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

Final Environmental Impact Statement

US Army Corps of Engineers ®
Portland District

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The Need for a Management Plan

In this Final Environmental Impact Statement, the U.S. Army Corps of Engineers (Corps) has evaluated 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 to collectively hereafter as salmonids; Figure ES-1) 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 from 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. The proposed management plan in this Final Environmental Impact Statement was developed to comply with reasonable and prudent alternative action 46 in the 2008 and associated 2010 and 2014 Supplements to the Federal Columbia River Power System Biological Opinion issued by NOAA Fisheries.

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 salmonids per year, although total consumption varies each year and by salmonid population. When compared to other known mortality factors, this level of predation is considered a substantial source of mortality. Predation-related losses of juvenile steelhead are of particular concern for resource managers, as data to date indicate they are most impacted by double-crested cormorant predation (NOAA Fisheries 2014). Average annual double-crested cormorant predation rates of juvenile steelhead originating upstream of the Bonneville Dam have ranged from 2 to 17 percent over the past 15 years (depending on the run, or distinct population segment, and year).

FIGURE ES-1. Juvenile salmonids.

Double-crested cormorants are native to the Columbia River Estuary. Approximately 98 percent of double-crested cormorants breeding in the Columbia River Estuary nest on East Sand Island. 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, likely due to changes regarding habitat, nesting, and foraging conditions near the mouth of the Columbia River that are favorable for the species. 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.

Based on the western population abundance estimates ca. 1990 and ca. 2009, the entire western population of double-crested cormorants has increased approximately 2 percent per year. This growth has been primarily associated with the growth of the East Sand Island colony. The estimated annual sums of breeding individuals across other western colonies, not including East Sand Island, are similar or higher when comparing population data from ca. 1990 to current, even when accounting for losses in portions of the range. Thus, a re-distribution has taken place; some locations have declined while others have increased. The number of active colonies has also increased. In about 1990, Carter et al. (1995) noted 99 active colonies in British Columbia, Washington, Oregon, and California. That number increased to 160 active colonies (2008-2012) for the same states and province (Pacific Flyway Council 2013).

With a typical foraging range of approximately 15 miles (25 kilometers; Figure ES-2), 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 on their out-migration to the ocean, they are susceptible to and consumed by double-crested cormorants; consumption is highest in early May, which coincides with the peak nesting season.

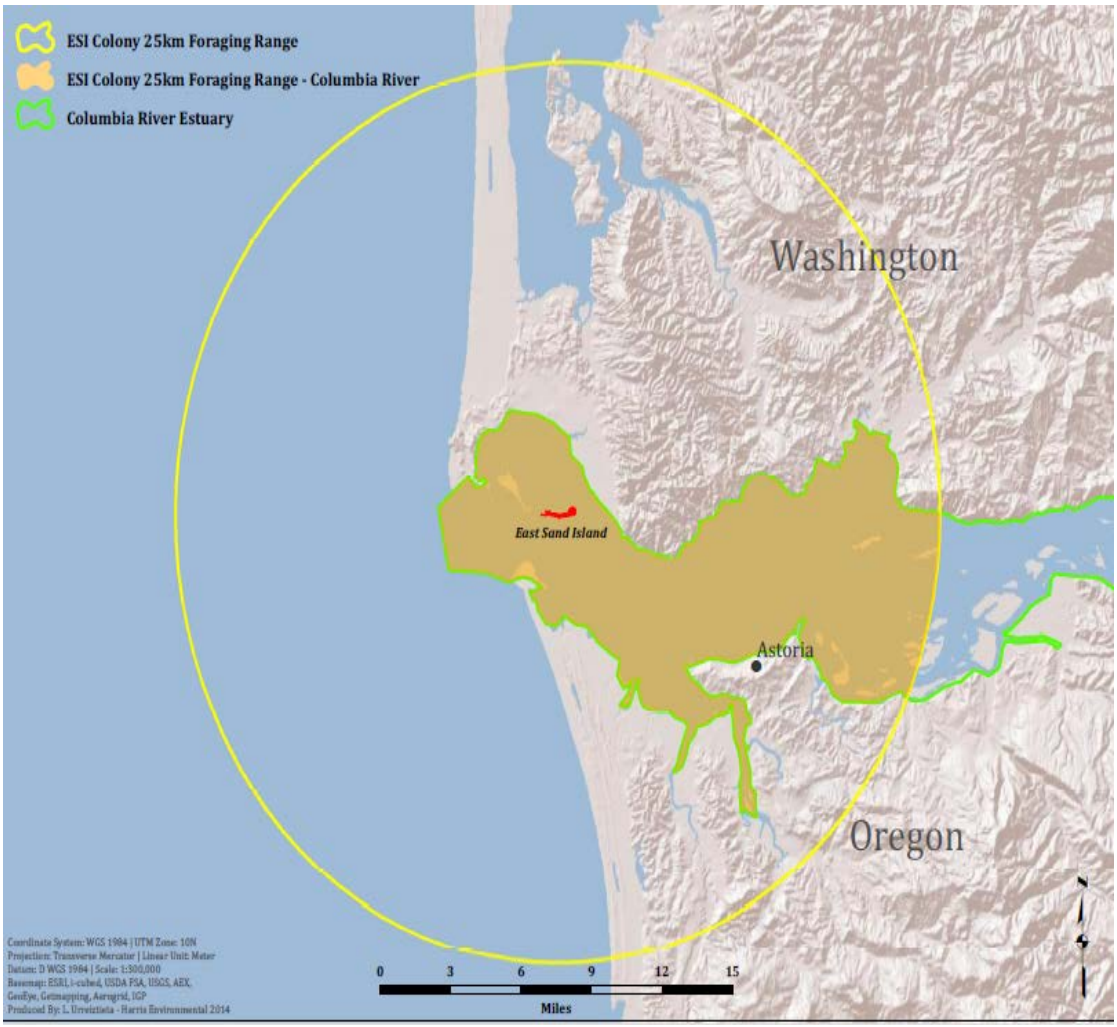

FIGURE ES-2. East Sand Island and the typical foraging range of nesting double-crested cormorants.

Management Goals

Management of the double-crested cormorant colony on East Sand Island was identified as reasonable and prudent alternative action 46 in the 2008 and associated 2010 and 2014 Supplements to the Federal Columbia River Power System Biological Opinion issued by NOAA Fisheries. In 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 improvements 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 3.5 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).*"

Developing the Plan

The Corps is the lead agency of the Final 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 – Wildlife Services, Oregon Department of Fish and Wildlife, and Washington Department of Fish and Wildlife are cooperating agencies. The analyses in this Final Environmental Impact Statement will support decision-making within the cooperating agencies and other agencies, which have connected actions as a result of the Corps' proposed action. Four action alternatives are considered in detail in the Final Environmental Impact Statement. Each alternative contains a set of actions, monitoring efforts, and potential adaptive responses that comprise an implementable management plan. Each alternative integrates non-lethal and lethal methods to manage the double-crested colony on East Sand Island, with focus on one method as the primary management strategy.

The reasonable and prudent alternative action 46 specified the primary management goals (i.e., a reduced colony size of approximately 5,600 nesting pairs of double-crested cormorants on East Sand Island to achieve a 3.5 percent survival increase for juvenile steelhead) and was adopted into the statement of purpose and need. In meeting this purpose, impacts to species not targeted for management would be minimized to the extent possible. The time period associated for implementation and achievement of management objectives is also connected to the Biological Opinion, which identifies

actions to begin by spring of 2015 and overall objectives to be achieved by the end of 2018.

Management Feasibility Studies

The Corps has conducted research to understand the dynamics of the double-crested cormorant colony on East Sand Island and test the feasibility of potential management techniques for reducing predation-related losses of juvenile salmonids. 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 techniques were employed on various islands within the Columbia River Estuary with some success at promoting double-crested cormorants to nest at alternative sites, primarily on Miller Sands Spit. However, nesting was very dependent upon continued management efforts, and the locations where nesting occurred were further upriver from East Sand Island, where double-crested cormorant predation impacts to salmonids have been documented to be higher. During 2007–2012, social attraction techniques were used outside of the Columbia River Estuary at five known roosting sites in Oregon, but there were no nesting attempts made by double-crested cormorants at any site.

In 2007 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). The objective of these investigations was to determine feasibility of various management actions and gather necessary information that would be needed to adequately inform a future management strategy (i.e., this Management Plan). Human hazing and use of visual deterrents was determined to be the most effective method to reduce the amount of available nesting habitat. Available nesting habitat was incrementally reduced during 2011 to 2013 but, by design, not to such a degree to actively reduce colony size. In 2013, double-crested cormorants were restricted to just 4.4 acres of habitat, which was a 75 percent reduction of their preferred nesting area.

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 the past management feasibility studies. 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. The level of habitat reduction and hazing during the management feasibility studies did not affect the size of the double-crested cormorant colony or nesting success, nor promote double-crested cormorant long-term dispersal or permanent emigration. These studies provided relevant information about double-crested cormorant commitment to East Sand Island and the Columbia River Estuary, likely dispersal locations, and the feasibility of various actions that would achieve the purpose and need of this Final Environmental Impact Statement.

TABLE ES-1. Nighttime Detections during April 1–May 30 (Years 2012 and 2013) by Double-crested Cormorants Satellite-tagged on East Sand Island within the Affected Environment.

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 (excludes East Sand Island)	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

Putting Predation Impacts in Context

Although there are many causes of mortality to juvenile salmonids 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 substantial. For example, dam passage survival of juvenile steelhead and yearling Chinook salmon is required to be 96 percent. The required survival passage at a dam (i.e., 4 percent) is less than the average annual 6.7 percent mortality for juvenile steelhead from 2003-2009 resulting from double-crested cormorant predation, as estimated in the NOAA Fisheries' analysis.

Even higher predation rates 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, 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 (e.g., 2011) 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 (Harnish et al. 2012), which overlaps geographically with the known foraging range of the double-crested cormorant colony on East Sand Island (Figure ES-2).

Reducing predation of juvenile salmonids from double-crested cormorants is an objective of several Columbia River Basin recovery plans. Direct mortality from avian predation (i.e., double-crested cormorants and Caspian terns) is identified as a key

limiting factor affecting all Middle Columbia River steelhead populations and Upper Willamette River Chinook and steelhead; one of the secondary factors limiting viability for all Lower Columbia River coho and late fall and spring Chinook salmon and steelhead populations; and a threat to Upper Columbia River spring Chinook and steelhead populations.

Double-crested cormorant predation can differ dramatically within a given nesting season and between years. During 2003–2013, when the colony size was relatively stable, estimates of total annual juvenile salmonid consumption ranged between 2.9 and 20.9 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 would be considered when predicting and interpreting the success of management actions on East Sand Island within a given year and over the long-term.

The potential benefits to juvenile salmonids, presented in the Final Environmental Impact Statement analyses, do not factor in any degree of compensatory mortality. Compensatory mortality is one type of mortality largely replacing or "compensating" for another kind of mortality, but where the total mortality rate of the population remains constant. This is in contrast to additive mortality, where one source of mortality is added to another for a combined total effect. The degree to which a source of mortality is compensatory or additive is likely not a static condition but changes within the context of dynamically changing environmental conditions, population abundances, and complex food webs.

Currently, the degree to which double-crested cormorant predation of juvenile salmonids is compensatory versus additive is unknown (Lyons et al. 2014). Therefore, the benefits to juvenile salmonids from reducing the double-crested cormorant colony are potential maximum benefits that could occur. These potential benefits would ultimately depend upon the degree of compensation actually occurring and other factors that could result in the management goals for reduced predation not being achieved throughout the entire Columbia River Estuary, such as double-crested cormorant dispersal and the effectiveness at precluding double-crested cormorants from the Columbia River Estuary.

A Complex Issue

Wildlife management is fundamentally a human concept that aims to manage the needs or goals of humans with the needs of wildlife. Thus, there is a large "human dimension" component to wildlife management, as individuals with an interest in the outcome of the management plan do not all share common values, nor would any one management action or alternative appease all stakeholders. The issues presented in this Final Environmental Impact Statement pose a complex problem that spans a diverse range of stakeholders, and the importance of the "human dimension" in making a decision cannot be overstated.

The differences in values held by the various stakeholders interested in the Corps' double-crested cormorant management plan were identified during public scoping and in comments received during the public comment period for the Draft Environmental Impact Statement. 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 salmonid runs, which these groups stated as overfishing, an excess of hatchery fish being released, and fish passage barriers such as the hydropower dams. Acknowledging the extremes in viewpoints, the Corps has sought to develop a balanced solution with its cooperating agencies that addresses competing needs and interests and achieves management objectives within established timeframes while minimizing environmental impacts.

Key Considerations in Developing Alternatives

Both double-crested cormorants and juvenile salmonids are natural components of the ecosystem and are protected under federal laws. Proposed management actions of double-crested cormorants must comply with the regulations implementing the Migratory Bird Treaty Act. In developing the range of alternatives, this and many other factors were considered in determining how best to achieve management goals while minimizing effects from the action.

Early in project planning and scoping, concerns were raised regarding adverse impacts to the western population of double-crested cormorants and other nesting waterbirds on East Sand Island. Short- and long-term effects of the proposed action on the western population of double-crested cormorants are described and considered for each alternative. The alternatives proposing lethal take include annual monitoring of the western population of double crested cormorants. This information will be used to evaluate and adjust future actions through an adaptive management strategy (Chapter 2, Section 2.1.2), which will reduce the potential risk of negatively affecting the long-term sustainability of the western population of double-crested cormorants. A sustainable population was defined for this Final Environmental Impact Statement as a population that is able to maintain a long-term trend with numbers above a level that would not result in a major decline or cause a species to be threatened or endangered. Based on the past population trend (described previously) and the current number of active colonies, it appears the western population is sustainable around 41,660 breeding individuals (ca. 1990 abundance).

Concerns were also 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 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. In response to these concerns, the Corps included extensive monitoring and adaptive management approaches into the alternatives to minimize dispersal.

Prior research and the scientific literature from double-crested cormorant and great cormorant management programs were reviewed to determine technically feasible methods. The results of past Corps-funded double-crested cormorant research, particularly the smaller scale management feasibility studies during 2011–2013, were assessed when selecting methods that would be technically feasible at the larger scale of management. As the purpose and need is to reduce double-crested cormorant predation over a large geographic area – 172 river miles of the Columbia River Estuary – special consideration was given to methods that would practically achieve this, both from a technically feasible and economic standpoint. Thus, only alternatives that were considered feasible in meeting the need to reduce double-crested cormorant depredation of juvenile salmonids throughout the Columbia River Estuary were carried forward for detailed study.

Public Comments on the Draft Environmental Impact Statement

On June 12, 2014, the Draft Environmental Impact Statement was announced via a public notice issued by the Corps and made available on the project website. On June 20, 2014, a Notice of Availability was published in the Federal Register, with an initial comment period of 45 days. A request to extend the comment period was granted and the comment period was extended 15 days and ended August 19, 2014. Numerous local and national media organizations published stories on the Corps' proposed action.

The Draft Environmental Impact Statement elicited a substantial number of public comments, with over 152,000 comments received. More than 98 percent (over 149,000) of all comments were submitted from two online petitions (CARE2 and National Audubon Society). The majority of comments expressed opinions about the range of alternatives and other issues regarding salmon recovery methods. Many suggested the Corps consider other methods, such as altering flow management, removal of dams, habitat restoration, etc., rather than managing native wildlife to improve salmonid populations. Comments were organized into two general categories: 1) opinion-based comments and 2) comments that challenged the methodologies, alternatives, and assumptions of effects made in the Draft Environmental Impact Statement, to which the Corps would respond with adding clarifying information, additional analysis, or changes to the alternatives in preparing a Final Environmental Impact Statement.

The majority of substantive comments challenged the science supporting the need for double-crested cormorant management; criticized the range of alternatives considered; challenged the adequacy of the cumulative impacts analysis for the western population of double-crested cormorants, citing drought, human disturbance, and other threats; challenged the proposed management plan's lethal focus for consistency with Migratory Bird Treaty Act depredation permit regulations; and claimed the Corps misrepresented the scope and scale of research to justify selecting lethal methods for the preferred alternative.

In response to public and agency comments, the Final Environmental Impact Statement was updated to address the comments and make factual corrections. Important changes resulting from comments about the science supporting the need to manage double-

crested cormorants include revisions to NOAA Fisheries' "survival gap" analysis as presented in the purpose and need, and an explanation of methods, limits, assumptions, and uncertainty in the bioenergetics modeling that was used in the "survival gap" analysis. Contextual information was added with an expanded discussion on the rationale for not evaluating other alternatives (such as dam removal, hatchery or flow management, etc.) that would not involve managing double-crested cormorants.

In response to comments regarding the cumulative impacts to the western population of double-crested cormorants, the Final Environmental Impact Statement includes Alternative C-1, which is the preferred alternative. Alternative C-1 is a modification to Alternative C that includes both nest oiling and culling as the lethal management strategy. Alternative C-1 reduces the total amount of take of individual double-crested cormorants by approximately 40 percent compared to Alternative C, leaving more breeding adults in the population. Additionally, changes were made to the double-crested cormorant population model parameters to incorporate a future reduced carrying capacity scenario to account for potential long-term threats and risks to the western population of double-crested cormorants. Furthermore, the adaptive management strategy was revised for alternatives considering lethal take to adjust take levels dependent upon information received from annual monitoring of the western population of double-crested cormorants, per the Pacific Flyway Council Monitoring Strategy. This revision further mitigates the potential for adverse effects to the western population of double-crested cormorants.

In response to comments regarding the Migratory Bird Treaty Act and the mischaracterization of the scope and scale of past research, the Corps, in cooperation with the U.S. Fish and Wildlife Service, reorganized the Appendices and developed Appendix G to include the full summary of non-lethal methods attempted to date by the Corps and the results of those methods. This information was considered when evaluating the feasibility of those methods to be applied at the scale necessary to achieve management objectives. No comments were received that challenged the results from other cited studies attempting non-lethal management on similar geographic scales, nor compelling evidence provided or cited to suggest that non-lethal management could be effectively implemented to reduce double-crested cormorant predation on a geographic area as large as the Columbia River Estuary.

Summary of Alternatives

In coordination with its cooperating agencies, the Corps further refined the alternatives based on public comments from scoping and those received on the Draft Environmental Impact Statement. Four action alternatives (including the preferred) and a no-action alternative are considered in detail (Table ES-2). All action alternatives employ an "integrated" approach (using a combination of non-lethal and lethal methods, but with a focus on one or the other as a primary method) and a two-phased approach. Phase I involves efforts to directly reduce the size of the colony on East Sand Island to the management goal set in reasonable and prudent alternative action 46 (i.e., no more than 5,380 to 5,939 breeding pairs).

Phase II includes non-lethal efforts to ensure management goals for the colony size are retained and to evaluate the success of management. Phase II also includes modifying the terrain on the western portion of East Sand Island, which would allow for more frequent inundation of the island and reduce double-crested cormorant nesting habitat. Evaluation of the proposed action includes monitoring double-crested cormorants and other species that use East Sand Island and the recovery of salmonid passive integrated transponder tags deposited by double-crested cormorants on the East Sand Island colony. Passive integrated transponder tags are inserted into fish and their recovery allows for the 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. Compliance with reasonable and prudent alternative 46 and fulfillment of the purpose and need would not be met. Comparative survival improvements for juvenile salmonids would need to be achieved by other actions.	n/a	n/a
Alternative B *Non-Lethal Management Focus with Limited Egg Take*	Phase I - Use primarily non-lethal methods to achieve 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 breeding 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 limited egg take on East Sand Island (500 eggs) and on Corps dredge material islands 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. Extensive off-island land- and boat-based hazing would occur throughout the Columbia River Estuary where accessible to preclude double-crested cormorants from nesting, roosting, and foraging. Phase II - Terrain modification to inundate the western portion of East Sand Island and preclude nesting, combined with continued monitoring and hazing efforts, supported with limited egg take, as needed. No management actions would be taken to ensure a minimum colony size.	Phase I - Surveys to measure peak colony size on East Sand Island and detect movement of double-crested cormorants in the Columbia River Estuary. Monitoring response of 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 at least once per year during the peak breeding season. Phase II - Monitoring would decrease in frequency depending on information needs. 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.	Corps would convene Adaptive Management Team, consisting of the cooperating agencies, NOAA Fisheries, and tribal entities, to meet as needed during implementation. Monitoring results would be used to determine need for adjustments in field techniques. 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
Alternative C *Culling with Integrated Non-Lethal Methods*	Phase I - Culling of individuals to achieve colony size of ~5,600 breeding pairs. Culling would occur over 4 years with 24.0 percent of the colony culled per year. In total, 18,185 double-crested cormorants would be taken in all years (6,202, 4,887, 3,881, and 3,214 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-island and over water 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 East Sand Island. Take levels would be reported annually. Hazing in the Columbia River Estuary would occur at Corps dredge material islands under the Corps' Channels and Harbors program. Phase II - Same as Alternative B.	Phase I – Same monitoring on East Sand Island as Alternative B with the addition of monitoring and reporting take. Monitoring the western population annually per Pacific Flyway Council Monitoring Strategy. 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 (25km) of East Sand Island. Phase II - Same as Alternative B.	Same Adaptive Management Team as described in Alternative B, but no individual marking would occur. Take levels could increase or decrease depending upon information gained from monitoring when comparing predicted and observed abundances. Monitoring locations in the Columbia River Estuary could change and the need for hazing could increase or decrease based upon monitoring results.
Alternative C-1 *Culling with Egg Oiling and Integrated Non-Lethal Methods*	Phase I – Same as Alternative C, except both culling of individuals and egg oiling would be used as the primary lethal strategy. Annual individual take of 13.5 percent in years 1 to 4 and associated nest loss and nest oiling rates of 72.5 percent in years 1 to 3 and 13.5 percent in year 4. In total, 10,912 individuals and 26,096 total nests is proposed to be taken in all years (3,489, 3,114, 2,408, and 1,902 individuals taken in years 1-4; 9,368, 8,361, 6,466, and 1,902 nests lost in years 1-4). Phase II - Same as Alternative B.	Phase I – Same as Alternative C. Phase II - Same as Alternative B.	Same as Alternative C.

Alternative	Summary of Actions*	Monitoring	Adaptive Management
Alternative D *Culling with Exclusion of Double-crested Cormorant Nesting on East Sand Island in Phase II*	Phase I - Same as Alternative C-1. Phase II - The same primarily non-lethal methods described in Phase II of Alternatives B, C, and C-1 (terrain modification supplemented with hazing, supported 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.	Phase I - Same as Alternative C-1. Phase II - Same as Phase I of Alternative B initially, but would transition to Phase II of Alternatives B and C.	Same as Phase I of Alternative B initially, but would transition to Phase II of Alternatives B and C.

* Sum of annual take totals may not equal overall take total due to rounding.

Summary of Resources in the Affected Environment

Because double-crested cormorants are migratory birds and use a large area and action alternatives proposed in the Final 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. Additionally, sub-regions within the affected environment were identified where double-crested cormorant dispersal and usage may be more likely and the potential for resources to be affected is greater. The effects analysis for double-crested cormorants included the entire western population of double-crested cormorants, which spans from southern British Columbia to California and from the Pacific coast to the Continental Divide. 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 increased from approximately 100 breeding pairs in 1989 to approximately 15,000 breeding pairs in 2013. Approximately 98 percent of double-crested cormorants breeding in the Columbia River Estuary nest on East Sand Island. 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 approximately 1987 to 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. Based on abundance estimates ca. 1990 and ca. 2009, the entire western population of double-crested cormorants has increased approximately 2 percent per year. Since the 1990s, large-scale distributional changes occurred, largely as a result of growth at East Sand Island.

Affected Resource	Summary
Other Birds on East Sand Island	Gulls, Caspian terns, and Brandt's cormorants nest on the island. Large numbers of California brown pelicans use the island for roosting and limited past instances of nesting have been observed. 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.
Other Birds	Streaked horned larks, listed as threatened under the Endangered Species Act, occupy designated critical habitat on nearby islands (Rice, Miller, and Pillar Rock) where double-crested cormorants are likely to prospect for new habitat. 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	Five salmonid species, representing thirteen 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 during the past 15 years. Green sturgeon and Pacific eulachon are also Endangered Species Act species present in the Columbia River Estuary. Pacific eulachon are a potential prey species for double-crested cormorants but green sturgeon are not.
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 and are potentially vulnerable to double-crested cormorant predation.
Public Resources and Social Values	Public resources identified as having potential impacts from management actions include: public health and human safety (as is related to possible exposure to concentrations of double-crested cormorant guano, and the use of firearms under lethal take strategies); transportation facilities (particularly the Astoria-Megler Bridge); and dams and hatcheries (where double-crested cormorants congregate and depredate juvenile salmonids). Social values were identified as individual existence and aesthetic values of double-crested cormorants or salmonid populations, and depend upon an individual's value system and perspective.

Affected Resource	Summary
Columbia River Basin Salmon Fisheries	Columbia 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. The value of tribal ceremonial and subsistence harvests cannot be measured in terms of dollars and are culturally significant beyond economic gain. Columbia River tribes contribute greatly to the production of hatchery fish. An estimated $49.7 million in personal income (2012 dollars) was generated by Columbia River in-river fisheries from hatchery surpluses (1 percent), tribal commercial (15 percent), non-Indian commercial (14 percent), and freshwater sport recreational (70 percent) fisheries.
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-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, compliance with reasonable and prudent alternative 46 and fulfillment of the purpose and need of the Final Environmental Impact Statement would not be met. This would require re-initiation of consultation with NOAA Fisheries. 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 an increase in juvenile salmonid survival equivalent to NOAA Fisheries' "survival gap" analysis. These actions could have potentially significant environmental and economic impacts given 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 effects that could continue to occur if no efforts were taken to manage the double-crested cormorant colony on East Sand Island.

Double-crested cormorant predation would continue to be a substantial 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. Direct or indirect effects to threatened or endangered fish outside of the Lower Columbia River Basin would be similar to past conditions.

The average size of the double-crested cormorant colony on East Sand Island is expected to remain similar to current estimates in the near-term (approximately 26,000 breeding individuals). The abundance of the western population of double-crested cormorants is expected to remain similar to current estimates in the near-term (approximately 62,400 breeding individuals) but may decline in the future due to potential loss of habitat from cumulative adverse effects, such as drought caused by climate change, increasing depredation by an expanding bald eagle population, and other regional impacts. Based on modeled results of long-term trend, a gradual decrease from current levels is predicted, with abundance stabilizing at approximately 53,000 breeding individuals in 20 years, approximately 11,300 breeding individuals more than observed in ca. 1990. The East Sand Island colony would continue to account for approximately 40 to 50 percent of the breeding 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. With the exception of the Caspian tern colony, which is currently subject to management and hazing, the 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 likely be similar.

The annual economic value of in-river Columbia River fisheries would likely remain similar to current levels in the near-term ($41.9 million direct financial value [i.e., revenue received by harvesters and expenditures made by anglers]; $49.7 million regional economic impact [i.e., expenditures as related to personal income and jobs]). When compared to Alternative D, which proposes to exclude all nesting by double-crested cormorants on East Sand Island, current levels of juvenile salmonid predation by double-crested cormorants on East Sand Island would likely continue to result in potential annual losses of $2.6 million to Columbia River in-river fisheries (i.e., for both direct financial value and regional economic impact) and $6.4 million in hatchery production investment costs.

Direct or indirect adverse effects to public resources would be similar to past conditions before the management feasibility studies and dissuasion research, which potentially increased dispersal of double-crested cormorants. This alternative could have the greatest beneficial effects regarding existence and aesthetic value to individuals with positive perceptions of double-crested cormorants and the greatest adverse effects to individuals with negative perceptions of double-crested cormorants or high existence values of juvenile salmonids. There would be no adverse effects to historic properties, since there would be no ground disturbance on the island.

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

Movement data from research indicates double-crested cormorants are strongly committed to nesting on East Sand Island and roosting in the Lower Columbia River Basin when hazing has prevented that nesting. Substantial and continued efforts would likely be needed to deter and disperse double-crested cormorants from this area under Alternative B. Similar impacts to salmonids would continue to occur if double-crested cormorant abundance near East Sand Island remains similar to current levels, and impacts could be higher if double-crested cormorants disperse upriver, where salmonids compose a higher proportion of their diet. With high double-crested cormorant dispersal outside of the Columbia River Estuary under Alternative B, there is a greater potential for adverse effects to other ESA-listed fish species outside of the Columbia River Estuary located in double-crested cormorant high use areas, particularly along the Washington coast and Salish Sea. When compared to Alternative A (no action) and Alternatives C-D, which propose lethal removal, predation rates of juvenile salmonids could increase in Phase I in these areas.

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. However, these benefits represent maximum values (as previously described) and there would be less certainty in achieving these benefits because hazing is unlikely to be effective in keeping double-crested cormorants out of the Columbia River Estuary and thus reducing their predation impacts on salmonids.

Even if hazing were effective at preventing double-crested cormorants from foraging and/or nesting in the Columbia River Estuary, there is the potential that the impacts of

double-crested cormorant predation of ESA-listed juvenile salmonids could be shifted to other areas outside of the Columbia River Estuary. Bull trout susceptibility to double-crested cormorant predation may be greater for migratory fish compared with resident fish, especially for bull trout that utilize estuaries. Extended use of estuaries and nearshore marine environments by juvenile Puget Sound Chinook and juvenile Hood Canal chum suggests they would be more vulnerable to double-crested cormorant predation if double-crested cormorants disperse to coastal estuaries in Washington. Puget Sound steelhead smolts may move offshore more quickly, as compared with Puget Sound Chinook and Hood Canal chum salmon, and this would likely lessen their susceptibility to double-crested cormorant predation. Impacts to Ozette Lake sockeye are unknown but the potential for conflict exists, especially if sockeye use estuary or nearshore habitats for extended periods of time.

Because this alternative proposes to utilize primarily non-lethal methods to achieve the colony size reduction on East Sand Island, the abundance of the western population of double-crested cormorants is expected to remain similar to current levels in the near term (62,400 breeding individuals) but may decline to a greater extent than Alternative A due to the factors described plus additional loss of habitat at East Sand Island from the Phase II terrain modification and future limitation of the colony. Based on modeled results of long-term trend, a gradual decrease is predicted, with abundance stabilizing at approximately 46,000 breeding individuals in years 13-20 after implementation, approximately 4,300 breeding individuals more than observed in ca. 1990. 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 24 percent (11,200/46,000) of the western population of breeding double-crested cormorants could nest at East Sand Island.

With a reduced double-crested cormorant colony on East Sand Island, 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 and provide beneficial effects to shorebirds and long-term benefits to juvenile salmonids, but could have short-term adverse effects from localized increases of turbidity and sedimentation from ground-disturbing work.

Non-target species common to the island have the greatest potential for experiencing adverse effects from human disturbance (human hazing, etc.), which could flush adults

or young birds and increase exposure time of eggs and juveniles to predators. Depending on the proximity, frequency, and duration of these activities, this disturbance could result in reduced survival for individuals. 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 other species may completely abandon East Sand Island after repeated hazing, as well as a potential for increased 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 double-crested cormorant dispersal and hazing to affect streaked horned larks, which were recently listed as threatened under the Endangered Species Act and occupy designated critical habitat on nearby islands in the Columbia River Estuary. The entire population of streaked horned larks in the world is estimated to be less than 1,700 individuals, with approximately 45 to 60 breeding pairs nesting in the Columbia River Estuary. Pelagic cormorants and American white pelicans also overlap with double-crested cormorants in the Columbia River Estuary and could be affected by hazing activities.

The 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 3.4 percent ($1.4 million) and 3.0 percent ($1.5 million), respectively, and $3.6 million savings in direct financial investment in hatchery production. Similar to juvenile salmonid survival benefits, economic benefits are not expected to be fully realized and are less certain, at least in the short-term, because hazing is not expected to be 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. 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. Compared to no management (Alternative A), Alternative B may have adverse effects to individuals who have high existence and aesthetic value for double-crested cormorants and believe that humans should not manage nature or ecosystems. There could be adverse effects to individuals who have high existence or aesthetic value for salmonids or other species if they become affected, or are perceived to be affected, by double-crested cormorant dispersal or redistribution.

Alternative C: Culling with Integrated Non-Lethal Methods

The expectation for double-crested cormorant dispersal is low under this alternative. Because the end colony size is the same as Alternative B, the potential range of survival benefits for juvenile salmonids and economic benefits could be the same. However, because the potential for dispersal is lower, these benefits would likely be fully realized and predation rates would be substantially reduced when compared to Alternative B. Additionally, because Alternative C does not propose to redistribute double-crested cormorants, the potential for adverse effects to listed fish in other areas would be low.

Culling would adversely impact the abundance and future growth rate of the western population of double-crested cormorants, which is expected to decline due to regional cumulative factors, plus the proposed cull and additional loss of habitat at East Sand Island from the Phase II terrain modification. Based on modeled results of long-term trend, the abundance of the western population of double-crested cormorants is projected to be approximately 35,000 breeding individuals at the end of four years of management, which is approximately 6,700 breeding individuals less than observed abundance in ca. 1990. The projected abundance falls below ca. 1990 population level for 9 years after implementation of Phase I actions and increases to a long-term 20-year projected size of approximately 44,500 breeding individuals, approximately 2,800 breeding individuals greater than observed abundance in ca. 1990. Approximately 25 percent (11,200/44,500) of the western population of breeding double-crested cormorants could nest at East Sand Island.

Other birds nesting on East Sand Island would likely be affected (i.e., flushing, loss of eggs, etc.) from human disturbance. This effect would likely be less than or similar to

that of Alternative B. There is a low potential for overall double-crested cormorant use and hazing outside the area where nesting occurs on East Sand Island because habitat would not be restricted on the western portion of the island.

Due to the potential for misidentification, there is a potential for take of up to 0.1 to 0.3 percent of the regional population of Brandt's cormorants per year under the proposed 4-year strategy, or up to 3 to 6 percent of the colony on East Sand Island (i.e., colony is approximately 1,600 breeding pairs) per year. Because Brandt's cormorants nest in close association with double-crested cormorants, adverse effects could occur to Brandt's cormorants that overlap in areas where culling activities occur, although this would be minimized to the extent possible. There is a high potential for a substantial reduction in the size of the Brandt's cormorant colony when available nesting habitat would be reduced on East Sand Island during Phase II.

There is also a potential for take of up to 0.03 to 0.06 percent per year of the regional population of pelagic cormorants, or up to 6 to 12 percent of the colony that nest on the Astoria-Megler Bridge (i.e., colony is approximately 75 to 100 breeding pairs). Take levels would vary depending on the field techniques used and location (i.e., shooting over water has a greater potential for take of Brandt's and pelagic cormorants due to misidentification). The potential for take would be reduced by the implementation of the best management practices and adaptive management strategies described in Chapter 2.

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 for reasons previously stated; however, additional hazing, beyond what is currently planned by the Corps' Channels and Harbors Program, is not expected.

The 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 as described for Alternative B. Effects to public resources and 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 shooters would employ safety protocols. This alternative could have adverse or beneficial effects (depending on the individual's values and perspective) regarding existence and aesthetic values and effects would likely be greater

than the other alternatives because culling adults is the primary lethal strategy. Effects to historic properties would be the same as Alternative B.

Alternative C-1: Culling with Egg Oiling and Integrated Non-Lethal Methods (*Preferred Management Alternative)*

Alternative C-1 is a modification to the primary lethal strategy proposed in Phase I for Alternative C and would combine egg oiling with culling on East Sand Island. The expectation for double-crested cormorant dispersal is similar to Alternative C, but there is a potential for an increased number of disturbance events on East Sand Island when combining culling and egg oiling. Depending upon double-crested cormorant response and the effectiveness of boat-based culling, the number of disturbance events could be similar to Alternative C. Overall, benefits to juvenile salmonids, economic benefits, and adverse effects to other resources would be the same as or similar to Alternative C; however, if there is more dispersal in-season or between years, these benefits could be reduced. Effects to existence and aesthetic values would be similar to Alternative C, but the reduction in culling by 40 percent and the inclusion of egg oiling into the alternative could lessen the effects to individuals who have a high existence value for double-crested cormorants and who perceive egg oiling as a more humane method compared to culling adults.

The number of individual double-crested cormorants culled would be reduced by approximately 40 percent when compared to Alternative C (i.e., total take of approximately 11,000 versus 18,000 breeding individuals). The abundance of the western population of double-crested cormorants is projected to be approximately 38,500 breeding individuals at the end of four years of management, which is approximately 3,200 breeding individuals less than observed abundance in ca. 1990. The projected abundance falls below ca. 1990 population level for 4 years after implementation of Phase I actions and increases to a long-term 20-year projected size of approximately 44,500 breeding individuals, approximately 3,300 breeding individuals greater than observed abundance in ca. 1990. In total, 72.5 percent of nests (including both associated nest loss and nests destroyed from egg oiling) would be lost in years 1–3 on East Sand Island.

Because fewer individual double-crested cormorants would be culled, there is less potential for take of Brandt's and pelagic cormorants. However, under Alternative C-1, a greater proportion of individuals could be culled over water compared to Alternative C to reduce the number of disturbances to the colony, which may reduce the difference in

potential take levels of Brandt's and pelagic cormorants between the two alternatives. Implementation of Alternative C-1 would likely occur later into the breeding season compared to Alternative C, and this could have additional impacts to non-target nesting birds on East Sand Island due to egg oiling activities.

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

Alternative D is identical to Alternative C-1 in Phase I, and the effects described under Alternative C-1, both on and off of East Sand Island, would be the same for Alternative D in the short-term. 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. Loss of the East Sand Island colony would result in a substantial effect to the distribution of the western population of double-crested cormorants and potentially greater effects to those described in Phase I of Alternative B, where redistribution of the colony is proposed. In the long-term, Alternative D has the greatest overall adverse impact to the western population of double-crested cormorants, as abundance is projected to decrease to a low of approximately 33,000 breeding individuals and slightly increase to a long-term 20-year projected size of approximately 37,500 breeding individuals, approximately 4,200 breeding individuals less than observed abundance in ca. 1990.

There could be 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 no 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 6.1 percent ($2.6 million; annual direct financial value) and 5.3 percent ($2.6 million; regional economic impact) and savings of $6.4 million in direct financial investment in hatchery production may be realized.

Double-crested cormorant dispersal and non-lethal management and hazing efforts on East Sand Island and in the Columbia River Estuary would be similar to Phase I of Alternative B. Thus, the expected benefits from additional double-crested cormorant abundance reduction would be less certain and the potential adverse effects to resources potentially affected by double-crested cormorant dispersal and hazing (e.g.,

streaked horned lark, Astoria-Megler bridge, ESA-listed fish within and outside the Columbia River Estuary) would similar to Phase I of Alternative B and greater than the other alternatives during Phase II.

Effects to individuals with high existence and aesthetic values for double-crested cormorants would be similar to those described in Alternative C-1 in Phase I. In Phase II, although the overall regional abundance would still be large, loss of the species from the local geographic area could have greater adverse or beneficial effects (depending on the individual's values and perspective) than just a reduction in colony size abundance. There is potential for greater beneficial effects to individuals who have high existence or aesthetic value for Columbia River salmonids as there is potential that double-crested cormorant predation could be reduced to greater levels and even eliminated in Phase II.

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-1 was identified as the preferred alternative after evaluating the environmental consequences of each alternative when compared to the technical and logistical feasibility of achieving the Final Environmental Impact Statement purpose and need. In fulfilling the Corps' statutory responsibilities, adoption and implementation of the double-crested cormorant management plan described in Alternative C-1 meets the consultation requirements under the Endangered Species Act as identified by the 2014 Federal Columbia River Power System Supplemental Biological Opinion. Additionally, Alternative C-1 addresses many of the substantive comments received on the Draft Environmental Impact Statement during the public review period.

Because Alternative C-1 proposes a reduction in colony size through culling and egg oiling, there is more certainty 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. Compared to Alternative C, Alternative C-1 would lessen the potential effects to the short- and long-term population trend of the western population of double-crested cormorants by decreasing the number of adults lethally removed annually. Risk to the long-term sustainability of the western population is further reduced given that take on East Sand Island would

occur within a well-monitored and adaptive management framework (see Chapter 2, Section 2.1), and proposed take levels would be reviewed annually under a depredation permit application. Monitoring of the western population would occur annually and this information would be used to evaluate and adjust future management activities. This allows time for annual evaluation and adaptive management changes and increases the ability for the western population to respond from a potential catastrophic event.

Minimal double-crested cormorant dispersal is expected under Alternative C-1 given proposed field techniques, adaptive management protocols, and knowledge from other similar programs. Dispersal levels would likely be similar to Alternative C and lower than Alternatives B and D. Given the proposed adaptive management techniques to minimize dispersal, this alternative would likely have few direct and indirect adverse effects to non-target species and resources off East Sand Island.

Alternative C-1 would have similar costs compared to Alternative C and lower associated dollar costs for implementation than Alternatives B and D. Alternative C-1 is expected to have greater direct adverse effects to individual double-crested cormorants and the colony on East Sand Island than Alternative B, but less than Alternatives C and D. Additionally, a reduction in culling by 40 percent and the inclusion of egg oiling into the alternative could lessen the effects to individuals who have a high existence value for double-crested cormorants and who perceive egg oiling as a more humane method compared to culling adults.

Public Review and Agency Decisions

The Corps is making the Final Environmental Impact Statement available for public review. The Corps has responded to comments received on the Draft Environmental Impact Statement. The Final Environmental Impact Statement includes a discussion of opposing views which were not adequately discussed in the Draft Environmental Impact Statement and indicates the Corps' response to the issues raised during the public comment period.

The Corps will make a decision on the proposed action that will be described in a record of decision thirty days after publication of the notice of availability of the Final Environmental Impact Statement in the Federal Register. The Corps will make the record of decision available to the public and it will identify all of the alternatives considered,

state what the Corps' decision regarding a double-crested cormorant management plan is, identify all of the alternatives considered, and state whether all practicable means to avoid or minimize environmental harm have been adopted. If the Corps makes a decision to implement an action alternative, the Corps will submit a depredation permit application to the U.S. Fish and Wildlife Service after making the record of decision available and will request assistance from the U.S. Department of Agriculture's Wildlife Services to directly assist the Corps in implementing the management plan.

The Final Environmental Impact Statement will be available for public review for 30 days after publication of the notice of availability in the Federal Register by the U.S. Environmental Protection Agency. This period is anticipated to begin February 13, 2015. For more information on the schedule of this review, please visit the project webpage at http://www.nwp.usace.army.mil/Missions/Current/CormorantEIS.aspx.

Written comments may be sent electronically or by traditional mail to:

Mr. Robert Winters
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E-14-08/Double-crested Cormorant Final EIS
P.O. Box 2946
Portland, Oregon 97208-2946

Send electronic comments to **cormorant-eis@usace.army.mil**