Environmental Assessment
Issuance of a Protected Species Conservation and Recovery Grant to the Cowlitz Indian Tribe Natural Resources Department (Award File NA10NMF4720373) to Conduct Research on Eulachon (*Thaleichthys pacificus*) in Lower Columbia River Tributaries

Lead Agency:	USDC National Oceanic and Atmospheric Administration **National Marine Fisheries Service, Office of Protected Resources**
Responsible Official:	James H. Lecky, Director, Office of Protected Resources
For Further Information Contact:	Office of Protected Resources National Marine Fisheries Service 1315 East West Highway Silver Spring, MD 20910 (301) 713-2332
Location:	Columbia River below RM 146, and tributaries, Oregon and Washington States, USA

CHAPTER 1 PURPOSE OF AND NEED FOR ACTION

1.1 DESCRIPTION OF PROPOSED ACTION

The National Marine Fisheries Service, Office of Protected Resources (NMFS PR) proposes to provide financial assistance in the form of a grant to the Cowlitz Indian Tribe Natural Resources Department (Taylor Aalvik, P.I.). This award would be issued through the Protected Species Conservation and Recovery Grant Program (CFDA no. 11.472, Unallied Science Programs) authorized under the Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq.*).

This financial assistance award is planned to extend for three years (three annual payments) and is subject to semi-annual review by NMFS. The grant would support scientific research actions that will return information directly applicable to improving species management and habitat needs, ultimately assisting in the recovery of the ESA-listed (threatened) southern Distinct Population Segment (DPS) of Pacific eulachon.

Purpose and Need

The National Marine Fisheries Service's (NMFS) recognizes the unique importance of many protected species to tribes and values ongoing efforts by tribal nations to conserve and protect species under NMFS' jurisdiction. NMFS is authorized to provide Federal assistance to tribes to support conservation programs for marine and anadromous species under its jurisdiction. Scientific research is an important means of gathering valuable information about protected species to inform conservation and management measures and, ultimately, to recover listed species. In order to fully carry out these responsibilities, NMFS needs to act in response to a request from the Cowlitz Indian Tribe for financial assistance to support a program of scientific research within the Columbia River estuary/tributary system that will increase the basic state of eulachon knowledge. Specifically, the funded work would be used to 1) identify environmental factors influencing spawning run-timing and tributary selection; 2) identify spawning distribution in principle tributaries; 3) correlate spawning distribution with habitat quality factors; and 4) investigate egg mortality potentially caused by sedimentation.

1.2 PROPOSED RESEARCH AREA AND METHODS

The proposed research under Award File NA10NMF4720373 to the Cowlitz Indian Tribe would take place in tributary rivers to the lower Columbia River below RM 146. Research would occur in both Oregon and Washington. The principle research sites would include the Grays River, Skamokawa River, Elochoman River, Cowlitz River, Kalama River, Lewis River and the Sandy River. Other rivers that may also be sampled include the Naselle River, Deep River, or parts of the Clatskanie River system. Research would occur from 2010 to 2013.

Identify spawning distribution in principle tributaries

The applicant would deploy plankton nets with flow meters in order to collect larval abundance samples and correct for flow volume. The net set locations and timing would be coordinated with the WDFW ESA section 6 funded eulachon project and would occur from December to March in 2010, 2011, and 2012. Sample stations would likely occur ever kilometer for an average of 10 stations up each tributary. At Grays and Kalama rivers theses distances would be shorter that 10 km and in the Cowlitz and Lewis rivers the distances would likely be 20-30 km

upriver. Samples would be preserved in 95% ethanol (dilutes to approximately 50% alcohol during rinsing of sample into the bottle). In the laboratory, Rose Bengal would be added to make the larvae more visible for counting. The applicant would use spawning substrate frames (see Romano *et al*., 2001 for description) anchored overnight on the river bottom for at least two days following observations of adult eulachon presence to identify spawning areas. The overall expected catch would be less than 500 eulachon eggs based on maximum catch rates observed by Romano *et al*. (2001) during sampling conducted at sites in the mainstem Columbia River. Dip netting (dip nets would measure no more than 36 inches across the bag frame) would occur throughout the sampled area to identify fish presence.

Investigate egg mortality potentially caused by sedimentation.
The applicant would investigate the impacts of egg burial using both extensive and intensive methods. The applicant would extensively investigate burial of eulachon eggs by taking cores samples of accreting sediments in the lower Cowlitz River (below the confluence of the Cowlitz and Toutle Rivers), in the weeks after adult eulachon have entered the Cowlitz River and spawned. The applicant would examine the core samples to identify the typical depth to which eulachon eggs may be buried by accreting sediments. Sediment accumulation rates may also be measured in the Cowlitz River with sediment traps, though sediment traps may not work optimally in a high-velocity river environment.

The researchers would intensively examine burial impacts to eggs by collecting mature, ripe male and female eulachon, collecting and fertilizing eggs, transferring eggs to incubation trays, verifying egg development, and then establishing experimental treatments by slowly burying developing eggs in varying depths of sediment. This work would be conducted at the USFWS Abernathy Fish Technology Center in Stella, WA over three years. Less than 500 adult fish (25-50 pounds) would be lethally taken per year from the Columbia River or its tributaries.

Correlate spawning distribution with habitat quality factors
The applicant would characterize river substrate and water column factors throughout key spawning distribution areas to the upper physical limits of distribution in the 6 principal tributaries to the Lower Columbia River. Analysis factors would include, but are not limited to, substrate size and complexity (silt, sand, gravel, cobble, presence of large woody debris) or water quality (depth and velocity). If the opportunity presents itself, the applicant would also conduct video transects and/or sonar mapping from a boat. If significant correlations are observed, the quantity of suitable/optimal eulachon spawning habitat would be calculated and mapped.

Identify environmental factors influencing spawning run-timing and tributary selection
The applicant proposes to identify, assemble and statistically evaluate sets of historic data to identify if any environmental factors (or combination thereof) strongly correlate with past initiation of spawning in the lower Columbia River estuary and associated tributaries. This development of a predictive model would use existing data-sets and would be conducted in an office setting.

1.3 APPLICABLE LAWS AND NECESSARY FEDERAL PERMITS, LICENSES, AND ENTITLEMENTS

This section summarizes federal, state, and local permits, licenses, approvals, and consultation requirements necessary to implement the proposed action, as well as who is responsible for obtaining them. Even when it is the applicant's responsibility to obtain such permissions, NMFS is obligated under NEPA to ascertain whether the applicant is seeking other federal, state, or local approvals for their action.

National Environmental Policy Act
The National Environmental Policy Act (NEPA) was enacted in 1969 and its Environmental Impact Assessment requirement is applicable to all "major" federal actions with the potential to significantly affect the quality of the human environment. A major federal action is an activity that is fully or partially funded, regulated, conducted, or approved by a federal agency. The procedural provisions outlining federal agency responsibilities under NEPA are provided in the Council on Environmental Quality's implementing regulations (40 CFR Parts 1500-1508).

NOAA has, through NOAA Administrative Order (NAO) 216-6, established agency procedures for complying with NEPA and the implementing regulations issued by the Council on Environmental Quality. When a proposed action that would otherwise be categorically excluded is the subject of public controversy based on potential environmental consequences, has uncertain environmental impacts or unknown risks, establishes a precedent or decision in principle about future proposals, may result in cumulatively significant impacts, or may have an adverse effect upon endangered or threatened species or their habitats, preparation of an EA or EIS is required.

This Environmental Assessment is prepared in accordance with NEPA, its implementing regulations, and NAO 216-6.

Endangered Species Act
Section 7 of the ESA requires consultation with the appropriate federal agency (either NMFS or the U.S. Fish and Wildlife Service) for federal actions that "may affect" a listed species or adversely modify critical habitat. NMFS issuance of an award affecting ESA-listed species or designated critical habitat, directly or indirectly, is a federal action subject to these Section 7 consultation requirements. Section 7 requires federal agencies to use their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of endangered and threatened species. NMFS is further required to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any threatened or endangered species or result in destruction or adverse modification of habitat for such species. Regulations specify the procedural requirements for these consultations (50 Part CFR 402).

Marine Mammal Protection Act
The MMPA prohibits takes of all marine mammals in the U.S. (including territorial seas) with a few exceptions. The act defines "take" to mean "to hunt, harass, capture, or kill" any marine mammal or attempt to do so.

National Marine Sanctuaries Act
The NMSA (32 U.S.C. 1431 *et seq*.) authorizes the Secretary of Commerce to designate and manage areas of the marine environment with special national significance. The National

Marine Sanctuary Program, operating under the NMSA and administered by NOAA's National Ocean Service (NOS) has the authority to issue special use permits for research activities that would occur within a National Marine Sanctuary. Obtaining special use permits is the responsibility of individual researchers. However, as a courtesy, the Office of Protected Resources consults with NOS when proposed research would occur in or near a National Marine Sanctuary.

Magnuson-Stevens Fishery Conservation and Management Act. Under the MSFCMA Congress defined Essential Fish Habitat (EFH) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). The EFH provisions of the MSFCMA offer resource managers means to accomplish the goal of giving heightened consideration to fish habitat in resource management. NMFS Office of Protected Resources is required to consult with NMFS Office of Habitat Conservation for any action it authorizes, funds, or undertakes, or proposes to authorize, fund, or undertake that may adversely affect EFH. This includes renewals, reviews or substantial revisions of actions.

CHAPTER 2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 ALTERNATIVE 1 - NO ACTION ALTERNATIVE

Under the No Action alternative, Award File NA10NMF4720373 would not be approved. This alternative would not fund basic scientific research on eulachon life history, distribution, and habitat quality that would improve species management methods and knowledge of required habitat quality that would ultimately support the recovery of the ESA-listed (threatened) southern Distinct Population Segment of Columbia River eulachon. Existing and future research would continue to occur.

2.2 ALTERNATIVE 2 - GRANT APPROVAL FOR RESEARCH AS PROPOSED

Under the Proposed Action alternative, as more fully described on pages 2-3, Award File NA10NMF4720373 would be approved. This approval would provide financial assistance and fund basic scientific research on eulachon life history, distribution, and habitat quality that would improve species management methods and knowledge of required habitat quality that would ultimately support the recovery of the ESA-listed (threatened) southern Distinct Population Segment of Columbia River eulachon.

CHAPTER 3 AFFECTED ENVIRONMENT

The following discussion identifies resource areas that may be directly or indirectly affected by the proposed research activities.

3.1 SOCIAL AND ECONOMIC ENVIRONMENT

Although economic and social factors are listed in the definition of effects in the CEQ regulations and NAO 216-6, the definition of human environment states that "economic and social effects are not intended by themselves to require preparation of an EIS." However, an EIS or EA must include a discussion of a proposed action's economic and social effects when these

effects are interrelated with effects on the natural or physical environment. The social and economic environment is not described in detail because there is no potential for social and economic effects because communities do not depend socially or economically on the target or non-target species which may be affected by the action. There are no significant social or economic impacts of the proposed action interrelated with significant natural or physical environmental effects. Take of eulachon is currently not federally prohibited.

3.2 ***BIOLOGICAL AND PHYSICAL ENVIRONMENT***

Eulachon

Background

Eulachon (commonly called smelt, candlefish, or hooligan) are endemic to the eastern Pacific Ocean, ranging from northern California to southwest Alaska and into the southeastern Bering Sea. In the portion of the species' range that lies south of the U.S./Washington–Canada border, most eulachon production originates in the Columbia River Basin. Other river basins in the United States where consistent runs of eulachon have been documented include: Mad River and Klamath rivers in northern California; and infrequently in Oregon and Washington coastal rivers and tributaries to Puget Sound (Emmett *et al*., 1991). Within the Columbia River Basin, the major and most consistent spawning runs return to the mainstem of the Columbia River (from just upstream of the estuary, river mile (RM) 25, to immediately downstream of Bonneville Dam, RM 146) and in the Cowlitz River. Periodic spawning also occurs in the Grays, Skamokawa, Elochoman, Kalama, Lewis, and Sandy rivers (tributaries to the Columbia River) (Emmett *et al*., 1991; Musick *et al*., 2000). Throughout the species' range, the historic major production areas in the United States were the Klamath, Columbia, and Cowlitz rivers. Major production areas in Canada are the Fraser and Nass rivers (Willson *et al*., 2006). There are undocumented observations of eulachon occasionally using numerous other rivers for spawning. Many sources note that runs tend to be erratic, appearing in some years but not others, and appearing only rarely in some river systems. Some rivers have two eulachon runs per year.

Eulachon typically spend 2–5 years in saltwater before returning to fresh water to spawn from late winter through mid-spring (Barraclough, 1964; Parente and Snyder, 1970; Langer *et al*., 1977; Barrett *et al*., 1984; Hay and McCarter, 2000), although some adults can reach 9 years old (WDFW and ODFW, 2001). Spawning grounds are typically in the lower reaches of larger rivers fed by snowmelt (Hay and McCarter, 2000). Spawning occurs at night. Willson *et al*. (2006) concluded that the age distribution of eulachon in a spawning run probably varies among rivers and also varies between sexes in some years and among years in the same river system. Males typically outnumber females by 2:1 or more. Spawning occurs at temperatures from 4° to 10°C over sand, coarse gravel, or detrital substrates. The sexes must synchronize their activities closely, unlike some other group spawners such as herring, because eulachon sperm remain viable for only a short time, perhaps only minutes (Hay and McCarter, 2000). Some researchers report that males lie next to females, either beside or on top of them, in riffles (Lewis *et al*., 2002). Langer *et al*. (1977) report that males congregate upstream of groups of females, releasing milt simultaneously, and females lay eggs as the milt drifts over them. Eggs are fertilized in the water column, sink, and adhere to the river bottom typically in areas of gravel and coarse sand. Most or possibly all eulachon adults die after spawning.

In many rivers, spawning is limited to the part of the river that is influenced by tides (Lewis *et al*., 2002), but some exceptions exist. Eulachon once ascended more than 160 km in the Columbia River system. There is some evidence that water velocity greater than 0.4 m/sec begins to limit the upstream movements of eulachon (Lewis *et al*., 2002).

Entry into the spawning rivers appears to be related to water temperature and the occurrence of high tides (Ricker *et al*., 1954; Lewis *et al*., 2002; Spangler, 2002). Spawning occurs in January, February, and March in the Columbia River. Attempts to characterize eulachon run timing are complicated further by marked annual variation in timing. Willson *et al*. (2006) give several examples of spawning run timing varying by a month or more in rivers in British Columbia and Alaska.

Although spawning generally occurs at temperatures from 4 to 10 °C, runs can occur in colder water (Langer *et al*., 1977; Franzel and Nelson, 1981). In the Cowlitz River, temperatures during spawning ranged from 4 to 7 °C (Smith and Saalfeld, 1955). High water temperatures can be lethal to spawning eulachon. For fish acclimated to 5 °C, an increase to 11 °C for several days resulted in 50 percent mortality and spawning failure. Langer *et al*. (1977) suggested that the contrast between ocean and river temperatures might be more critical than river temperatures *per se*.

Eulachon eggs are approximately 1 mm in diameter, averaging about 43 mg; however, mean weight often varies by river (Hay and McCarter, 2000). Eggs are enclosed in a double membrane; after fertilization in the water, the outer membrane breaks and turns inside out, making a sticky stalk by which the egg adheres to sand grains and small gravels (Hart and McHugh, 1944; Hay and McCarter, 2000). Eulachon eggs hatch in 20–40 days with incubation time dependent on water temperature. Shortly after hatching the larvae are carried downstream and dispersed by estuarine and ocean currents. Similar to salmon, juvenile eulachon are thought to imprint on the chemical signature of their natal river basins. However, juvenile eulachon spend less time in these freshwater environments compared to juvenile salmon, and researchers believe that eulachon's short freshwater residence time may cause eulachon to stray at higher rates when they return to fresh water to spawn (Hay and McCarter, 2000).

After leaving estuarine rearing areas, juvenile eulachon move from shallow nearshore areas to deeper areas. Larvae and young juveniles become widely distributed in coastal waters, with fish found mostly at depths up to 15 m (Hay and McCarter, 2000) but sometimes as deep as 182 m (Barraclough, 1964). There is currently little information available about eulachon movements in nearshore marine areas and the open ocean. Willson *et al*. (2006) summarize the results of surveys showing concentrations of eulachon off Vancouver Island, in the Bering Sea, in the Gulf of Alaska, in Prince William Sound, and in the Coastal Fjords of Southeast Alaska. The amount of eulachon bycatch in the pink shrimp fishery seems to indicate that the distribution of these organisms overlap in the ocean.

Eulachon feed on plankton, chiefly eating crustaceans such as copepods and euphausiids, including *Thysanoessa* (Barraclough, 1964; Hay and McCarter, 2000), unidentified malacostracans (Sturdevant *et al*., 1999), and cumaceans (Smith and Saalfeld, 1955). Eulachon larvae and post-larvae eat phytoplankton, copepods, copepod eggs, mysids, barnacle larvae, worm larvae, and eulachon larvae (WDFW and ODFW, 2001). Adults and juveniles commonly

forage at moderate depths (15 to 182 m) in inshore waters (Hay and McCarter, 2000).

It is difficult to compare eulachon body lengths among reports because researchers have used different length measures (i.e., standard, fork, and total length). As expected, both length and body mass increase with age. Eulachon in the Kemano, Kitimat, Nass, Stikine, and Columbia rivers have similar distributions of size-at-age, but the increase in size-at-age is small for both sexes (10 mm from age 3 to 4 and 4 mm from age 4 to 5; Lewis *et al*., 2002).

Eulachon generally spawn in rivers that are glacier-fed and have a pronounced peak freshet in spring. Some researchers hypothesize that the rapid flushing of eggs and larvae due to these freshets may cause eulachon to imprint and home to an estuary rather than to individual spawning rivers (Hay and McCarter, 2000). Thus, the estuary has been invoked as the likely geographic stock unit for eulachon (Hay and McCarter, 2000; Hay and Beacham, 2005).

Variation in spawn timing among rivers has also been cited as indicative of local adaptation in eulachon (Hay and McCarter, 2000), although the wide overlap in spawn timing among rivers makes it difficult to discern distinctive patterns in this trait. In general, eulachon spawn earlier in southern portions of their range than in rivers to the north. River-entry and spawning begin as early as December and January in the Columbia River Basin. Eulachon have been known to spawn as early as January in rivers of the Copper River Delta of Alaska and as late as May in northern California.

Coastwide, there appears to be an increase in both mean length and weight of eulachon at maturity with an increase in latitude. Mean eulachon fork length and weight at maturity range to 175 mm and 37 g in the Columbia River. This pattern is typical of many vertebrate poikilotherms (i.e., cold-blooded animals), for which higher rearing temperatures result in reduced size at a given stage of development (Lindsey, 1966; Atkinson, 1994). This pattern of larger body size at age in more northern populations is also apparent in Pacific herring (Stout *et al*., 2001a). A study by Clarke *et al*. (2007) found that the age at maturity, based on otolith chemistry, is older for northern populations of eulachon.

McLean *et al*. (1999) examined mtDNA variation in 285 eulachon samples collected at 11 freshwater sites ranging from the Columbia River to Cook Inlet, Alaska, and also in 29 ocean-caught fish captured in the Bering Sea. They concluded that, overall, there was little differentiation in mtDNA among eulachon collected from distinct freshwater locations throughout the eulachon range, consistent with the hypothesis that eulachon dispersed from a single glacial event. However, McLean *et al.* (1999) noted that association of geographic distance and genetic differentiation among eulachon populations suggested an emerging population subdivision throughout the range of the species.

In a later study, McLean and Taylor (2001) used five microsatellite loci to examine variation in the same set of populations as McLean *et al*. (1999). The populations in the Columbia and Cowlitz rivers were represented by 2 years of samples with a total sample size of 60 fish from each river. However, several populations were represented by very few samples, including just five fish from the three rivers in Gardner Canal and just 10 fish from the Fraser River. Results from a hierarchical analysis of molecular variance test were similar to those of the McLean *et al*. (1999) mtDNA study, with 0.85 percent of variation occurring among large regions and 3.75

percent among populations within regions. In contrast to the mtDNA analysis, genetic distances among populations using these five microsatellite loci were not correlated with geographic distances. Overall, however, McLean and Taylor (2001) concluded that their microsatellite DNA results were mostly consistent with the mtDNA findings of McLean *et al.* (1999) and that both studies indicated that eulachon have some degree of population structure.

The most extensive genetic study of eulachon, in terms of sample size and number of loci examined, is that of Beacham *et al.* (2005). Beacham *et al*. (2005) examined microsatellite DNA variation in eulachon collected at 9 sites ranging from the Columbia River to Cook Inlet, Alaska, using the 14 loci developed in an earlier study by Kaukinen *et al*. (2004). Sample sizes per site ranged from 74 fish from the Columbia River to 421 from the Fraser River. Samples collected in multiple years were analyzed from populations in the Bella Coola and Kemano rivers (2 years of sampling) and also in the Nass River (3 years of sampling). Beacham *et al*. (2005) observed much greater microsatellite DNA diversity within populations than that reported by McLean and Taylor (2001), and all loci were highly polymorphic in all of the sampled populations. Significant genetic differentiation was observed among all comparisons of the nine populations in the study. A cluster analysis of genetic distances showed genetic affinities among the populations in the Fraser, Columbia, and Cowlitz rivers and also among the Kemano, Klinaklini, and Bella Coola rivers along the central British Columbia coast. In particular, there was evidence of a genetic discontinuity north of the Fraser River, with Fraser and Columbia/Cowlitz samples being approximately 3–6 times more divergent from samples further to the north than they were to each other. Similar to the mtDNA study of McLean *et al*. (1999), the authors also found that genetic differentiation among populations was correlated with geographic distances.

Beacham *et al*. (2005) found stronger evidence of population structure than the earlier genetic studies, and concluded that their results indicated that management of eulachon would be appropriately based at the level of the river drainage. In particular, the microsatellite DNA analysis showed that populations of eulachon in different rivers are genetically differentiated from each other at statistically significant levels. The authors suggested that the pattern of eulachon differentiation was similar to that typically found in marine fish, which is less than that observed in most salmon species.

Although Beacham *et al*. (2005) found clear evidence of genetic structure among eulachon populations, the authors also noted that important questions remained unresolved. The most important one in terms of identifying DPSs for eulachon is the relationship between temporal and geographic patterns of genetic variation. In particular, Beacham *et al*. (2005) found that year-to-year genetic variation within three British Columbia coastal river systems was similar to the level of variation among the rivers, which suggests that patterns among rivers may not be temporally stable. However, in the comparisons involving the Columbia River samples, the variation between the Columbia samples and one north-of-Fraser sample from the same year was approximately 5 times greater than a comparison within the Columbia from 2 different years.

Ecological Boundaries

The fidelity with which eulachon return to their natal river, estuary, or inlet implies some association between a specific stock and its freshwater and/or estuarine environment. Differences in life-history strategies among eulachon populations or stocks may have arisen, in part, in response to selective pressures of different freshwater/estuarine environments. If the

boundaries of distinct freshwater or estuarine habitats coincide with differences in life histories, it would suggest a certain degree of local adaptation.

Historically, the distribution of eulachon in Washington, Oregon, and California corresponds closely with the Coastal Range Ecoregion as defined in Omernik (1987). Extending from the Olympic Peninsula through the Coast Range proper and down to the Klamath Mountains and the San Francisco Bay area, this region is influenced by medium to high rainfall levels because of the interaction between marine weather systems and the mountainous nature of the region. Topographically, the region averages about 500 m in elevation, with mountain tops under 1,200 m in elevation. The region is heavily forested, primarily with Sitka spruce, western hemlock, and western red cedar. Streams occupied by eulachon within this region generally follow two distinct annual flow patterns: (1) Streams draining coastal watersheds, where winter rain storms are common, have high flow periods coinciding with these storms; (2) streams draining more interior areas, such as the Columbia and Cowlitz Rivers, have a distinct spring freshet period coinciding with snow melt. Eulachon production is highest in these latter systems. Ecological features of the ocean environment also affect eulachon ecology. Ware and McFarlane (1989) built upon previous descriptions of oceanic domains in the northeast Pacific Ocean by Dodimead *et al*. (1963) and Thomson (1981) to identify three principal fish production domains: (1) a Southern Coastal Upwelling Domain, (2) a Northern Coastal Downwelling Domain, and (3) a Central Subarctic Domain (the Alaskan Gyre). The boundary between the Coastal Upwelling Domain and Coastal Downwelling Domain occurs where the eastward flowing Subarctic Current (also called the North Pacific Current) bifurcates to form the north-flowing Alaska Current and the south-flowing California Current in the vicinity of a Transitional Zone between the northern tip of Vancouver Island and the northern extent of the Queen Charlotte Islands (an archipelago off the northwest coast of British Columbia, Canada, just south of the Nass River outlet). Similarly, Longhurst (2006) identifies an Alaska Downwelling Coastal Province and a California Current Province within the Pacific Coastal Biome.

Within Longhurst's (2006) Pacific Coastal Biome, ocean distribution of eulachon spans the Alaska Downwelling Coastal Province and the northern portion of the California Current Province. Longhurst (2006) places the boundary between the Alaska Coastal Downwelling Province and the California Current Province between the Queen Charlotte Islands at 53° N. and the northern end of Vancouver Island at 47–48° N. latitude, where the eastward flowing North Pacific Current encounters the North American continent and bifurcates to form the north-flowing Alaska Current and south-flowing California Current.

Eulachon from Washington, Oregon, and California are part of a newly listed DPS that extends beyond the conterminous United States and that the northern boundary of the DPS occurs in northern British Columbia south of the Nass River. This is based on the evidence indicating that eulachon occurring in this area are discrete from eulachon occurring north of this area based on differences in spawning temperatures; length- and weight-at-maturity in the species' range; ecological features of both the oceanic and freshwater environments occupied by eulachon; and genetic characteristics. This DPS is significant to the species as a whole because it constitutes over half of the geographic range of the entire species' distribution and includes three of the major production areas (Klamath, Columbia, and Fraser rivers) for the entire species.

Historically important spawning areas for eulachon south of the Nass River included the

Klamath, Columbia, and Fraser Rivers, and numerous coastal rivers in British Columbia. The Columbia River and its tributaries support the largest known eulachon run. Although direct estimates of adult spawning stock abundance are unavailable, records of commercial fishery landings begin in1888 and continue as a nearly uninterrupted data set to the present time (Gustafson *et al*., 2008). A large recreational dipnet fishery for which catch records are not maintained has taken place during the commercial fishery (WDFW and ODFW 2001).

Although commercial eulachon landings do not provide a quantitative measure of spawning stock abundance, since they can be driven by market and environmental conditions as well as supply, the WDFW and ODFW Joint Columbia River Management Staff (JCRMS 2007) has concluded that "they do provide a useful measure of the relative annual run strength." In particular, State fisheries managers of Columbia River eulachon use commercial landings to judge whether population trends are upward, neutral, or downward (JCRMS 2007). The Columbia River, estimated to have historically represented fully half of the taxon's abundance, experienced a sudden decline in its commercial eulachon fishery landings in 1993-1994 (ODFW and WDFW 2001, JCRMS 2007). Persistent low returns and landings of eulachon in the Columbia River, from 1993 to 2000, prompted the States of Oregon and Washington to adopt a Joint State Eulachon Management Plan in 2001 that provides for restricted harvest management when parental run strength, juvenile production, and ocean productivity indicate a poor return is likely (WDFW and ODFW 2001). Despite a brief period of improved returns in 2001-2003, the returns and associated commercial landings, have again declined to the very low levels observed in the mid 1990s (JCRMS 2007) and the fishery has operated at the most conservative level allowed for in the Joint State Eulachon Management Plan since 2005 (JCRMS 2005, 2006, 2007). Commercial catch of eulachon in the Columbia River, which averaged 998 metric tons between 1936 and 1992, has declined by an order of magnitude to an average of 99 metric tons from 1993 to the present.

In addition to concerns over range-wide declines in abundance, there is concern that the current abundance of the many individual populations within the DPS is sufficiently low to be an additional risk factor, even for populations (such as the Columbia) where the absolute population size may be considered "large" when compared to other animal population sizes. Several aspects of eulachon biology indicate that large aggregations of adult eulachon are necessary for maintenance of normal reproductive output. Eulachon are a short-lived, high-fecundity, high-mortality forage fish, and such species typically have extremely large population sizes. There is likely a biological requirement for a critical threshold density of eulachon during spawning to ensure adequate synchronization of spawning, mate choice, gonadal sterol levels, and fertilization success. Since eulachon sperm may remain viable for only a short time--perhaps only minutes--sexes must synchronize spawning activities closely. Large spawning aggregations of adult eulachon are also necessary to withstand predation pressure associated with large congregations of predators that target returning adults, and to produce enough eggs and pelagic larvae to overwhelm predators in the ocean (Bailey and Houde, 1989).

In addition, the effective population size of eulachon may be much lower than the census size. In marine species, under conditions of high fecundity and high mortality associated with pelagic larval development, local environmental conditions may lead to random "sweepstake recruitment" events where only a small minority of spawning individuals contribute to subsequent generations (Hedgecock, 1994). Available information (disjunct spawning

distribution, differences in spawn timing, genetics, life history diversity) suggests that population structure of eulachon roughly conforms to the classical concept of a metapopulation, in which local subpopulations are linked demographically by at least episodic migration, and extinction and recolonization of local subpopulations are common over ecological time frames. In this type of system, at any given point in time, some local subpopulations are expected to be increasing and some declining, and some suitable habitat patches are expected to be uninhabited. Eulachon are in decline throughout the DPS, current population trajectories are out of the range of historic patterns, and there are no identified eulachon runs in the DPS that could be considered healthy. The disappearance and recolonization of sub-populations is a natural occurrence in functioning metapopulations; however, it will be difficult for eulachon to re-establish viable populations in rivers in northern California, after 20 years of low abundance, when the closest viable population is in the Columbia River.

Other Affected Species- Biological and Physical Environment
In addition to eulachon located within the study region, a wide variety of non-target species could be found within the action area, including other marine mammals, invertebrates, teleost and elasmobranch fish, and sea birds. Since merely being present within the action area does not necessarily mean an organism will be affected by the proposed action, the following discussion focuses not only on the distribution and abundance of various species with respect to the timing of the action, but also on whether and by what means the proposed research activities may affect any non-targeted species. Due to the nature of netting, the researchers would expect to have some non-target species interactions, including interactions with listed species.

ESA Listed Species- Fish

Lower Columbia River Chinook
This Evolutionary Significant Unit (ESU) includes naturally spawned populations of spring and fall chinook (*Oncorhynchus tshawytscha*) in the Columbia River Basin and tributaries from the mouth of the Columbia River up to a transitional line above the Hood River and (Big) White Salmon River. This ESU includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River. The Lower Columbia River Chinook ESU was listed under the ESA as threatened, effective March 24, 1999 (64 FR 14308, 24 March 1999; 70 FR 37160, 28 June 2005).

Spring Chinook salmon enter the lower Columbia River during mid-February to late-March. The larger Age-5 fish dominate the earlier portion of the run. The bulk of the spring Chinook are from the Willamette River (not part of the Lower Columbia River Chinook ESU).

Fall Chinook generally enter the Columbia River from late July through October, peak in the lower river from mid-August to mid-September. Columbia River fall Chinook are comprised of five major components; Lower River Hatchery (LRH), Lower River Wild (LRW), Bonneville Pool Hatchery (BPH), Upriver Brights (URB), and Mid-Columbia Brights (MCB). The LRH and BPH stocks are referred as tules and the LRW, URB, and MCB are referred to as brights. Minor run components include Lower River Brights (LRB) and Select Area Brights (SAB). The Lower Columbia Evolutionary Significant Unit (ESU) includes naturally spawning fish in the LRH and LRW management groups.

There appear to be three self-sustaining populations of fall Chinook in the lower Columbia River basin that have had little or no hatchery influence (Coweeman, East Fork Lewis, and Sandy rivers). Ocean distribution of tule fall Chinook (LRH) is primarily off the Washington coast. LRH hatchery stock return to the Columbia River in August and early September and mature soon after freshwater entry. Peak spawning time is in late September and early October.

The LRW management stock is comprised of wild/naturally-produced fish from the North Lewis, East Fork Lewis, and Sandy rivers (brights). These populations are self-sustaining with no significant hatchery influence. Ocean distribution of LRW fall Chinook is more northerly and they contribute to Canadian and Alaskan fisheries. LRW fall Chinook return to the Columbia River from August through December, with peak spawning in mid-November.

Chinook are the largest species of Pacific salmon (adults returning to the Columbia River in August average over 20 pounds). They have a moderately compressed elongated body, with the widest girth around the tips of the pectoral fins. Head length is about 3.7 into standard length (Hart ,1973). Large mesh-sizes are used to target Chinook, while allowing escapement of smaller salmonids. For example, recent August and Late Fall Non-Indian Commercial Gillnet seasons in the lower Columbia River have used a minimum of 9 inches and a maximum of 9-3/4 inches mesh size.

Chinook adults appear to favor the top of the water column during the late flood stage and the bottom of the water column during ebb tides, but are found throughout the water column. (Vertical distributions are based on Bernhardt *et al.'s* (1969) gillnet selectivity studies, at Astoria and Vancouver sites in the lower Columbia River).

Upper Willamette Spring Chinook

The Willamette River spring Chinook salmon pass through the lower Columbia River from February through May, with peak abundance during mid-March to mid-April. Historically, wild spring Chinook salmon spawned in nearly all east side Willamette tributaries above Willamette Falls. During the 1950s and 60s, dams were constructed on all these tributaries. The wild run has been supplemented with hatchery fish, and currently the percent of wild fish in the current Willamette spring Chinook population is about 10-12%, with the majority destined for the McKenzie River.

NMFS classified spring Chinook salmon destined for the Willamette Falls and the Clackamas River (below the falls) into a single, and listed the wild component as a threatened species under the ESA, effective May 24, 1999 (64 FR 14308, 24 March 1999; 70 FR 37160, 28 June 2005). Returns of the component spawning above Willamette Falls (mostly comprised of hatchery fish) improved (2004 being a record return of 143,700 fish), but fell far short of the Willamette Basin Fish Management Plan objective of 100,000 fish during the past two years. Projections for 2007 forecast a return of 52,000 to the Columbia River mouth, with 10% (5,200 fish) being wild. Returns of Clackamas River component has averaged about 15,000. About 16% (1,600 fish) of the run is wild.

Upriver Spring Chinook

Mature spring chinook salmon, destined for watersheds above Bonneville Dam (Rkm 233), enter the Columbia River in late February and early March, reaching peak abundance in the lower river during April and early May, and clearing Bonneville Dam by mid June. The upriver run is

composed of stocks from three geographically separate production areas: 1) the Columbia River system above the confluence with the mouth of the Snake River, 2) the Snake River system, and 3) Columbia River tributaries between Bonneville Dam and the Snake River confluence. The Snake River component (also see next section) was listed as threatened effective May 22,1992 (57 FR 14653, 22 April 1992; 57 FR 23458, 3 June 1992; 70 FR 37160, 28 June 2005), and the upper Columbia wild spring Chinook listed as endangered effective May 24, 1999.

The 1995 run marked an all-time low of 12,600 fish. The 2000-2004 run sizes were large with an annual average return of 283,900 adults to the Columbia River. An all-time record high of 437,900 fish was reached in 2001; however the run sizes have declined since that peak. The 2007 forecast of 78,500 adult upriver spring Chinook returning to the Columbia River, includes 1,200 wild upper Columbia spring Chinook.

Snake River Sockeye Salmon

Historically, eight tributary lake systems produced sockeye salmon (*Oncorhynchus nerka*) in the Columbia Basin. Six decades of hydropower development, has blocked access to 96% of the critical lake habitat (in terms of surface acreage). Today, modest returns occur in the Wenatchee and Okanogan subbasins, and extremely low numbers return to the Snake subbasin (WDFW and ODFW 2002). In 1991, the Snake River sockeye salmon were listed under the ESA as endangered (November 20, 1991, 57 FR 58619; effective December 20, 1991). The five-year average return to the Stanley Basin is 12 adult sockeye. Only 3 returned in 2006. During some years in the 1990s, no fish returned. In order to prevent extinction of the Snake River sockeye, a captive brood program was initiated.

Columbia River sockeye fisheries were closed from 1989 through 1999. Large returns in 2000 and 2001 allowed managers to open limit commercial, tribal, and recreational fisheries in the Columbia River. To avoid harvest of Snake River sockeye, fishers were not allowed to retain adipose fin-clipped fish (from the captive brood program). This preventive measure did not work as well as expected, because some fishers thought clipped fish were to be retained—traditionally fin-clipped (hatchery) fish are keepers, and unmarked (wild) fish are thrown back (personal communication, Lisa Harlan, Pacific States Marine Fish Commission, now with Smith-Root). The 2007 forecast for sockeye to the Columbia River is 27,300 adults. The Snake River component is forecast to be 300 fish. That would be the largest run since 2000.

Weighing only 4 pounds on average, Columbia River sockeye are the smallest of their kind in North American (WDFW and ODFW 2002). They have an elongated body that is moderately compressed, with the widest girth at the origin of the dorsal fin. The head length is about 4.5 into the standard length (Hart, 1973). Because of their small size, sockeye are able to escape capture in large mesh gillnets. Smaller mesh sizes are used to target sockeye (e.g., there was a 4-1/2 inch maximum mesh size restriction in the 2000 Columbia River Non-Indian Commercial Sockeye Fishery).

Ozette Lake Sockeye Salmon

Lake Ozette, along the north coast of the Olympic Peninsula, supports a small run of sockeye salmon. That run of sockeye was listed under the ESA as endangered in 1999 (64 FR 14528, 25 March 1999; 70 FR 37160, 28 June 2005). The Ozette Lake Sockeye ESU includes all naturally spawned populations of sockeye salmon in Ozette Lake and the streams and tributaries flowing

into Ozette Lake. It also includes fish from the Umbrella Creek and Big River sockeye hatchery programs.

Snake River Fall Chinook Salmon
Snake River fall Chinook salmon were listed under the ESA as threatened (April 22, 1992, 57 FR 14653; effective May 22, 1992), but their status was revised effective August 18, 1994 to endangered through an emergency interim rule (59 FR 42529, 18 August 1994; also see, 57 FR 23458, 3 June 1992, and 70 FR 37160, 28 June 2005).

The Columbia River fall gillnet fishery is split into an early fall (August) season and a late fall (mid- or late-September through October) season (Figure 12 in WDFW and ODFW 2002). Fall Chinook are landed mainly during the early fall, while coho (*Oncorhynchus kisutch*) are caught in the late fall season (Bernhardt *et al*. 1969). During the early to mid-September timeframe, early coho and fall Chinook salmon are intermingled in the lower Columbia River (Langness 1992). Bernhardt *et al*. (1969) suggested that restricting fishing gear to small mesh single wall gillnets would increase the coho harvest while protecting fall Chinook, particularly the large females. Subsequently, stretch mesh size restrictions have been imposed in the late fall, whenever it was desirable to harvest surplus coho but limit the Chinook take (for example in 2000; Table 7 of WDFW and ODFW 2002).

Lower Columbia River Coho Salmon
Coho salmon (*Oncorhynchus kisutch*) return to the Columbia River from August through November. The run consists of two components—early coho stock returns peak in early September, and late coho stock returns peak in mid-October. The major contributor of both stocks is hatchery production with wild production probably comprising less than 10% of the total run. Oregon facilities dominate the hatchery component in the early run. Fish from the Clackamas and Sandy rivers are the main components, since stocks below the Willamette River confluence are extirpated (WDFW and ODFW 2002).

In 1990, the wild portion of the coho salmon run from the Columbia River and its tributaries (exclusive of the Willamette River) downstream of Bonneville Dam, was petitioned for listing as threatened or endangered. NOAA Fisheries did not list these fish, because the small remnant runs are predominately hatchery-maintained and are not a species as defined in the ESA. In 1995, NOAA Fisheries combined the Columbia River (including the Willamette River), Willapa Bay, and Grays Harbor coho into the single Lower Columbia River/Southwest Washington Coast ESU, and identified it as a candidate species, worthy of further consideration (July 25, 1995; 60 FR 142). In July 1999, the State of Oregon listed wild coho salmon destined for lower Columbia River tributaries as endangered under their state ESA. In 2000, NOAA Fisheries accepted another petition to federally list lower Columbia River coho, and found that there was insufficient evidence to support emergency listing (November 3, 2000; 65 FR 214). Eventually, all coho salmon spawning naturally from the mouth of the Columbia up to and including the White Salmon and Hood rivers were listed under the ESA as threatened, effective August 26, 2005 (70 FR 37160, 28 June 2005).

Coho are a modest-sized species of Pacific salmon (adults returning to the Columbia River average around 6.5 pounds for early coho and 8.5 pounds for late coho). They have a moderately compressed elongated body, with the widest girth around the tips of the pectoral fins. Head

length is about 3.4 into standard length (Hart, 1973). In recent years, a maximum 6-inch stretch mesh size has been used to select coho during periods of low Chinook abundance (e.g., during the 2000 late fall non-Indian commercial fishery in the lower Columbia River; WDFW and ODFW 2002).

Coho appear to be at the top or the bottom of the water column during the late flood stage in the Columbia River estuary (near Astoria). During ebb tides, they appear to remain on the bottom. This is true in deeper waters upriver (near Vancouver), but there is some distribution throughout the water column in this situation (vertical distributions based on gillnet selectivity studies by Bernhardt *et al*. 1969).

Columbia River Chum

Chum salmon (*Oncorhynchus keta*) return to the Columbia River from mid-October through mid December. A few are caught incidentally in the late fall non-Indian commercial gillnet fishery, with landings occurring after mid-October. Primary production areas include the Grays River, smaller tributaries just downstream from Bonneville Dam, and the mainstem Columbia River in select locations from the I-205 Bridge upstream to Bonneville Dam. Currently there are two hatchery supplementation programs releasing fry in these areas. Columbia River chum salmon were listed under the ESA as a threatened species effective May 24, 1999 (64 FR 14508, 25 March 1999; 70 FR 37160, 28 June 2005).

Winter Steelhead

Winter steelhead (*Oncorhynchus mykiss*) enter the Columbia River from November through May. All wild winter steelhead in the proposed study area are listed under the ESA as threatened (since 1999), except those within the Southwest Washington ESU (listing not warranted; see steelhead listing review 71 FR 834 dated 5 June 2006).

The non-listed Southwest Washington ESU includes all naturally spawned populations of winter-run steelhead in river basins of, and tributaries to the Columbia River below the Cowlitz River in Washington and the Willamette River in Oregon. The Southwest Washington ESU also includes all winter-run steelhead in river basins of Grays Harbor and Willapa Bay.

The other Columbia River winter steelhead are part of the Upper Willamette River Steelhead ESU, Lower Columbia River Steelhead ESU, or the Middle Columbia River ESU. The Upper Willamette River ESU steelhead are all winter-run, while the other two ESU are a mix of summer-run and winter-run steelhead. The Upper Willamette River ESU fish spawn in the tributaries from Willamette Falls up to and including Calapooia River. The Lower Columbia River ESU fish spawn in Washington tributaries between the Cowlitz and Wind rivers, inclusively. They also spawn in Oregon tributaries between the Willamette and Hood rivers, inclusively (except upper portion of Willamette is separate ESU). The Middle Columbia River ESU covers fish spawning from Mosier Creek, Oregon, upstream to Yakima River, Washington, inclusively. There are 16,200 wild winter-run steelhead (listed and non-listed ESU) expected in the Columbia River during 2007.

Summer Steelhead

The Columbia River summer steelhead run is comprised of populations from lower and upper river tributaries. Summer steelhead enter freshwater year-round, with the majority entering from

June through October. The lower river component of the run tends to arrive earlier than the upriver stocks, with abundance peaking in the estuary during May and June. The lower Columbia River steelhead ESU was listed as threatened by NMFS in 1998. Wild lower river summer steelhead are present in the Cowlitz, Kalama, Lewis, Wind, and Washougal rivers in Washington, and the Hood River in Oregon. The upper river component passes Bonneville Dam with a peak in early August (Group A Index; fish less than 78 cm fork length passing Bonneville dam from July 1st through October 31st) and a second peak in mid-September (Group B Index; larger fish destined for Snake River tributaries; fish greater than or equal to 78 cm fork length that pass Bonneville Dam from July 1st through October 31st). Fish passing Bonneville Dam during April 1st and June 30th are considered to be Skamania Index (primarily fish originating from the hatchery transplants above Bonneville Dam of lower river hatchery fish). NMFS divided the upriver summer steelhead run into three ESU: the middle Columbia ESU listed as threatened; the upper Columbia ESU (including the hatchery component) listed as endangered and later downgraded to threatened, and the Snake River ESU (including both Group A and B fish) listed as threatened (see steelhead listing review 71 FR 834 dated January 5, 2006). The summer steelhead run at Bonneville is expected to hit 241,500 (41,600 wild) Group A Index steelhead, and 56,400 (56,400 wild) Group B Index steelhead.

Southern Oregon/Northern California Coast Coho ESU
Listed as threatened on May 6, 1997. The ESU includes all naturally spawned populations of coho salmon in coastal streams between Cape Blanco, Oregon, and Punta Gorda, California, as well as three artificial propagation programs in the Cole River Hatchery (ODFW stock #52), Trinity River Hatchery, and Iron Gate Hatchery.

Oregon Coast Coho ESU
Listed as threatened with critical habitat designated on February 11, 2008. The ESU includes all naturally spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco, including Cow Creek (ODFW stock #37) coho hatchery. program.

Snake River Spring/Summer-run Chinook ESU
Listed as threatened on April 22, 1992. The ESU includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, as well as fifteen artificial propagation programs: the Tucannon River conventional Hatchery, Upper Grande Ronde, Imnaha River, Big Sheep Creek, McCall Hatchery, Johnson Creek Artificial Propagation Enhancement, Lemhi River Captive Rearing Experiment, Pahsimeroi Hatchery, East Fork Captive Rearing Experiment, West Fork Yankee Fork Captive Rearing Experiment, and the Sawtooth Hatchery spring/summer-run Chinook hatchery programs.

Green Sturgeon
The Southern DPS of green sturgeon was listed as threatened in April 7, 2005 (71 FR 17757). The Northern DPS and Southern DPS are distinguished based on genetic data and spawning locations, but their distributions outside of natal waters generally overlap with one another (Chadwick, 1959; Miller, 1972; California Department of Fish and Game (CDFG), 2002; Erickson and Webb, 2007; Moser and Lindley, 2007; Lindley *et al.*, 2008). Both Northern DPS and Southern DPS fish occupy coastal waters from southern California to Alaska and are known

to aggregate in the Columbia River estuary and Washington estuaries in the late summer (Israel *et al.*, 2004; Moser and Lindley, 2007; Lindley *et al.*, 2008). Thus, green sturgeon observed in coastal bays, estuaries, and coastal marine waters outside of natal rivers may belong to either DPS. However, the Northern DPS of green sturgeon is not classified as a listed species under the ESA.

ESA Listed Species- Marbled Murrelet

The Marbled Murrelet (*Brachyramphus marmoratus*) was listed as a threatened species pursuant to the ESA on October 1, 1992 (57 FR 191: 45328-45337, 1 October, 1992). The adults spend most of their time feeding in shallow areas, and within 1 to 2 kilometers offshore. They are usually sighted in pairs, but do aggregate in foraging areas during the summer and winter. Nesting occurs in coastal old growth forests. The breeding periods of incubation and rearing run from April through June. Juvenile birds begin to appear on the water shortly afterwards. By July, many of the chicks are fledgling (Speich *et al*. 1992).

From 1971 through 1985, several field studies observed a total of 500 Marbled Murrelets along the southern outer coast of Washington (Speich and Wahl 1989, and Speich *et al*. 1992). Marbled Murrelets were consistently observed in Grays Harbor Channel as well as near shore off Grays Harbor, and south to the Columbia River. There were no systematic surveys conducted within Grays Harbor or Willapa Bay, although Marbled Murrelets were observed in small numbers at the mouth of the Naselle River (south end of Willapa Bay) and near the north end of Grassy Island, near Leadbetter Point (north end/ mouth of Willapa Bay).

Alcid mortality was estimated for a gillnet sockeye fishery in Barkley Sound, British Columbia, by Carter and Sealy (1984). During their study, Marbled Murrelets were observed in small flocks landing or resting near gillnets. The birds were observed diving in the immediate proximity of nets, perhaps attracted to the presence of small fish that may congregate along the net wall. Marbled Murrelets were taken in gillnets almost exclusively at night (apparently associated with nocturnal feeding trips during the breeding period). Carter and Sealy (1984) stated that fewer birds would have been killed later in the summer, because murrelets are distributed in small and widely scattered flocks while molting.

Ainley *et al.* (1981) tested a variety of mesh sizes ranging from 37 mm (1.5 inches) to 233 mm (9.2 inches) and recorded their entanglement rates with seabirds. The highest entanglement rate occurred with mesh sizes from 106mm (4.2 inches) to 130mm (5.1 inches), which was significantly higher than the other three classes that were compared.

ESA and/or MMPA Listed Species- Marine Mammals

Pacific Harbor Seal

Since enactment of the Marine Mammal Protection Act of 1972, northwest populations of Pacific harbor seals (*Phoca Vitulina*) have steadily increased. They are now considered by NMFS to be healthy, productive, and growing. Harbor Seals are opportunistic feeders, preying on a wide variety of cephalopods (squid and octopus), and benthic and epibenthic fish. Their diet varies as they take advantage of food that is seasonally and locally abundant (NMFS 1997). In the Washington outer coastal estuaries and Columbia River, harbor seals have been found to feed

primarily on eulachon (*Thaleichthys pacificus*), other smelt (*Osmeridae spp.*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*) codfish (*Gadidae spp.*), flatfish, crustaceans, lamprey (*Lamptera spp.*), and staghorn sculpin (*Leptocottus armatus*).

California Sea Lion

Since enactment of the Marine Mammal Protection Act of 1972, northwest populations of Pacific harbor seals (*Phoca Vitulina*) have steadily increased. They are now considered by NMFS to be healthy, productive, and growing (Emmett 1997). California sea lions are opportunistic feeders, preying on a wide variety of fish and squid. Their diet is diverse, varying by location as well as seasonally and annually. During the non-breeding season, sea lions move into specific areas in response to local abundance of prey (NMFS 1997). In the Columbia River, they feed primarily on eulachon, rockfish (*Sebastes spp.*), Pacific herring, lamprey, and Pacific sand lance (*Ammodytes hexapterus*) (Brown *et al*., 1995). Based on studies along the Oregon and California coasts (Riemer and Brown 1996), Pacific mackerel (*Scomber japonicus*), cephalopods, codfish, skates (*Rajidae spp.*), and spiny dogfish are also significant parts of the sea lion diet that may show up in the Washington outer coastal estuaries. During the late winter/early spring of 2006 and 2007, California sea lions have been observing the behavior of the larger Steller sea lions below Bonneville Dam.

Steller Sea Lion eastern DPS

The eastern DPS Steller sea lion is found from Southeast AK to Central California. Although this DPS has been doing well it is still listed as threatened under the ESA. Stellers breed and use haulouts in Oregon and only use haulouts in WA. Beach *et al.* (1985) obtained gastrointestinal tract samples from beach-cast specimens in the Columbia River, year-round for 1980 and 1981. Prey included Pacific Whiting (*Merluccius productus*), rockfish, eulachon, anchovy, Pacific herring, staghorn sculpin and lamprey.

Killer Whales

The NMFS Biological Review Team (BRT) concluded that there were two distinct population segments (DPS) to the resident killer whale subspecies: a Northern Resident DPS; and, a Southern Resident DPS (Krahn *et al*., 2004). The Southern Resident DPS was classified as depleted under the MMPA in May 2003 (68 FR 31980), and listed under the ESA as endangered on November 18, 2005 (70 FR 69903).

Individuals and pods of Southern DPS resident killer whales have been sighted from Central California up to the Queen Charlotte Islands in northern British Columbia. In the winter months, the Southern DPS killer whales are found in the coastal waters. From late spring to early fall, the Southern Resident DPS pods are found in the Georgia Basin (Georgia Strait, San Juan Islands, and Strait of Juan de Fuca), with the K and L pods arriving in May-June and departing in October-November. However, during this season these pods make frequent short trips out to the Washington coast. Fish are the main diet of resident killer whales, especially salmon. These movements to the coast might be associated with the arrival of salmon. NMFS reports several sightings of these Southern Resident DPS pods off the three main coastal estuaries (Grays Harbor, Willapa Bay, and Columbia River), during March-April and September-October (corresponding to the bimodal peaks in salmon runs entering these estuaries). There are historic reports of Orcas entering the Columbia River and ascending to RM 120 (Nathan Reynolds, Cowlitz Tribe, May 2010, pers. comm.).

Critical Habitat
Species with designated critical habitat within the sampling areas include Chinook salmon, chum salmon, coho salmon, Steller sea lions, and green sturgeon. Maps of the specific proposed or designated critical habitat areas can be found at:
http://www.nmfs.noaa.gov/pr/species/criticalhabitat.htm

Essential Fish Habitat (EFH)
Congress defined essential fish habitat for federally managed fish species as "those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). As such, EFH varies by species, geographic location, life stage, etc. A description of specific designated EFH for species within the action area can be found at:
http://www.nmfs.noaa.gov/habitat/habitatprotection/profile/htm

Non-Target Non-Listed Species
Due to the nature of larval netting, researchers would expect some other non-target species to become trapped. The limited duration and unique window of eulachon run-timing would greatly minimize these impacts, as would the effective handling of nets and preferential release by researchers of trapped non-target individuals. Other species may include, but are not limited to, resident trout species, white sturgeon, and lamprey.

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

4.1 EFFECTS OF ALTERNATIVE 1: No Action

An alternative to the proposed action is no action, i.e., denial of the grant. This alternative would eliminate any potential risk to the environment from the proposed research activities. However, the no-action alternative would not allow research to be conducted and would deny fisheries and habitat managers the opportunity to benefit from the results of the research anticipated in this proposal.

4.2 EFFECTS OF ALTERNATIVE 2: Issue grant with standard conditions

Any impacts of the proposed action would be limited to the biological environment. Sample collections and fish-handling would be conducted by trained personnel according to standard scientific protocols. The impacts of the plankton tows, spawning substrate frames surveying and dip-netting would have negligible impacts on the physical environment. The type of research actions proposed in this grant application would be unlikely to adversely affect the socioeconomic environment or pose a risk to individual and/or public health or safety. There are no significant social or economic impacts of the proposed action interrelated with significant natural or physical environmental effects.

Environmental Consequences to the Biological Environment

Eulachon Interactions
While the activities of this project would lethally take eulachon, the impacts are not expected to have population level effects. Plankton tows are likely to lethally take less than 10,000 larvae

per year. Given the typical low larvae to adult survival rate for forage fish, this amounts to just a few adult equivalents. Spawning substrate frames (egg mats) are likely to collect only a few hundred eggs per year. That equates to less than one adult equivalent. Less than 500 adult fish (25-50 pounds) would be lethally taken per year from the Columbia River or its tributaries. This is a small amount relative to adult abundance even in low population years. While there is no adequate population estimate to date, fisheries records indicate that there are likely at least 1,250,000 fish in the Columbia River system (see NMFS BiOp for this award for more details). While eulachon are listed as threatened under the ESA, NMFS has not issued a rule prohibiting their take.

Salmon and Steelhead Interactions

Although ESA listed salmon and steelhead could be taken by this proposed research, interactions are expected to be rare. The use of dip-nets to capture adult samples from the mainstem Columbia River or tributaries has only a small potential to entangle fish other than smelt because this gear is non-selective to larger species. Furthermore, the run-timing of smelt does not significantly overlap with the migration of salmon or steelhead. The lower Columbia River Chinook ESU (spring Chinook adult component), the upper Willamette spring Chinook ESU, and the upriver spring Chinook ESU start to arrive during late February or March, but do not peak until past the primary work window for the eulachon study. Migration of the Columbia River chum ESU typically occurs before December. Summer steelhead ESU species would not be encountered, but the Columbia River winter steelhead ESU species might, given their migration through the lower Columbia River from November through May. Impacts to these fish would be negligible given the limited interaction potential. Steelhead would not likely be caught in dipnets, and could immediately be released alive if encountered, hence no salmonid mortalities are expected. The use of plankton nets on tributaries would occur during the same limited window of exposure to salmonid species. Columbia River winter steelhead ESU species might be encountered, but again, impacts to these fish would be negligible. Steelhead would not likely be caught in plankton nets, and could immediately be released alive if encountered, hence no salmonid mortalities are expected. The applicant is confident that no salmon or steelhead would be harmed in the execution of this study.

Other Fish and Invertebrate Species Interactions

Few fish other than eulachon smelt spawn during the spawning substrate frame deployment time frame, so few interactions are expected. From previous research using similar techniques, the applicant is confident that only smelt eggs would be collected with that equipment. No fish other than smelt are expected to be captured in dip netting activities. No fish have been recorded as bycatch during plankton nets tows to capture eulachon larvae. It is possible that other species might be captured, such as resident trout, lamprey or white sturgeon, but any by-catch could immediately be released alive if encountered, hence no mortalities are expected from plankton nets research efforts. The applicant is confident that no other fish or invertebrates would be harmed in the execution of this study.

Bird Species Interactions

While interactions are expected to be limited, there is the possibility that bird species would be impacted by the proposed research. Most bird activity associated with smelt are gulls following a group of smelt up the Columbia River and into the rivers tributaries. Listed species, such as the Marbled Murrelet, are not likely to be observed, let alone encountered. The dipnet, plankton net, and spawning substrate frames research efforts are not a threat to birds. NMFS, in consultation

with the applicant, is confident that no seabirds would be harmed in the execution of this study.

Marine Mammal Interactions
Harbor seals and sea lions (both Steller and California) have been known to follow the smelt run into some of the tributaries; however, equipment proposed for use there would not pose a threat to these marine mammals. While direct interactions between vessels and seals or sea lions in the project area is rare, the possibility exists that these animals could be struck by the boat or stressed by the presence of the boat. As advised by the NMFS Office of Protected Resources and as noted in the mitigation measures below, measures to minimize marine mammal interactions would be required. The applicant would monitor and report any take of marine mammals or ESA-listed species to the NMFS Northwest Region Office of Protected Resources. Given the applicant's previous experience sampling in these areas with similar protocols, no take of marine mammals is expected.

Environmental Consequences to the Physical Environment

While the researcher's boats would pass through and over the water column of the area, this portion of the research activities would not likely impact the physical environment (including any portion that is considered critical habitat or EFH).

4.3 SUMMARY OF COMPLIANCE WITH APPLICABLE LAWS, NECESSARY FEDERAL PERMITS, LICENSES, AND ENTITLEMENTS

*Compliance with Endangered Species Act***:** To comply with Section 7 of the ESA Regulations (50 CFR 402.14(c)), a Section 7 consultation was initiated by the NMFS PR, under the ESA. In accordance with Section 7 of the ESA of 1973, as amended (16 U.S.C. 1531 et seq.), a biological opinion was prepared for this proposed action and it concluded that after reviewing the current status of the southern DPS eulachon, the environmental baseline for the action area, the effects of the take, and probable cumulative effects, it is NMFS' finding that issuance of Award No. NA10NMF4720373, as proposed, is not likely to jeopardize the continued existence of the southern DPS of Pacific eulachon or any other NMFS ESA-listed species and is not likely to destroy or adversely modify designated critical habitat.

Compliance with the Marine Mammal Protection Act: NMFS has determined that while the award creates the possibility of interactions with marine mammals, the possibility of incidental take (by harassment or otherwise) through such interactions is considered remote. The awarding of the grant, therefore, should not require the recipient to obtain authorization for incidental take under the MMPA in order to conduct the research activities.

*Compliance with the Magnuson-Stevens Act***:** Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) requires NMFS to complete an EFH consultation for any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by the agency that may adversely affect EFH. The issuance of the proposed award would not impact designated EFH. The Office of Habitat Conservation was contacted and concurred via email that the proposed action as it would be conditioned would have minimal impacts on EFH. Therefore, no further consultation was necessary.

Compliance with the National Marine Sanctuary Act: The actions in the application for Award No. NA10NMF4720373 would not occur in a National Marine Sanctuary. No coordination was therefore necessary.

4.4 MITIGATION MEASURES

The activities authorized under proposed Award No. NA10NMF4720373, if approved, will follow certain procedures in order to minimize and mitigate effects of the proposed action. If the grant is awarded, the following Special Award Conditions (SACs) would be placed on the award to ensure compliance with appropriate research protocols.

To minimize the potential adverse effects of the award activities, mitigating measures are included in the conditions of the grant award. Specifically, these conditions include:

Salmon, Steelhead, and Green Sturgeon
Should any of the above species be taken incidentally during the course of netting, researchers will notify and consult with NOAA Fisheries Northwest Region Protected Resources Division within 24 hours of any capture. These species will be released alive back to the river/estuary.

Marine Mammals
In all boating and research activities within the study area, a close watch will be made for marine mammals to avoid interaction and harassment. In areas where marine mammals may be present, nets will not be deployed when animals are observed within the vicinity of the research; nets will be monitored in areas where marine mammals are known to occur; and animals will be allowed to either leave or pass through the area safely before net deployment is initiated. Researchers will adhere to the marine mammal approach and viewing guidelines online at http://www.nero.noaa.gov/prot_res/mmv/.

In the unlikely event a marine mammal is captured, the animal will be assessed and, if possible, and if safe for the researchers and animal, the animal must be supported to prevent it from drowning. The NMFS Northwest Regional Office, Protected Resources Division must be immediately contacted as well as the appropriate local stranding partner, listed at http://www.nmfs.noaa.gov/pr/health/networks.htm.

In the unlikely event a captured marine mammal dies, or is severely injured, all activities will cease and researchers will contact the NMFS Office of Protected Resources.

4.5 CUMULATIVE EFFECTS

Effects of past and ongoing human and natural factors occurring in or near the action area have contributed to the current status of the species. Below is a brief discussion of relevant threats to the species.

Climate change may negatively impact eulachon. Marine, estuarine, and freshwater habitat in the Pacific Northwest has been influenced by climate change over the past 50–100 years, and this change is expected to continue into the future. Average annual Northwest air temperatures have increased by approximately 1 ^{o}C since 1900, or about 50 percent more than the global average

warming over the same period (ISAB, 2007). The latest climate models project a warming of 0.1 to 0.6 ^{o}C per decade over the next century (ISAB, 2007). Analyses of temperature trends for the U.S. part of the Pacific Northwest (Mote *et al*., 1999); the maritime portions of Oregon, Washington, and British Columbia (Mote, 2003a); and the Puget Sound-Georgia Basin region (Mote, 2003b) have shown that air temperature increased 0.8 °C, 0.9 °C, and 1.5 °C, in these respective regions during the twentieth century. Warming in each of these areas was substantially greater than the global average of 0.6 °C (Mote, 2003b). This change in surface temperature has already modified, and is likely to continue to modify, freshwater, estuarine, and marine habitats of eulachon, having myriad impacts on eulachon.

Dams and water diversions affect eulachon in the Columbia River where hydropower generation and flood control are major activities. Dams can slow or block eulachon migration. Dams and water divisions alter the natural hydrograph of river systems, in many cases reducing the magnitude of spring freshets with which eulachon have evolved. Dams can also impede or alter bedload movement, changing the composition of river substrates important to spawning eulachon.

Water quality degradation is common in some areas occupied by southern DPS eulachon. In the Columbia River, large-scale impoundment of water has increased water temperatures, potentially altering the water temperature during eulachon spawning periods (NMFS, 2008). Numerous chemical contaminants are also present in freshwater systems where eulachon spawn, but the exact effect these compounds may have on spawning and egg development is unknown (NMFS, 2008).

Dredging is a low to moderate threat to eulachon in the Columbia Rivers. Dredging during eulachon spawning would be particularly detrimental, as eggs associated with benthic substrates are likely to be destroyed.

Washington and Oregon developed a joint eulachon management plan in 2001 (WDFW and ODFW, 2001). Under this plan, three eulachon harvest levels can be authorized based on the strength of the prior years' parental run, resultant juvenile production, estimates, and ocean productivity indices. Due to the listing of the of the southern eulachon smelt distinct population segment as threatened, the Washington and Oregon Eulachon Management Plan will be reviewed and updated to incorporate results of the recent NOAA Fisheries stock status review and the listing decision. The two states will consult with NOAA Fisheries on authorizing any future eulachon commercial and sport fisheries for eulachon.

Under the current version of the joint state plan, the strictest regulations limit harvest to less than 10 percent of the run. If run sizes increase beyond current levels, the states would consider allowing additional harvest, but these more liberal harvest rates have not been specifically identified. In the mainstem Columbia River, permissible commercial gear includes gill nets with a mesh size of no more than 2 inches (51 mm), dip nets having a bag frame no more than 36 inches (91 cm) in diameter, and small trawl nets (Washington Administrative Code 220-33-040 and Oregon Administrative Rule 635-004-0075). In the past several years, the mainstem Columbia River commercial fishery has been open 7 days a week in December. Based on run predictions, the joint states fishery operates on a reduced schedule during January, February, and March. For 2010, the fishery was open on Mondays and Thursdays 1a.m. to 2 p.m. and 2 days a

week from January 1–March 10th. Current effort in the Columbia River mainstem fishery is typically low (less than 10 vessels) (John North, ODFW, pers. comm.).

Outside the mainstem Columbia River, Washington and Oregon set separate fishing seasons, within the parameters of the joint eulachon management plan. Commercial fishing for smelt has been carried out in several of the Columbia River tributaries over the years. In Washington, this has included the Cowlitz, Lewis, Kalama, and Grays rivers. Under the lowest fishery level of the joint state plan, only the Cowlitz River is open to commercial fishing. For the 2010 season, WDFW allowed commercial fishing in the Cowlitz River from 7 p.m. to 10 p.m. on Sunday and Wednesday nights during the month of February only. Outside the mainstem Columbia River in Oregon, commercial fishing for eulachon is allowed in the Sandy River (a tributary of the Columbia River), Umpqua River, and Pacific Ocean. In the Sandy River, commercial fishing is allowed in the lower river year-round with dip nets, 7 days a week, 24 hours a day. Only a small portion of the Sandy River, downstream from the U.S. Route 30 Alternate bridge at Troutdale, Oregon, is open for commercial fishing. The last large harvest of eulachon in the Sandy River occurred in 1985 (304,500 lb (138 metric tons)), with a moderate harvest occurring in 2003 (23,000 lb (10 metric tons)) (John North, ODFW, pers. comm.). In the Umpqua River, commercial fishing for eulachon is allowed year-round and 24 hours a day with dip nets and gill nets not more than 600 ft (183 m) in length and of a mesh size no more than 2 inches (51 mm). Those areas of the Umpqua River not closed to commercial fishing for shad (upstream from approximately river mile 21 (34 km) are open for commercial eulachon fishing. However, commercial fishing for eulachon has not occurred for many years in the Umpqua River (John North, ODFW, pers. comm.). In the Pacific Ocean, eulachon can be harvested year-round using any method otherwise authorized to harvest food fish in the open ocean.

The states of Oregon and Washington have altered sport fishing regulations in the past due to declining eulachon abundance (WDFW and ODFW, 2001). During the 2010 eulachon run, WDFW and ODFW allowed recreational fishers to dip net 10 lb (4.5 kg) per day of eulachon from the mainstem Columbia River below Bonneville Dam through March 10. Each fisher must have his or her own container; the first 10 lbs (4.5 kg) of fish captured may be retained. No angling license is required to harvest eulachon in Washington or Oregon. For the 2010 season, WDFW allowed dip net harvest of eulachon on the Cowlitz River, from 7 a.m. to 3 p.m. February 6, 13, 20, and 27th. The daily limit was 10 lb (4.5 kg) per person per day. All other rivers in Washington State, except for the mainstem Columbia river, closed to eulachon retention February 28. Outside the mainstem Columbia River, Oregon anglers were allowed to dip net up to 25 lb (11 kg) per person per day, during any day of 2010.

Bycatch of eulachon in commercial marine fisheries poses a moderate threat to eulachon in Oregon and Washington. In the past, protection of forage fishes has not been a priority when developing ways to reduce shrimp fishing bycatch. Eulachon are particularly vulnerable to capture in shrimp fisheries in the United States and Canada as the marine areas occupied by shrimp and eulachon often overlap. In Oregon, the bycatch of various species of smelt (including eulachon) has been as high as 28 percent of the total catch of shrimp by weight (Hannah and Jones, 2007).

In response to NMFS declaring canary rockfish overfished, the states of Oregon, Washington, and California enacted regulations to reduce canary rockfish bycatch that require bycatch

reduction devices (BRDs) on trawl gear used in the ocean shrimp fishery. The BRDs were successful in reducing bycatch of all finfish species (Hannah and Jones, 2007). In Oregon, these devices have been shown to reduce the smelt (including eulachon) bycatch to between 0.25 and 1.69 percent of the total catch weight (Hannah and Jones, 2007).

Little is currently known about collateral damage (physical injuries suffered by fish as they pass through BRDs) eulachon may experience as a result of shrimp BRDs. Suuronen *et al*. (1996a; 1996b) found that herring passing through mesh and rigid trawl net sorting devices (similar to BRDs) often die (mortality estimates ranging from 30-100 percent depending on herring size and season caught). Although eulachon bycatch rates in shrimp fisheries have declined significantly, it is not certain what percent of eulachon traveling through BRDs survive.

The aforementioned activities and threats are expected to continue. Synthesis of the information about the status of the species, past and present activities affecting the species, possible future actions that might affect the species, and effects of the proposed action provide a basis for determining the additive effects of the activities supported by the proposed grant. Given the cumulative threats information and the known effects of the proposed action, NMFS concludes that the proposed action would not likely reduce the species' likelihood of survival and recovery in the wild by adversely impacting eulachon at the population level. The DPS includes fish from several watersheds along the West Coast. The actions proposed are directed on only a portion of the DPS—mostly those fish associated with Columbia River tributaries. The likely impact of this proposed study (of several hundred pounds) is much smaller than existing foreign and domestic fishery impacts, or the perceived level of escapement.

This EA considers the cumulative effect the research would have on live animals that are occupying fresh and estuarine waters. NMFS expects the take of eulachon from the proposed research to have negligible effects on the population of eulachon and will not likely jeopardize the continued existence of the species. The award would contain conditions (see mitigation measures) to mitigate potential adverse impacts to other ESA-listed species. Other work is in the lab and office and would not have any appreciable impacts. Overall, the proposed actions would be expected to have no more than short-term effects on the listed eulachon population. The incremental impact of the action when added to other past, present, and reasonably foreseeable future actions discussed here would be minimal and not significant. The data generated by the research activities associated with the proposed action would help improve scientific knowledge of basic eulachon life history, distribution, and association with certain habitat types, and any effects of sedimentation on reproductive fecundity. The new information on the timing and geographic extent of spawning would inform future permits and federal regulations including critical habitat and 4(d) rules. The proposed action would not be expected to have any more than short-term effects any species or other portions of the environment and would not result in any cumulatively significant effects.

CHAPTER 5 LIST OF PREPARERS AND AGENCIES CONSULTED

Preparers:
Office of Protected Resources
National Marine Fisheries Service
Endangered Species Division
Silver Spring, MD 20910

Agencies Consulted:

Office of Protected Resources
National Marine Fisheries Service
Endangered Species Division (section 7 team)
Silver Spring, MD 20910

Northwest Regional Office
National Marine Fisheries Service
Habitat Conservation Division
Seattle, WA 98115

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