the loss of personal income due to reduced fishing opportunities is unacceptable. Alternately, many wildlife groups commented that double-crested cormorants are being made scapegoats and suggested the Corps look at the true causes endangering salmon and steelhead runs, which these groups stated as overfishing, an excess of hatchery fish being released, and fish passage barriers such as the hydropower dams. While there were extremes in viewpoints, the Corps is seeking a balanced approach in addressing these competing considerations, needs, and recommended potential solutions to this complex wildlife management issue.

Designing Research to Guide Future Management

The Corps has conducted research to understand the dynamics of the double-crested cormorant colony on East Sand Island and aid in the development of appropriate alternatives for this Environmental Impact Statement. Social attraction techniques (setting up decoys and broadcasting audio playback of bird calls to encourage nesting) were tested within and outside the Columbia River Estuary for several years as a possible method to redistribute the East Sand Island double-crested cormorant colony. During 2004–2008, social attraction was employed on Miller Sands Spit and Rice Island with some success, primarily on Miller Sands Spit. During 2007–2012, social attraction

techniques were used outside of the Columbia River Estuary at four known roosting sites in Oregon, but there were no nesting attempts made by double-crested cormorants.

In 2008 the Corps began to investigate the effectiveness of certain non-lethal methods to dissuade double-crested cormorants from nesting in specific locations on East Sand Island (Figure ES-3). Human hazing and use of visual deterrents was determined to be the most effective method to reduce the amount of available nesting habitat. In 2013, double-crested cormorants were restricted to just 4.4 acres of habitat, amounting to a 75 percent reduction of their preferred nesting area. Despite annual reductions in the amount of available nesting habitat, double-crested cormorants nested successfully on East Sand Island every year.

FIGURE ES-3. Cormorant colony on East Sand Island during dissuasion research.

Knowing where double-crested cormorants might relocate if dissuaded from nesting on East Sand Island was a high priority of dissuasion research during the last several years. As part of the studies, breeding adult double-crested cormorants were marked with radio or satellite transmitters. After some off-colony dispersal immediately following tagging, most returned to roost or nest on or near East Sand Island in the same year they were tagged and dissuaded from nesting. Double-crested cormorant use of areas during the breeding season was highest in the Lower Columbia River Basin, followed by the Washington Coast and Salish Sea (Table ES-1). Of all satellite-tagged cormorants

hazed from East Sand Island prior to the 2012-2013 nesting seasons, 98 percent remained in the Columbia River Estuary for the nesting season.

TABLE ES-1. Visits of Satellite-tagged Double-crested Cormorants during March 1–September 30 (Years 2012 and 2013) and the Number of Active and Historical Colonies in Each Region.

Region	# of Birds that Visited	% of Birds that Visited	# of Detections	% of Detections	Active Colonies	Active + Historical Colonies
Oregon Coast	0	0.0%	0	0.0%	22	40
Lower Columbia River Basin	93	97.9%	976	59.7%	4	8
Washington Coast	61	64.2%	460	28.1%	4	32
Salish Sea	20	21.1%	144	8.8%	12	44
Vancouver Island Coast	4	4.2%	55	3.4%	0	0

Key Considerations in Developing Alternatives

The Corps considered many factors in determining how best to achieve the purpose and need (management goal) of this Environmental Impact Statement. Both double-crested cormorants and juvenile salmonids are natural components of the ecosystem and are protected under federal laws. Proposed management actions to double-crested cormorants must comply with the regulations implementing the Migratory Bird Treaty Act. Special considerations were given to the logistics of managing the large colony over a broad geographic area such as the Columbia River Estuary. Consideration was given on how to minimize potential impacts to other birds on and outside East Sand Island, a designated Important Bird Area by the American Bird Conservancy and the National Audubon Society, with upwards of 60,000 birds on the island during the nesting season.

Early in project planning, concerns were raised regarding redistribution of a large number of double-crested cormorants, and how other species and resources, as well as states, local agencies, and the public, might be affected should predation impacts be transferred to other areas. Dispersal of double-crested cormorants has the potential to cause greater impact to juvenile salmonids if they move to upriver locations in the Columbia River Estuary where juvenile salmonids compose a higher proportion of their diet. The Corps included extensive monitoring and adaptive management approaches into the alternatives to minimize double-crested cormorant dispersal and adverse effects to other regions.

How Alternatives Were Developed

The 2008 Federal Columbia River Power System Biological Opinion included a reasonable and prudent alternative to develop a double-crested cormorant management plan. A target colony size was not specified. In 2010, an interagency working group was formed to develop a management plan which included general alternatives to reduce double-crested cormorant predation, based on percent reductions (i.e., 25 percent, 50 percent, 75 percent, etc.). In July 2012 the Corps published its Notice of Intent which identified these various alternatives. Subsequently, the 2014 Supplemental Federal Columbia River Power System Biological Opinion identified a target colony size for East Sand Island.

The Corps further refined the alternatives based on comments from public scoping in late 2012 and through discussions with cooperating agencies. The Corps evaluated potential alternatives for their ability to meet the purpose of and need (management goal). However, only alternatives that were considered feasible in meeting the purpose of and need (management goal) were carried forward for detailed study.

Summary of Alternatives

Three action alternatives (including the preferred) and a no-action alternative are considered in detail (Table ES-2). Alternatives were developed as management plans. All employ an "integrated" approach (using a combination of non-lethal and lethal methods, but with focus on one or the other as a primary method). Alternatives employ a two-phased approach. Phase I involves efforts to directly reduce the size of the colony on East Sand Island to the target range set in reasonable and prudent alternative 46 in the 2014 Supplemental Federal Columbia River Power System Biological Opinion (5,380 to 5,939 breeding pairs). Phase II involves efforts to ensure the target colony size is not exceeded and to evaluate the success of management. This would be done by monitoring peak annual size of the East Sand Island colony and recovery of salmonid passive integrated transponder tags deposited by double-crested cormorants within the colony. Passive integrated transponder tags are inserted into fish and allow for assessment of juvenile salmonid mortality resulting from the East Sand Island double-crested cormorant colony.

TABLE ES-2. Comparison of Alternatives.

Alternative	Summary of Actions	Monitoring	Adaptive Management
Alternative A No Action	No actions would occur to manage the colony on East Sand Island. The Corps would not meet its statutory responsibilities to fulfill reasonable and prudent alternative 46. Survival improvements for juvenile salmonids would need to be made up with other actions within the purview of the Federal Columbia River Power System.	n/a	n/a
Alternative B Non-Lethal Management Focus with Limited Egg Take	Phase I - Use primarily non-lethal methods to achieve target colony size of ~5,600 double-crested cormorant breeding pairs by dispersing >7,250 breeding pairs off East Sand Island over a 4-year period. Incremental dispersal (approximately 2,000-3,000 pairs per year) would occur by reducing available acreage incrementally and hazing elsewhere on the island to preclude nesting. An application for a depredation permit for minimal egg take on East Sand Island (500 eggs) and in the Columbia River Estuary (250 eggs) would be submitted to USFWS annually to support the effectiveness of hazing efforts after the beginning of the breeding season. Off-island land- and boat-based hazing could occur throughout the Columbia River Estuary. Boat-based and land-based monitoring and hazing efforts within the Columbia River Estuary concurrent with management actions on East Sand Island through July 31. Five to eight boat crews would survey and haze	Phase I - Tiered approach at monitoring (daily, weekly, and monthly as necessary) via aerial, boat-, and land-based surveys to measure peak colony size and detect movement of double-crested cormorants in the Columbia River Estuary. Aerial and ground monitoring on East Sand Island to determine abundance and response of double-crested cormorants and other birds. Recovery of passive integrated transponder tags after the breeding season to assess fish mortality. Outside the Columbia River Estuary, abundance surveys in the Columbia Basin above the Bonneville Dam and in coastal areas in Washington and Oregon would occur at least once a year during the peak breeding season. Phase II - Monitoring on East Sand Island and Columbia River Estuary would decrease in frequency depending on information needs.	Corps would convene Adaptive Management Team with cooperating agencies to meet as needed during implementation. Monitoring results would be used to determine need for in-season and between year adjustments in field techniques, including reduction in available habitat, hazing techniques, and egg take numbers. Monitoring frequency and locations adjusted based on information needs. If aerial surveys are not sufficient in assessing dispersal, individual marking techniques (i.e., primarily satellite tags, but also VHF radios and bands) could be used.

Alternative	Summary of Actions	Monitoring	Adaptive Management
	double-crested cormorants throughout the Columbia River Estuary. Phase II - Terrain modification to inundate the western portion of the island and preclude nesting, combined with continued monitoring and hazing efforts, supported with limited egg take, as needed, to ensure the colony target size is not exceeded. A colony size of ~5,600 breeding pairs could remain. No management actions would be taken to ensure a minimum colony size.	No annual abundance surveys in the Columbia Basin above the Bonneville Dam and in coastal areas in Washington and Oregon. Outside of the Columbia River Estuary, monitoring would match or supplement the Pacific Flyway Monitoring Strategy, which calls for monitoring at select sites every three years.	
Alternative C Culling with Integrated Non-Lethal Methods Including Limited Egg Take *(Preferred Management Plan)*	Phase I - Culling of individuals to achieve target colony size of ~5,600 breeding pairs. Culling would occur over 4 years, with the ability to achieve the target size in a shorter duration (3 or 2 years) under Adaptive Management. Under the 4-year strategy, 20.3 percent of the colony would be culled per year. In total, 15,955 double-crested cormorants would be taken in all years (5,230, 4,270, 3,533, and 2,923 double-crested cormorants in years 1 to 4, respectively). The Corps would submit an annual depredation permit application to the USFWS for the proposed individual take levels and associated nest loss from take of those individuals. Take would occur on- and off-island within the foraging range (25km) of the East Sand Island colony. Concurrent with culling, hazing supported with limited egg take would occur to prevent colony expansion on the island, along with land- and boat-based hazing and efforts to prevent double-crested cormorants from	Phase I - The same tiered monitoring on and off East Sand Island as Alternative B would occur. Take levels would be reported annually with more informal reporting as needed. Similar to Alternative B, abundance surveys in the Columbia Basin above the Bonneville Dam and in coastal areas in Washington and Oregon would occur at least once a year during the breeding season. Monitoring in the Columbia River Estuary would occur 2 to 3 days after a culling session and be used to assess potential dispersal to areas in the Columbia River Estuary, particularly upstream of the typical double-crested cormorant foraging range (25 km) of East Sand Island. Monitoring could decrease in frequency once take commences. Less than five boat crews would be needed.	Same Adaptive Management Team and adjustments to non-lethal techniques and monitoring as described in Alternative B, except no individual marking would occur. The adjusted 3-year or 2-year strategy could be selected if the proposed take levels for the respective strategy are expected to be achieved by June 26- (approximate mid-point of when active nests are typically present on East Sand Island) and the frequency of culling to achieve the proposed take levels would not exceed the lower dispersal

Alternative	Summary of Actions	Monitoring	Adaptive Management
	relocating in the Columbia River Estuary, similar to Alternative B. Phase II - Same as Alternative B.	Phase II - Same as Alternative B.	threshold (observed abundance 70 percent or less than expected abundance one week after a culling session). Take percentage in year 2 and 3 could be increased to 28.8 percent for the adjusted 3-year strategy (6,071 and 4,489 double-crested cormorants taken and associated active nests lost in year 2 and 3) or 48.0 percent for the adjusted 2-year strategy (10,156 double-crested cormorants taken and associate active nests lost in year 2). Selecting June 26 as a measure for adjusting future take levels would be contingent upon implementation occurring as planned. If this level of take could likely occur by June 26, the Corps, in consultation with the Adaptive Management Team, would then consider adjusting year strategies.
Alternative D Culling with Exclusion of Double-crested	Phase I - Same as Alternative C. Phase II - The same primarily non-lethal methods described in Phase II of Alternatives B and C (terrain modification, supplemented with hazing supported	Phase I - Same as Alternative C. Phase II - Same as Phase I of Alternative B initially, but would transition to Phase II of Alternative B and C.	Phase I - Same as Alternative C. Phase II - Same as Phase I of Alternative B initially, but would transition to Phase II of

Alternative	Summary of Actions	Monitoring	Adaptive Management
Cormorant Nesting on East Sand Island in Phase II	with limited egg take, as necessary) would be used to disperse all remaining double-crested cormorants (~5,600 breeding pairs) from East Sand Island and exclude future double-crested cormorant nesting. Hazing efforts in the Columbia River Estuary would be the same as Phase I of Alternative B.		Alternative B and C.

Summary of Resources in Affected Environment

Because double-crested cormorants are migratory birds and use a large area and action alternatives proposed in the Environmental Impact Statement are expected to cause some dispersal, the affected environment encompasses a large geographic area. This area includes the coastal and interior areas from northern California (San Francisco Bay) to southern British Columbia (Vancouver Island Coast) and the entire states of Oregon and Washington. Nearly all of the documented post-breeding and wintering locations of double-crested cormorants marked on East Sand Island as part of past monitoring efforts were found within this area. The affected environment is summarized below (Table ES-3):

TABLE ES-3. Affected Environment.

Affected Resource	Summary
Vegetation and Soils of East Sand Island	A mix of native and non-native plant species is found on the island. Several tidal and non-tidal wetlands and forested areas are present. Guano from double-crested cormorants on the western portion of the island has adversely affected vegetation establishment. Soils are generally sandy to sandy silt.
Double-crested Cormorants	The double-crested cormorant colony on East Sand Island has grown from approximately 100 breeding pairs in 1989 to approximately 15,000 breeding pairs in 2013. The colony accounts for approximately 40 percent of the western population of double-crested cormorants, which includes the breeding colonies from British Columbia to California and east to the Continental Divide. Although the western population of double-crested cormorants composes a small percentage of the continental population, the breeding colony on East Sand Island is the largest in North America. The coastal states and provinces account for greater than 90 percent of the western population, with approximately 70 percent of the breeding population along the coast. From 1987–1992 to approximately 2009, the number of double-crested cormorant breeding pairs estimated within coastal states and provinces increased by approximately 72 percent (i.e., 3 percent per year), or 12,000 breeding pairs, with most growth occurring at the East Sand Island colony. Large-scale distributional changes occurred, largely as a result of growth at East Sand Island.
Other Birds on East Sand Island	Gulls, Caspian terns, Brandt's cormorants, and California brown pelicans are present in large numbers on the island. Several raptors (eagles, owls, and falcons) are also present on the island, foraging on eggs, chicks, and adult birds. Waterfowl and shorebirds frequent the island to roost and forage, although in far fewer numbers than nesting colonial waterbirds. Shorebirds are observed in the tidal flats and beaches, and a variety of songbirds are present in the more vegetated areas on the central portion of the island. Most, if not all of these birds, overlap with double-crested cormorants throughout the affected environment.

Affected Resource	Summary
Other Birds	As a result of recent listing under the Endangered Species Act and the designation of critical habitat on nearby islands where double-crested cormorants are expected to prospect for new habitat, streaked horned larks are the species of most concern off of East Sand Island. American white pelicans and pelagic cormorants nest in the Columbia River Estuary. Along the Pacific Coast and Salish Sea, a number of other birds may overlap with double-crested cormorants, including auklets, petrels, puffins, oystercatchers, herons, and pigeon guillemot.
ESA-Listed Fish in the Lower Columbia River Basin	Six fish species, representing fifteen different Evolutionary Significant Units or Distinct Population Segments listed under the Endangered Species Act, occur in the Lower Columbia River Basin and are potential prey to double-crested cormorants. Direct mortality from avian predation, including double-crested cormorant predation, is identified in certain Endangered Species Act recovery plans as a secondary factor limiting viability for all Lower Columbia River coho, late fall and spring Chinook salmon and steelhead populations; a key limiting factor affecting all Middle Columbia River steelhead populations and Upper Willamette River Chinook and steelhead; and a threat to Upper Columbia River spring Chinook and steelhead populations. On average, double-crested cormorants have consumed approximately 11 million Columbia River Basin juvenile salmonids per year over the last decade.
Other ESA-Listed Fish	Oregon Coast coho and Southern Oregon and Northern California coho are found along the Oregon Coast. Puget Sound steelhead and Chinook, Hood Canal chum, Ozette Lake sockeye, and three species of rockfish (bocaccio, canary, and yelloweye) are found along the Washington Coast and Salish Sea areas. Bull trout and Pacific eulachon are widely distributed throughout the affected environment. All of these species are listed under the Endangered Species Act.
Public Resources	Public resources that were identified as having potential impacts from management actions include: public health and human safety, as it related to possible exposure to concentrations of double-crested cormorant guano and use of firearms under lethal take strategies; transportation facilities, particularly the Astoria-Megler Bridge (i.e., double-crested cormorants roosting or nesting on bridges, docks, airports, etc.); and dams and hatcheries, where double-crested cormorants congregate and predate upon juvenile salmonids.
Columbia River Basin Salmon Fisheries	Columbia River in-river commercial, tribal, and recreational fisheries are important regional economic contributors. Equally important is the cultural importance of salmon as a “first food” for Columbia River tribes. Hatchery production supplements the wild origin fish, supporting fisheries and conservation of the species. An estimated $49.1 million personal income in 2012 dollars was generated by hatchery surpluses (2%), tribal commercial (16%), non-Indian commercial (15%), and freshwater sport recreational (68%) Columbia River in-river fisheries. Columbia River tribes contribute greatly to the production of hatchery fish. The value of tribal ceremonial and subsistence harvests cannot be measured in terms of dollars and are culturally significant beyond economic gain.
Historic Properties	Four historic properties have been recorded on the island; two are associated with stabilization efforts (a basalt rock armored shoreline and an associated equipment bone

Affected Resource	Summary
	yard), and two are associated with the Harbor Defense System of World War II. Prior to a 1930s stabilization effort the island was a shifting sandbar and did not exist in its current configuration.

Summary of Environmental Consequences

Alternative A: No Action

If no actions are taken to manage the double-crested cormorant colony, predation rates on juvenile salmonids would likely remain higher than rates estimated during the environmental baseline of the 2008 Federal Columbia River Power System Biological Opinion and would continue to be a significant source of mortality. Additional measures would need to be identified to fill the gap in juvenile salmonid survival. These measures are unspecified at this time but would need to demonstrate a 3.6 percent increase in juvenile steelhead survival per the purpose and need. These actions could have potentially significant environmental and economic impacts given the magnitude of double-crested cormorant predation and the required survival improvement. Since these actions are unknown at this time, it would be speculative to evaluate the potential environmental and social effects. Therefore the no action alternative in this document describes the effects that could continue to occur if no efforts were taken to manage the double-crested cormorant colony on East Sand Island per the revised reasonable and prudent alternative 46.

Double-crested cormorant predation would continue to be a significant cause of juvenile salmonid mortality, with 11 million juvenile salmonids being consumed on average annually and potential predation rates as high as 17 percent on particular salmonid groups within a given year. Average size of the double-crested cormorant colony on East Sand Island (approximately 13,000 breeding pairs) and abundance of the western population of double-crested cormorants (approximately 31,200 breeding pairs) would presumably remain similar to current estimates in the near term. Future growth of the East Sand Island colony and the western population of double-crested cormorants would continue on current trends. The East Sand Island colony would continue to account for approximately 40 percent (13,000/31,200) of the western population.

Vegetation and soils within the 16 acres of the double-crested cormorant colony would continue to be impacted by guano, resulting in the western end of the island largely denuded from vegetation and species diversity reduced. Colony size and abundance of other bird species on and off East Sand Island would remain similar to current estimates, and spatial distribution of other nesting species would remain similar. The annual economic value of in-river Columbia River fisheries would likely remain similar to current levels in the near-term ($41.0 million direct financial value [i.e., revenue received by harvesters and expenditures made by anglers]; $48.4 million regional economic impact [i.e., expenditures as related to personal income and jobs]). Predation from the double-crested cormorant colony on East Sand Island would likely continue to result in a loss of up to $21 million in direct financial investment in hatchery production and potential annual losses of $2.7 million to in-river Columbia River fisheries. Direct or indirect adverse effects to public resources would be similar to past conditions before dissuasion research, which potentially increased dispersal of double-crested cormorants. There would be no adverse effects to historic properties, since there would be no ground disturbance on the island. Direct or indirect effects to threatened or endangered fish outside of the Lower Columbia River Basin would be similar to past conditions before dissuasion research.

Alternative B: Non-Lethal Management Focus with Limited Egg Take

If hazing and habitat reduction reduce the colony to approximately 5,600 pairs within 4 years, vegetation and soils may experience passive restoration in the short term, although dissuasion activities could adversely impact soils and vegetation while managing the colony. Later modification of the terrain would likely cause conversion of current bare sand to tidal mudflat or marsh areas, which may increase diversity of vegetation and soil complexity. Terrain modification may adversely affect two recorded historic properties on the island: the basalt rock armor, as the result of the removal of rock; and the World War II observation tower, as a result of increased tidal inundation.

Although the size of the double-crested cormorant colony on East Sand Island would be reduced through dispersal, the abundance of the western population of double-crested cormorants would likely remain similar to, or decrease from, current estimates (approximately 31,200 breeding pairs) in the near term. Future growth of the western population of double-crested cormorants could be reduced compared to current rates, as growth at East Sand Island would be limited. There may be a depression in recruitment prior to the successful breeding of individuals at new sites or if productivity

at new sites is lower than at East Sand Island. Approximately 18 percent (5,600/31,200) of the western population of breeding double-crested cormorants would be nesting at East Sand Island. Non-target species common to the island have the greatest potential for experiencing adverse effects. These effects would likely result from island-wide hazing, which is necessary to exclude double-crested cormorants greater than the target size from nesting. There is high potential for a significant reduction in abundance or the exclusion of nesting of Brandt's cormorants on East Sand Island as a consequence of management because they nest in close association with double-crested cormorants. There is a moderate to high potential for a significant reduction in colony size or abundance of other waterbird species (gulls, pelicans, and terns) on East Sand Island. There is a possibility that other species may completely abandon East Sand Island after repeated hazing, as well as a potential for inter-specific competition.

The potential for adverse effects off of East Sand Island is dependent upon and commensurate with dispersal levels to new areas and subsequent site-specific interactions. Within the Columbia River Estuary, there is potential for hazing to occur in new areas or to intensify in existing areas where hazing already occurs (i.e., upland dredged disposal areas on estuary islands). The greatest potential for adverse effects to other birds off of East Sand Island is the potential for hazing to affect streaked horned larks. Pelagic cormorants and American white pelicans also overlap with double-crested cormorants in the Columbia River Estuary and could be affected by hazing activities.

Reduction of the double-crested cormorant colony size to approximately 5,600 pairs is expected to reduce the rate of predation necessary to eliminate the survival gap identified by NOAA Fisheries, resulting in average annual juvenile salmonid survival increases of 1 to 4 percent, depending on Evolutionarily Significant Unit and Distinct Population Segment. These benefits are not expected to be fully realized from Alternative B in the short term, however, because hazing is unlikely to be 100 percent effective in keeping double-crested cormorants out of the Columbia River Estuary. For threatened and endangered fish outside of the Lower Columbia River Basin, potential adverse effects are the greatest for salmonid species in freshwater and estuary habitats that occur within the foraging range of double-crested cormorant breeding colonies. There is also potential for adverse effects in double-crested cormorant high use areas, particularly along the Washington coast and Salish Sea. Potential impacts to fish in these areas, however, may be less, given the size and life history of Pacific eulachon, rockfish species, bull trout, Puget Sound steelhead, and Hood Canal chum. Puget Sound Chinook salmon may be more vulnerable due to their extended use of estuaries and nearshore marine environments.

Proposed reduction in the colony size and the associated reduction of in-river Columbia River salmonid predation could result in increases of annual direct financial value and regional economic impacts of 3.6 percent ($1.5 million) and 3.1 percent ($1.5 million), respectively. Similar to survival benefits, economic benefits are not expected to be fully realized, at least in the short term, because hazing is not expected to be 100 percent successful in keeping double-crested cormorants out of the Columbia River Estuary. Persistent use of the Astoria-Megler Bridge by double-crested cormorants throughout the breeding season is expected, and there could be high potential for adverse effects from associated guano corrosion. Effects to other transportation structures, dams, and hatcheries would be commensurate with dispersal levels to new areas. No adverse effects to human health and safety are expected, as little direct contact between humans and double-crested cormorants would be expected and disease transmission is unlikely to occur.

Alternative C: Culling with Integrated Non-Lethal Methods Including Limited Egg Take *(Preferred Alternative/Management Plan)*

With reduction of the double-crested cormorant colony on East Sand Island primarily occurring as a result of culling, potential off-colony effects from dispersal and hazing would be substantially lower in Alternative C than with redistribution (Alternative B). The effects to vegetation and historic properties would be the same as Alternative B, as the result of terrain modification. Effects from a 4-year culling program (or adaptively adjusted 3- or 2-year program in subsequent years) is expected to reduce the western population of double-crested cormorants to approximately 23,250 breeding pairs (approximately 2,500 breeding pairs greater than ca. 1990 abundance [20,830 breeding pairs]) after Phase I and could potentially reduce future growth rates. Since 1990, the growth of the western population of double-crested cormorants has been primarily associated with the growth of the East Sand Island colony. Thus, it appears that the western population of double-crested cormorants is sustainable at approximately ca. 1990 numbers. A sustainable population is defined for this analysis as a population that is able to maintain numbers above a level that would not result in a major decline or cause a species to be threatened or endangered. Approximately 24 percent (5,600/23,250) of the western population of breeding double-crested cormorants would be at East Sand Island under this alternative.

There is a low potential for overall double-crested cormorant use and hazing outside the area where nesting occurs. The potential is moderate to high during the primary period of lethal take on-island, which likely would be 2 to 3 weeks. Due to the potential for misidentification, there is a potential for take of up to approximately 0.1 to 0.2 percent of the regional population of Brandt's cormorants per year under the 4-year strategy, or approximately 3 to 5 percent of the colony on East Sand Island per year (i.e., colony is approximately 1,600 breeding pairs). If take levels increase in subsequent years under adaptive management, take levels could be as high as 0.4 percent of the regional population and 10 percent of the colony on East Sand Island in year 2 under the adjusted 2-year lethal strategy. There is high potential for a substantial reduction in the size of the Brandt's cormorant colony on East Sand Island. There would be a low to moderate potential for a substantial reduction in colony size of other species and a low potential for species to abandon East Sand Island.

The expectation for double-crested cormorant dispersal is low under this alternative. Because the end target colony size is the same as Alternative B, the potential range of survival benefits for juvenile salmonids (1 to 4 percent annual increase, depending on Evolutionarily Significant Unit and Distinct Population Segment) and economic benefits (increases of annual direct financial value and regional economic impacts of 3.6 percent ($1.5 million) and 3.1 percent ($1.5 million), respectively) could be the same as Alternative B. However, the expectation is that benefits from Alternative C would be fully realized, particularly in the short-term, because dispersal in the Columbia River Estuary would be minimal. The reduction in predation associated with the colony target size would likely be achieved under Alternative C, whereas this is less likely under Alternative B. There is a much lower potential to realize adverse effects to other species or public resources off of East Sand Island, as compared to Alternative B. Streaked horned larks are the primary species of concern; however, additional hazing, beyond what is currently done for the Corps' navigation program, is not expected. Effects to other birds or fish in the affected environment would likely remain similar to existing conditions. Due to the potential for misidentification, there is a potential for take of up to 0.03 to 0.05 percent of the regional population of pelagic cormorants per year under the 4-year strategy, or up to 6 to 10 percent of the colony in the Columbia River Estuary (i.e., colony is approximately 75 to 100 breeding pairs) per year. If take levels increase in subsequent years under adaptive management, take levels could be as high as 0.1 percent of the regional population and 20 percent of the population in the Columbia River Estuary in year 2 under the adjusted 2-year lethal strategy. However, take levels of pelagic cormorants are expected to be lower than the upper range analyzed due to proposed field techniques.

Alternative D: Culling with Exclusion of Double-crested Cormorant Nesting on East Sand Island in Phase II

Alternative D is identical to Alternative C in Phase I, and effects described under Alternative C, both on and off of East Sand Island, would be the same for Alternative D in the short term (2 to 4 year period of culling). Abundance of the western population of double-crested cormorants is expected to be reduced to approximately 23,250 breeding pairs (approximately 2,500 breeding pairs greater than ca. 1990 abundance) after Phase I, and future growth rates could be reduced even more than Alternative C. The western population of double-crested cormorants appears sustainable (as defined in Alternative C) at approximately ca. 1990 abundance (20,830 breeding pairs). The key difference in Alternative D is that non-lethal management would be used to exclude double-crested cormorants from nesting on East Sand Island after Phase I colony size is attained. This would result in a substantial effect to the distribution of the western population of double-crested cormorants and potentially greater, or similar, effects to those described in Phase I of Alternative B, where redistribution of the colony is proposed. Precluding all double-crested cormorant nesting on East Sand Island would likely have greater effects to the western population of double-crested cormorants compared to just redistributing a portion of the colony. Effects would become less if dispersed double-crested cormorants breed at new sites outside of the Columbia River Estuary.

The broad scale hazing effort in the Columbia River Estuary, as discussed in Phase I of Alternative B, would occur under Phase II of Alternative D. Key differences in the potential effects of this alternative compared to others are the greater benefits for juvenile salmonid survival increases, as well as the expected economic benefits in the long-term. These benefits may be substantially higher in the long-term than other alternatives, should double-crested cormorants be completely excluded from the Columbia River Estuary, resulting in potentially zero double-crested cormorant predation impacts, although this may not be realized for many years after Phase II. With no double-crested cormorant nesting on East Sand Island, average annual juvenile salmonid survival increases of 2 to 8 percent (depending on Evolutionarily Significant Unit and Distinct Population Segment) and economic increases to in-river Columbia River fisheries of 3.6% ($1.5 million; annual direct financial value) and 3.1% ($1.5 million; regional economic impact) may be realized.

The Preferred Alternative/Management Plan

The Council on Environmental Quality defines the agency's preferred alternative as "the alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors." Alternative C was identified as the preferred alternative and management plan after evaluating the environmental consequences of each alternative when compared to the technical and logistical feasibility of reducing predation impacts throughout the Columbia River Estuary. In fulfilling the Corps' statutory responsibilities, Alternative C best meets the consultation requirements under the Endangered Species Act as identified by the 2014 Federal Columbia River Power System Supplemental Biological Opinion.

Because Alternative C proposes a reduction in colony size through culling, there is more certainty that this alternative would meet the need of reducing double-crested cormorant predation throughout the Columbia River Estuary than Alternatives B and D, which propose abundance reduction through dispersal. Minimal double-crested cormorant dispersal is expected under Alternative C given proposed field techniques and knowledge from other similar programs. This alternative has the greatest certainty of having least direct and indirect adverse effects to non-target species and resources off East Sand Island, particularly streaked horned larks, which would likely be adversely affected by high levels of double-crested cormorant dispersal and associated hazing activities within the Columbia River Estuary.

Alternative C has the lowest associated dollar costs for implementation and, given the breadth of the Columbia River Estuary, the greatest certainty that indefinite commitment of resources would not be needed to achieve the level of predation reduction specified in reasonable and prudent alternative 46. Alternative C is expected to have greater direct adverse effects to individual double-crested cormorants and the double-crested cormorant colony on East Sand Island than Alternative B, but less than Alternative D. Under Alternative C, abundance of the western population of double-crested cormorants is expected to be greater than ca. 1990 abundance. Since 1990, the growth of the western population of double-crested cormorants has been primarily associated with the growth of the East Sand Island colony. Thus, it appears that the western population of double-crested cormorants is sustainable at approximately ca. 1990 numbers. A sustainable population is defined for this analysis as a population that

is able to maintain numbers above a level that would not result in a major decline or cause a species to be threatened or endangered.

Public Review and Comment

The Corps is seeking public comment on the draft Environmental Impact Statement. The comment period is intended to provide those interested in or affected by this action with an opportunity to make their concerns known. Specifically, the Corps is seeking input that can inform our decision or analysis. After receiving public comments, the Corps and cooperating agencies will address substantive comments and incorporate them into a final Environmental Impact Statement.

Comment Timeframe: Comments will be accepted for 45 days from publication of the Notice of Availability of the draft Environmental Impact Statement in the Federal Register by the U.S. Environmental Protection Agency. This is anticipated to be June 19, 2014. Written comments may be sent electronically or by traditional mail to:

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E-14-08/Double-crested Cormorant draft EIS
P.O. Box 2946
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Send electronic comments to **cormorant-eis@usace.army.mil**