APPENDIX A

COMPREHENSIVE STATUS OF THE SPECIES AND DESIGNATED CRITICAL HABITAT

During the consultation we identify those endangered or threatened species or designated critical habitat that may be affected by the proposed action. For a proposed action to be determined to not likely adversely affect species or designated critical habitat, all the effects of that action must be expected to be discountable, insignificant, or completely beneficial. Discountable effects are those that are extremely unlikely to occur. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or designated critical habitat.

1 Species and Critical Habitat Not Likely to be Adversely Affected

For this opinion, we determined that exposures to construction stormwater discharges authorized under USEPA's CGP would be extremely unlikely for those species that do not frequent near coastal waters where USEPA has permitting authority (i.e., effects would be discountable). Therefore, USEPA's the CGP is not likely to adversely affect the following species:

- blue whale (*Balaenoptera musculus*, endangered)
- false killer whale (*Pseudorca crassidens*, endangered)
- fin whale (*Balaenoptera physalus*, endangered)
- sei whale (*Balaenoptera borealis*, endangered)
- sperm whale (*Physeter macrocephalus*, endangered)
- Humpback Whale (*Megaptera novaeangliae*, endangered)
- North Atlantic Right Whale (*Eubalaena glacialis*) and designated critical habitat (endangered)
- Scalloped Hammerhead (*Sphyrna lewini*) Eastern Pacific DPS (endangered)
- Scalloped Hammerhead (*Sphyrna lewini*) Central and Southwest Atlantic DPS (endangered)
- Bocaccio (*Sebastes paucispinis)*
- Yelloweye Rockfish (*Sebastes ruberrimus*)
- Canary Rockfish (*Sebastes pinniger*)

The USEPA is the permitting authority on Indian Country lands within range of Gulf sturgeon (threatened) and smalltooth sawfish (endangered), but these lands are inland. While these species may be exposed to CGP-authorized discharges, such exposures are expected to be insignificant given the dilution and settling that would occur before reaching the waters they occupy. USEPA does not have permitting authority in waters where white and black abalone (both endangered) occur or where the Carolina DPS and south Atlantic DPS of Atlantic sturgeon (both endangered) occur. For these species, exposures to stormwater discharges authorized under the CGP are extremely unlikely (i.e., effects would be discountable), therefore USEPA's CGP is not likely to adversely affect these species.

1.1 Species and Designated Critical Habitat Considered in this Opinion

The ESA-listed species and designated critical habitats which occur within the action area that fall under NMFS' jurisdiction and may be exposed to the construction stormwater discharges and experience direct or indirect effects of those exposures are identified in Table 1 and Table 2.

Table 1. Endangered and threatened species and designated critical habitat under NMFS' jurisdiction considered in this opinion.

Species	ESA Status	Designated Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Southern Resident Killer Whale *(Orcinus orca)*	E – 70 FR 69903	71 FR 69054	73 FR 4176
Salmonids			
Chinook salmon (*Oncorhynchus tshawytscha*)			
California Coastal DPS	T – 64 FR 50393	70 FR 52488	– –
Central Valley Spring-run DPS	T – 64 FR 50393	70 FR 52488	79 FR 42504
Lower Columbia River DPS	T – 64 FR 14308	70 FR 52630	78 FR 41911
Upper Columbia River Spring-run DPS	E – 64 FR 14308	70 FR 52630	72 FR 57303
Puget Sound DPS	T – 64 FR 14308	70 FR 52630	72 FR 2493
Sacramento River Winter-run DPS	E – 59 FR 440	58 FR 33212	79 FR 42504
Snake River Fall-run DPS	T – 59 FR 42529	58 FR 68543	– –
Snake River Spring/summer-run DPS	T – 59 FR 42529	64 FR 57399	– –
Upper Willamette River DPS	T – 64 FR 14308	70 FR 52630	76 FR 52317b
Chum salmon (*Oncorhynchus keta*)			
Columbia River DPS	T – 64 FR 14507	70 FR 52630	78 FR 41911
Hood Canal Summer-run DPS	T – 64 FR 14507	70 FR 52630	72 FR 29121
Coho salmon (*Oncorhynchus kisutch*)			
Central California Coast DPS	E – 61 FR 56138	65 FR 7764	– –
Oregon Coast DPS	T – 63 FR 42587	73 FR 7816	78 FR 41911
Southern Oregon & Northern California Coasts DPS	T – 62 FR 24588	64 FR 24049	– –

Species	ESA Status	Designated Critical Habitat	Recovery Plan
Lower Columbia River DPS	T – 70 FR 37160	81 FR 9251	78 FR 41911
Sockeye Salmon (*Oncorhynchus nerka*)			
Ozette Lake DPS	T – 64 FR 14528	70 FR 52630	74 FR 24706
Snake River DPS	E – 56 FR 58619	58 FR 68543	– –
Steelhead Trout (*Oncorhynchus mykiss*)			
California Central Valley DPS	T – 71 FR 834	70 FR 52488	79 FR 42504
Central California Coast DPS	T – 71 FR 834	70 FR 52488	– –
South-Central California Coast DPS	T – 71 FR 834	70 FR 52488	– –
Southern California DPS	E – 71 FR 834	70 FR 52488	– –
Northern California DPS	T – 71 FR 834	70 FR 52488	– –
Lower Columbia River DPS	T – 71 FR 834	70 FR 52630	74 FR 50165
Middle Columbia River DPS	T – 71 FR 834	70 FR 52630	– –
Upper Columbia River DPS	T – 74 FR 42605	70 FR 52630	72 FR 57303
Upper Willamette River DPS	T – 71 FR 834	70 FR 52630	76 FR 52317b
Snake River Basin DPS	T – 71 FR 834	70 FR 52630	– –
Puget Sound DPS	T – 72 FR 26722	81 FR 9251	– –
Atlantic Salmon (*Salmo salar*)	E – 74 FR 29344	74 FR 29300	70 R 75473
Gulf of Maine DPS			
Non-Salmonid Anadromous Species			
Eulachon (*Thaleichthys pacificus*)	T – 75 FR 13012	76 FR 65323	– –
Shortnose Sturgeon (*Acipenser brevirostrum*)	E – 32 FR 4001	– –	63 FR 69613
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)			
Gulf of Maine DPS	T – 77 FR 5880	81 FR 35701 (Proposed)	– –
New York Bight DPS	E - 77 FR 5880		

Species	ESA Status	Designated Critical Habitat	Recovery Plan
Chesapeake Bay DPS			
Green Sturgeon, (*Acipenser medirostris*) Southern DPS	T – 71 FR 17757	74 FR 52300	– –
Marine Fish			
Nassau grouper (*Epinephelus striatus*)	T – 79 FR 51929		
Sea Turtles			
Green Turtle *(Chelonia mydas)* North Atlantic DPS	E – 43 FR 32800	63 FR 46693	63 FR 28359
Hawksbill Turtle *(Eretmochelys imbricata*)	E – 35 FR 8491	63 FR 46693	57 FR 38818
Kemp's Ridley Turtle *(Lepidochelys kempii)*	E – 35 FR 18319	– –	75 FR 2496
Olive Ridley Turtle (*Lepidochelys olivacea*)			
Pacific Coast of Mexico breeding populations	E – 43 FR 32800	– –	63 FR 28359
all other populations	T – 43 FR 32800		
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710	63 FR 28359
Loggerhead Turtle (*Caretta carettaCaretta caretta*)			
Northwest Atlantic and North Pacific DPS	E – 76 FR 58868	79 FR 39856	63 FR 28359
Corals			
Elkhorn Coral (*Acropora palmata*)	T – 71 FR 26852	73 FR 72210	80 FR 12146
Staghorn Coral (*Acropora cervicornis*)			

Species	ESA Status	Designated Critical Habitat	Recovery Plan
Coral Species *Mycetophyllia ferox* The *Orbicella:* *O.faveolata* O. franksi *O. annularis* Pillar *(Dendrogyra cylindrus)* *The Acropora* *A. globiceps, A. jacquelineae* *A. lokani, A. pharaonis* *A. retusa, A. rudis* *A. speciose, A. tenella* *Anacropora spinosa* *Euphyllia paradivisa* *Isopora crateriformis* *Montipora australiensis* *Pavona diffluens* *Porites napopora* *Seriatopora aculeata*	T – 79 FR 54122	– –	– –

Table 2. Physical and biological features of designated critical habitat that are essential to the conservation of the species (DPS or Evolutionarily Significant Units – ESUs). Water quality and biological features which may be affected by stormwater are in boldface.

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species
Invertebrates	
Elkhorn Coral & Staghorn Coral	**Substrate of suitable quality** and availability to support successful larval settlement and recruitment, and reattachment and recruitment of fragments
Reptiles	
Green Turtle Florida & Mexico Pacific coast breeding colonies; all other areas	Activities requiring special management considerations include: • Vessel traffic • Coastal construction • Point and non-point source pollution • Fishing activities • Dredge and fill activities • Habitat restoration
Hawksbill Turtle	
Leatherback Turtle	• Activities identified as modifying CH include: recreational boating ◦ swimming, ◦ sandmining (see 77 FR 32909 for the 6/4/2012 determination on Sierra Club's petition to revise the CH) • **Forage species, primarily Scyphomedusae (*Chrysaora*, *Aurelia*, *Phacellophora*, and *Cyanea*) of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development** • Migratory pathway conditions to allow for safe and timely passage and access to/from/within high use foraging areas

<table>
<tr><th>Species
DPS or ESU</th><th>Physical or Biological Features Essential for the Conservation of the Species</th></tr>
<tr><td colspan="2">Marine Mammals</td></tr>
<tr><td>Killer Whale
- Southern Resident</td><td>• Water quality to support growth and development;
• Forage species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and
• Passage conditions to allow for migration, resting, and foraging.</td></tr>
<tr><td colspan="2">Marine and anadromous fish other than Pacific salmonids</td></tr>
<tr><td>Green Sturgeon
- Southern</td><td>Freshwater areas:
• Abundant prey items for larval, juvenile, subadult, and adult life stages.
• Substrate type or size (i.e., structural features of substrates)
• A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages.
• Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.
• A migratory pathway necessary for the safe and timely passage of Southern DPS fish within riverine habitats and between riverine and estuarine habitats (e.g., an unobstructed river or dammed river that still allows for safe and timely passage).
• Deep (≥5 m) holding pools for both upstream and downstream holding of adult or subadult fish, with adequate water quality and flow to maintain the physiological needs of the holding adult or subadult fish.
• Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.
Estuarine areas:
• Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.
• Within bays and estuaries adjacent to the Sacramento River (i.e., the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds.
• Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.
• A migratory pathway necessary for the safe and timely passage of Southern DPS fish within estuarine habitats and between estuarine and riverine or marine habitats.
• A diversity of water depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages.
• Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of elevated levels of contaminants
Coastal Marine Areas:
• A migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine and between estuarine and marine habitats.
• Coastal marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, PAHs, heavy metals that may disrupt</td></tr>
</table>

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species
	the normal behavior, growth, and viability of subadult and adult green sturgeon). • Abundant prey items for subadults and adults, which may include benthic invertebrates and fish.
Atlantic sturgeon - Gulf of Maine - New York Bight - Chesapeake Bay	• Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0 to 0.5 parts per thousand range) for settlement of fertilized eggs, refuge, growth, and development of early life stages • Aquatic habitat with a gradual downstream salinity gradient of 0.5 to 30 parts per thousand and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development • Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (1) Unimpeded movement of adults to and from spawning sites; (2) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (3) staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (e.g., ≥1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river • Water, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support: (1) Spawning; (2) annual and interannual adult, subadult, larval, and juvenile survival; and (3) larval, juvenile, and subadult growth, development, and recruitment (e.g., 13 °C to 26 °C for spawning habitat and no more than 30° C for juvenile rearing habitat, and 6 mg/L dissolved oxygen for juvenile rearing habitat)
Eulachon - Southern	• Freshwater spawning and incubation sites with water flow, quality, and temperature conditions and substrate supporting spawning and incubation, and with migratory access for adults and juveniles. • A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of freshwater discharge over time) that supports spawning, and survival of all life stages. • Water quality suitable for spawning and viability of all eulachon life stages. Sublethal concentrations of contaminants affect the survival of aquatic species by increasing stress, predisposing organisms to disease, delaying development, and disrupting physiological processes, including reproduction. • Suitable water temperatures, within natural ranges, in eulachon spawning reaches. • Spawning substrates for eulachon egg deposition and development. • Freshwater and estuarine migration corridors associated with spawning and incubation sites that are free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted. • Safe and unobstructed migratory pathways for eulachon adults to pass from the ocean through estuarine areas to riverine habitats in order to spawn, and for larval eulachon to access rearing habitats within the estuaries and juvenile and adults to access habitats in the ocean. • A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of freshwater discharge over time) that supports spawning migration and outmigration of larval eulachon from spawning sites. • Water quality suitable for survival and migration of spawning adults and larval eulachon. • Water temperature suitable for survival and migration.

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species
	• Prey resources to support larval eulachon survival. • Nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. • Prey items, in a concentration that supports foraging leading to adequate growth and reproductive development for juveniles and adults in the marine environment. • Water quality suitable for adequate growth and reproductive development.
Pacific Salmonids	
Chum Salmon - Columbia River - Hood Canal summer run Sockeye - Lake Ozette Chinook Salmon - Puget Sound - Lower Columbia River - Upper Willamette River Steelhead - Upper Columbia River - Snake River - Middle Columbia River - Upper Willamette River - Lower Columbia River - Puget Sound Coho Salmon - Lower Columbia River	• Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; • Freshwater rearing sites with: ◦ Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; ◦ Water quality and forage supporting juvenile development; ◦ Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. ◦ Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival; • Estuarine areas free of obstruction and excessive predation with: ◦ Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater; ◦ Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; ◦ Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. • Nearshore marine areas free of obstruction and excessive predation with: ◦ Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and ◦ Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. • Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Coho Salmon - Central California Coast - Southern Oregon/Northern California Coast	Within the range of both ESUs, the species' life cycle can be separated into 5 essential habitat types: • juvenile summer and winter rearing areas; • juvenile migration corridors; • areas for growth and development to adulthood; • adult migration corridors; and • spawning areas. Essential features of coho designated critical habitat include adequate: Substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, safe passage
Steelhead - Puget Sound	• Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species
Coho Salmon - Lower Columbia River	• Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. • Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival. • Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. • Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. • Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Coho Salmon - Oregon Coast	• Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. • Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. • Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival. • Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. • Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. • Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Chinook Salmon - Snake River fall-run - Snake River spring/summer run	juvenile rearing areas include adequate: spawning gravel, water quality, water quantity , water temperature, cover/shelter, food, riparian vegetation, space **juvenile and adult migration corridors are the same as for Snake River sockeye salmon
Sockeye Salmon - Snake River	spawning and juvenile rearing areas: spawning gravel, water quality, water quantity, water temperature, food, riparian vegetation, access, juvenile migration corridors:substrate, water quality, water quantity, water temperature,

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species
	water velocity, cover/shelter, food, riparian vegetation, space, safe passage conditions **adult migration corridor has the same essential features, excluding "food"**

The following sections describe the status of species that occur in the action area and the threats to those species and where applicable, their designated critical habitat.

2 *CETACEANS*

2.1 Southern Resident Killer Whale

Status. We used information available in the final rule, the 2012 Status Review (NMFS 2013) and the 2011 Stock Assessment Report to summarize the status of this species. The Southern Resident killer whale DPS was listed as endangered in 2005 in response to the population decline from 1996 to 2001, small population size, and reproductive limitations (i.e., few reproductive males and delayed calving). This species occurs in the inland waterways of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait during the spring, summer and fall. During the winter, they move to coastal waters primarily off Oregon, Washington, California, and British Columbia.

The most recent abundance estimate for the Southern Resident DPS is 87 whales in 2012. This represents an average increase of 0.4 percent annually since 1982 when there were 78 whales. Population abundance has fluctuated during this time with a maximum of approximately 100 whales in 1995 (NMFS 2013). As compared to stable or growing populations, the DPS reflects a smaller percentage of juveniles and lower fecundity (NMFS 2014) and has demonstrated weak growth in recent decades.

Life history. Southern Resident killer whales are geographically, matrilinearly, and behaviorally distinct from other killer whale populations. The DPS includes three large, stable pods (J, K, and L), which occasionally interact (Parsons et al. 2009). Most mating occurs outside natal pods, during temporary associations of pods, or as a result of the temporary dispersal of males (Pilot et al. 2010). Males become sexually mature at 10 – 17 years of age. Females reach maturity at 12 – 16 years of age and produce an average of 5.4 surviving calves during a reproductive life span of approximately 25 years. Mothers and offspring maintain highly stable, life-long social bonds, and this natal relationship is the basis for a matrilineal social structure. They prey upon salmonids, especially Chinook salmon (Hanson et al. 2010).

Threats. Current threats to its survival and recovery include: contaminants, vessel traffic, and reduction in prey availability. Chinook salmon populations have declined due to degradation of habitat, hydrology issues, harvest, and hatchery introgression; such reductions may require an increase in foraging effort. In addition, these prey contain environmental pollutants (e.g., flame retardants; PCBs and DDT). These contaminants become concentrated at higher trophic levels and may lead to immune suppression or reproductive impairment.

The inland waters of Washington and British Columbia support a large whale watch industry, commercial shipping, and recreational boating; these activities generate underwater noise, which may mask whales' communication or interrupt foraging. The factors that originally endangered the species persist throughout its habitat: contaminants, vessel traffic, and reduced prey. The DPS's resilience to future perturbation is reduced as a result of its small population size (N = 86); however, it has demonstrated the ability to recover from smaller population sizes in the past and has shown an increasing trend over the last several years. NMFS is currently conducting a status review prompted by a petition to delist the DPS based on new information, which indicates that there may be more paternal gene flow among populations than originally detected (Pilot et al. 2010).

Designated critical habitat. The designated critical habitat consists of approximately 6,630 km^2 in three areas: The Summer Core Area in Haro Strait and waters around the San Juan Islands; Puget Sound; and the Strait of Juan de Fuca. It provides the following physical and biological features: water quality to support growth and development; forage species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and inter-area passage conditions to allow for migration, resting, and foraging.

3 Pacific Salmonids

The Pacific salmonid species have similar life histories, habitat needs, and threats. These are discussed in the sections below, before proceeding to describing the essential features of critical habitat for each species. In May 2016, NOAA Fisheries' West Coast Region completed a five-year status review of all 28 West Coast salmon and steelhead species listed under the ESA (Table 3). Some species, such Oregon Coast coho salmon, mid-Columbia steelhead and Hood Canal chum, rebounded from the lows of past decades. Highly endangered Snake River sockeye have benefitted from a captive broodstock program while Snake River steelhead populations are steady. The California drought and unusually high ocean and stream temperatures over the 5-year period hit many populations hard. In the case of Sacramento River winter-run Chinook salmon, for example, drought conditions and high stream temperatures reduced the 2015 survival of juvenile fish in the first stretch of river to just three percent.

Since 1997 NMFS promulgated a total of 29 limits to the ESA section 9(a) take prohibitions for 21 threatened Pacific salmon and steelhead ESUs or Distinct Populations Segments (DPSs)(62 FR 38479, July 18, 1997; 65 FR 42422, July 10, 2000; 65 FR 42485, July 10, 2000; 67 FR 1116, January 9, 2002; 73 FR 7816, February 11, 2008). On June 28, 2005, as part of the final listing determinations for 16 ESUs of West Coast salmon, NMFS amended and streamlined the 4(d) protective regulations for threatened salmon and steelhead (70 FR 37160). NMFS took this action to provide appropriate flexibility to ensure that fisheries and artificial propagation programs are managed consistently with the conservation needs of threatened salmon and steelhead. Under this change, the section 4(d) protections apply to natural and hatchery fish with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed prior to release into the wild. Throughout this section discussing listed salmonids, we use the word "species" to apply to DPSs and ESUs.

Table 3. Summary of Current ESA Listing Status, Recent Trends and Summary of Conclusions for the Most Recent Five-year Review for Pacific Salmonids (Northwest Fisheries Science Center 2015, Williams et al. 2016).

Species	ESU/DPS	Five-Year Review Risk Trend	ESA Listing Status
Chinook	UpperColumbiaspring	Stable	Endangered
	SnakeRiverspring/summer	Stable	Threatened
	SnakeRiverfall	Improving	Threatened
	UpperWillamettespring	Declining	Threatened
	LowerColumbia	Stable/Improving	Threatened
	PugetSound	Stable/Declining	Threatened
	CaliforniaCoastal	Mixed	Threatened
	CentralValleySpring	Decreasedriskofextinction	Threatened
	SacramentoRiverwinter	Increasedriskofextinction	Endangered
Coho	LowerColumbia	Stable/Improving	Threatened
	OregonCoast	Improving	Threatened
	SouthernOregon/NorthernCalifornia	Mixed	Threatened
	CentralCaliforniaCoast	Mixed	Endangered
Sockeye	SnakeRiver	Improving	Endangered
	LakeOzette	Stable	Threatened
Chum	HoodCanalsummer	Improving	Threatened
	ColumbiaRiver	Stable	Threatened
Steelhead	UpperColumbia	Improving	Threatened
	SnakeRiver	Stable/Improving	Threatened
	MiddleColumbia	Stable/Improving	Threatened
	UpperWillamette	Declining	Threatened
	LowerColumbia	Stable	Threatened
	PugetSound	Stable	Threatened
	NorthernCalifornia	Mixed	Threatened
	CentralCaliforniaCoast	Uncertain	Threatened
	SouthCentralCalifornia	Declining	Threatened
	SouthernCalifornia	Uncertain	Endangered

The most recent status review for Atlantic salmon was published in 2006 (Fay et al. 2006). This review stated that fewer than 1,500 adults have returned to spawn each year since 1998. The Population Viability Analysis estimates of the probability of extinction for the Gulf of Mexico DPS of Atlantic Salmon ranges from 19 percent to 75 percent within the next 100 years, even with the continuation of current levels of hatchery supplementation. The abundance was estimated at 1,014 individuals in 2007, the most recent year for which abundance records are available.

3.1 Salmonid Life Histories

Salmonids exhibit either an ocean-type or stream-type behavior. Ocean-type migrate to the ocean within their first year of life (sub-yearlings). Stream-type salmonids usually migrate to sea at a larger size, after months or years of freshwater rearing. Stream-type salmonids of the genus *Oncorhynchus* include steelhead, coho, and most types of Chinook and sockeye salmon. Stream type salmonids depend more on freshwater conditions than on favorable estuarine conditions. All Pacific salmon species are semelparous (i.e., they die after spawning) and exhibit obligatory anadromy (i.e., there are no recorded landlocked or naturalized freshwater populations; they must spend portions of their lives in both salt and freshwater habitats). Atlantic salmon and some southern populations of steelhead are iteroparous, being capable of returning to the ocean after spawning and returning to freshwaters to spawn again after recovery.

3.2 Threats to Salmonids

Specifically, during all freshwater life stages, salmonids require cool water that is free of contaminants. Water free of contaminants supports survival, growth, and maturation of salmon and the abundance of their prey. In addition to affecting survival, growth, and fecundity, contaminants can disrupt normal behavior necessary for successful migration, spawning, and juvenile rearing. Sufficient forage is necessary for juveniles to maintain growth that reduces freshwater predation mortality, increases overwintering success, initiates smoltification, and increases ocean survival. Natural riparian cover such as submerged and overhanging large wood and aquatic vegetation provides shelter from predators, shades freshwater to prevent increase in water temperature, provides nutrients from leaf litter, supports production of insect prey, and creates important side channels. Riparian vegetation stabilizes bank soils and captures fine sediment in runoff, which maintains functional channel bottom substrate for development of eggs and alevins.

The process of smoltification enables salmon to adapt to the ocean environment. Environmental factors such as exposure to chemicals including heavy metals and elevated water temperatures can affect the smoltification process, not only at the interface between fresh water and saltwater, but higher in the watershed as the process of transformation begins long before fish enter saltwater (Wedemeyer et al. 1980).

The three major threats to Atlantic salmon identified in the listing rule also threaten Pacific salmonids: dams, regulatory mechanisms related to dams, and low marine survival. In addition, a number of secondary threats were identified, including threats to habitat quality and accessibility, commercial and recreational fisheries, disease and predation, inadequacy of regulatory mechanisms related to water withdrawal and water quality, aquaculture, artificial propagation, climate change, competition, and depleted fish communities.

3.3 Salmonids

The action area for this consultation overlaps with designated critical habitat for all Pacific salmonids. NMFS has identified features of designated critical habitat that are essential to the conservation of the species. Many of these features specific to each life stage (e.g., migration, spawning, rearing, and estuary, see Table 2) are common for each species. To fully understand the conservation role of these habitats, specific physical and biological habitat features (e.g., water temperature, water quality, forage, natural cover, etc.) were identified for each life stage.

3.3.1 Chinook Salmon

Life history. There are 9 ESA-listed Chinook salmon ESUs. Chinook are the largest of the Pacific salmon and prefer streams that are deeper and larger than those used by other Pacific salmon species. Chinook salmon ESUs exhibit either “stream-type” or “ocean-type” life histories. Stream-type Chinook salmon reside in freshwater for a year or more following emergence before migrating to salt water. Stream-type ESUs normally return in late winter and early spring (spring-run) as immature adults and reside in deep pools during summer before spawning in fall. Ocean-type Chinook salmon migrate to the ocean within their first year and usually return as full mature adults in fall (fall-run) and spawn soon after river entry. (Healey 1991).

Temperature and stream flow can significantly influence the timing of migrations and spawning, as well as the selection of spawning habitat (Geist et al. 2008, Hatten et al. 2009). All Chinook salmon are semelparous (i.e. they die after spawning). Fall-run Chinook salmon generally spawn in the mainstem of larger rivers and are less dependent on flow, although early autumn rains and a drop in water temperature often provide cues for movements to spawning areas. Spring-run Chinook salmon take advantage of high flows from snowmelt to access the upper reaches of rivers. Chinook salmon primarily feed on small invertebrates and vertebrates, with the diet of adult oceanic Chinook salmon comprised primarily of fish.

Designated Critical Habitat. Designated critical habitat for the Puget Sound, Lower Columbia River, and Upper Willamette River ESUs for Chinook salmon identify features essential to the conservation of the species and sites necessary to support one or more Chinook salmon life stage(s). These features essential to the conservation of the species are detailed in Table 2 and include biological elements that are vulnerable to the stressors of the action. These include water quality conditions that support spawning and incubation, larval and juvenile development, and physiological transitions between fresh and saltwater. The features essential to the conservation of the species also include aquatic invertebrate and fish forage species and water quality to support juvenile and adult development, growth, and maturation, and natural cover of riparian and nearshore vegetation and aquatic vegetation. Designated critical habitat for the Snake River fall-run and Snake River spring/summer run Chinook salmon generically designates water quality, food, and riparian vegetation features essential to the conservation of the species.

3.3.2 Chum Salmon

Life history. In general, North American chum salmon migrate north along the coast in a narrow coastal band that broadens in southeastern Alaska. Chum salmon usually spawn in the lower reaches of rivers during summer and fall. Redds are dug in the mainstem or in side channels of rivers from just above tidal influence to nearly 100 km from the sea. Juveniles use shallow, low flow habitats for rearing that include inundated mudflats, tidal wetlands and their channels, and sloughs. The duration of estuarine residence for chum salmon juveniles are known for only a few estuaries. Observed residence time ranges from 4 to 32 days, with about 24 days as the most common.

Immature chum salmon disperse over the North Pacific Ocean and maturing adults return to the home streams usually at two to five years of age, and in some cases up to seven years (Bigler 1985). This ocean-type life history means that the survival and growth for juvenile chum salmon depends less on freshwater conditions than on favorable estuarine conditions. Chum salmon feed on a variety of prey organisms depending upon life stage and size. In freshwater Chum salmon feed primarily on small invertebrates; in saltwater, their diet consists of copepods, tunicates, mollusks, and fish.

Designated Critical Habitat. Areas designated as critical habitat are important for the species' overall conservation by protecting quality growth, reproduction, and feeding. features essential to the conservation of the species for both chum salmon ESUs include freshwater spawning, rearing, and migration areas; estuarine and nearshore marine areas free of obstructions; and offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity.

3.3.3 Coho Salmon

Life History. North American coho salmon will migrate north along the coast in a narrow coastal band that broadens in southeastern Alaska. During this migration, juvenile coho salmon tend to occur in both coastal and offshore waters. Coho salmon exhibit a stream-type life history. Most coho salmon enter rivers between September and February. In many systems, coho salmon wait to enter until fall rainstorms have provided the river with sufficiently strong flows and depth. Coho salmon spawn from November to January, and occasionally into February and March. Some spawning occurs in third-order streams, but most spawning activity occurs in fourth- and fifth-order streams with gradients of 3 percent or less. After fry emerge in spring they disperse upstream and downstream to establish and defend territories with weak water currents such as backwaters and shallow areas near stream banks. Juveniles rear in these areas during the spring and summer. In early fall juveniles move to river margins, backwater, and pools. During winter juveniles typically reduce feeding activity and growth rates slow down or stop. By March of their second spring, juveniles feed heavily on insects and crustaceans and grow rapidly before smoltification and outmigration (Olegario 2006), spending only a short time (one to three days) in the estuary with little feeding (Thorpe 1994, Miller and Sadro 2003). After entering the ocean, immature coho salmon initially remain in nearshore waters close to the parent stream. Along the Oregon/California coast, coho salmon primarily return to rivers to spawn as three-year olds, having spent approximately 18 months rearing in fresh water and 18 months in salt water. In some streams, a smaller proportion of males may return as two-year olds. The presence of two-year old males can allow for substantial genetic exchange between brood years. The relatively fixed three-year life cycle exhibited by female coho salmon limits demographic interactions between brood years. This makes coho salmon more vulnerable to environmental perturbations than salmonids that exhibit overlapping generations, i.e., the loss of a coho salmon brood year in a stream is less likely to be reestablished by females from other brood years than for other Pacific salmon.

Coho salmon feed on a variety of prey organisms depending upon life stage and size. While at sea, coho salmon tend to eat fish including herring, sand lance, sticklebacks, sardines, shrimp and surf smelt. While in estuaries and in fresh water coho salmon are significant predators of Chinook, pink, and chum salmon, as well as aquatic and terrestrial insects. Smaller fish, such as fry, eat chironomids, plecoptera and other larval insects, and typically use visual cues to find their prey.

Designated Critical Habitat. The essential features of designated critical habitat for the Central California Coast and Southern Oregon/Northern California Coast coho salmon ESUs that are vulnerable to the stressors of the action are generically identified as water quality, food, and riparian vegetation. The essential features of designated critical habitat for the Lower Columbia River and Oregon Coast ESUs are more detailed. They include water quality conditions supporting spawning, incubation and larval development, water quality and forage supporting juvenile development; and natural cover of riparian and aquatic vegetation, water quality conditions supporting juvenile and adult physiological transitions between fresh- and saltwater, and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation (Table 2).

3.3.4 Sockeye Salmon

Life History. Most sockeye salmon exhibit a lake-type life history (i.e., they spawn and rear in or near lakes), though some exhibit a river-type life history. Spawning generally occurs in late summer and fall, but timing can vary greatly among populations. In lakes, salmon commonly spawn along “beaches” where underground seepage provides fresh oxygenated water. Incubation is a function of water temperature, but generally lasts between 100 to 200 days (Burgner 1991). Sockeye salmon fry primarily rear in lakes; river-emerged and stream-emerged fry migrate into lakes to rear. Juvenile sockeye salmon generally rear in lakes from one to three years after emergence, though some river-spawned salmon may migrate to sea in their first year. Juvenile sockeye salmon feeding behaviors change as they transition through life stages after emergence to the time of smoltification. In the early fry stage, from spring to early summer, juveniles forage exclusively in the warmer littoral (i.e., shoreline) zone where they depend mostly on fly larvae and pupae, copepods, and water fleas. In summer, underyearling sockeye salmon move from the littoral habitat to a pelagic (i.e., open water) existence where they feed on larger zooplankton; however, flies may still make up a substantial portion of their diet. Older and larger fish may also prey on fish larvae. Distribution in lakes and prey preference is a dynamic process that changes daily and yearly depending on many factors, including: water temperature; prey abundance; presence of predators and competitors; and size of the juvenile. Peak emigration to the ocean occurs in mid-April to early May in southern sockeye populations (<52ºN latitude) and as late as early July in northern populations (62ºN latitude) (Burgner 1991). Adult sockeye salmon return to their natal lakes to spawn after spending one to four years at sea. The diet of adult salmon consists of amphipods, copepods, squid, and other fish.

Designated Critical Habitat. The essential features of designated critical habitat for Lake Ozette sockeye ESU that are potentially affected by the stressors of the action include water quality conditions and forage species supporting spawning, incubation, development, growth, maturation, physiological transitions between fresh and saltwater, and natural cover of riparian and nearshore vegetation and aquatic vegetation. The essential features of designated critical habitat for Snake River sockeye potentially affected by the stressors of the action are identified generically as water quality, food, and riparian vegetation (Table 2).

3.3.5 Steelhead Trout (Eleven ESUs)

Life History. Steelhead have a longer run time than other Pacific salmonids and do not tend to travel in large schools. They can be divided into two basic run-types: the stream-maturing type (summer steelhead) and the ocean-maturing type (winter steelhead). Summer steelhead enter fresh water as sexually immature adults between May and October (Nickelson et al. 1992, Busby et al. 1996) and hold in cool, deep pools during summer and fall before moving to spawning sites as mature adults in January and February (Barnhart 1986, Nickelson et al. 1992). Winter steelhead return to fresh water between November and April as sexually mature adults and spawn shortly after river entry (Nickelson et al. 1992, Busby et al. 1996). Steelhead typically spawn in small tributaries rather than large, mainstem rivers and spawning distribution often overlaps with coho salmon, though steelhead tend to prefer higher gradients (generally two to seven percent, but up to 12 percent or more) and their distributions tend to extend further upstream than coho salmon. Summer steelhead commonly spawn higher in a watershed than do winter steelhead, sometimes even using ephemeral streams from which juveniles are forced to emigrate as flows diminish. Fry usually inhabit shallow water along banks and stream margins of streams (Nickelson et al. 1992) and move to faster flowing water such as riffles as they grow. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson et al. 1992). In Oregon and California, steelhead may enter estuaries where sand bars create low salinity lagoons. Migration of juvenile steelhead to these lagoons occurs throughout the year, but is concentrated in the late spring/early summer and in the late fall/early winter periods (Shapovalov and Taft 1954, Zedonis 1992). Juveniles rear in fresh water for one to four years, then smolt and migrate to the ocean in March and April (Barnhart 1986). Steelhead typically reside in marine waters for two or three years prior to returning to their natal streams to spawn as four or five-year olds. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby et al. 1996). Females spawn more than once more commonly than males, but rarely more than twice before dying (Nickelson et al. 1992). Iteroparity is also more common among southern steelhead populations than northern populations (Busby et al. 1996).

Steelhead feed on a variety of prey organisms depending upon life stage, season, and prey availability. In freshwater juveniles feed on common aquatic stream insects such as caddisflies, mayflies, and stoneflies but also other insects (especially chironomid pupae), zooplankton, and benthic organisms (Pert 1993 , Merz 2002). Older juveniles sometimes prey on emerging fry, other fish larvae, crayfish, and even small mammals, though these are not a major food source (Merz 2002). The diet of adult oceanic steelhead is comprised primarily of fish and squid (Light 1985, Burgner et al. 1992).

Designated Critical Habitat. The essential features of designated critical habitat for all steelhead DPSs that are potentially affected by the stressors of the action include water quality conditions and/or forage species supporting spawning, incubation, development, growth, maturation, physiological transitions between fresh and saltwater, and natural cover of riparian and nearshore vegetation and aquatic vegetation (Table 2).

3.3.6 Atlantic Salmon, Gulf of Maine Distinct Population Segment

Status. The Gulf of Maine DPS of Atlantic salmon was first listed as endangered in response to population decline caused by many factors, including overexploitation, degradation of water quality, and damming of rivers, all of which remain persistent threats. The species' listing currently includes all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment. The USFWS has jurisdiction over this species in freshwater, so the NMFS' jurisdiction is limited to potential CGP-authorized discharges from the coastal lands belonging to the Passamoquoddy Tribe at Pleasant Point. The most recent status review for Atlantic salmon was published in 2006 (Fay et al. 2006).

In 2015, NMFS announced a new program to focus and redouble its efforts to protect some of the species that are currently among the most at risk of extinction in the near future with the goal of reversing their declining trend so that the species will become a candidate for recovery in the future. Atlantic salmon is one of the eight species identified for this initiative (NMFS 2015b). These species were identified as among the most at-risk of extinction based on three criteria (1) endangered listing, (2) declining populations, and (3) are considered a recovery priority #1. A priority #1 species is one whose extinction is almost certain in the immediate future because of a rapid population decline or habitat destruction, whose limiting factors and threats are well understood and the needed management actions are known and have a high probability of success, and is a species that is in conflict with construction or other developmental projects or other forms of economic activity.

Life History. Adult Atlantic salmon in the Gulf of Maine typically spawn in early November and juveniles spend approximately two years feeding on small invertebrates and occasionally small vertebrates in freshwater until they weigh approximately two ounces and are six inches in length. Smoltification (the physiological and behavioral changes required for the transition to salt water) usually occurs at age two for this DPS after which the species migrates more than 4,000 km in the open ocean to reach feeding areas in the Davis Strait between Labrador and Greenland. Adult salmon feed opportunistically and their diet is composed primarily of other fish. The majority (90 percent) spend two winters at sea before reaching maturity and returning to their natal rivers, with the remainder spending one or three winters at sea. At maturity, Gulf of Maine DPS salmon typically weigh between 8 to 15 pounds and average 30 inches in length.

Designated Critical Habitat. The designated critical habitat includes all anadromous Atlantic salmon streams whose freshwater range occurs in watersheds from the Androscoggin River northward along the Maine coast northeastward to the Dennys River, and wherever these fish occur in the estuarine and marine environment. The features essential to the conservation of the species identified within freshwater and estuarine habitats of the occupied range of the Gulf of Maine DPS include sites for spawning and incubation, juvenile rearing, and migration. Designated critical habitat and features essential to the conservation of the species were not designated within marine environments because of the limited of the physical and biological features that the species uses during the marine phase of its life.

4 NON-SALMONID ANADROMOUS FISH

4.1 Southern Pacific Eulachon

Status. Eulachon are small smelt native to eastern North Pacific waters from the Bering Sea to Monterey Bay, California, or from 61º N to 31º N (Hart and McHugh 1944, Eschmeyer et al. 1983, Minckley et al. 1986, Hay and McCarter 2000). Eulachon that spawn in rivers south of the Nass River of British Columbia to the Mad River of California comprise the southern population of Pacific eulachon. This species status is classified as “at moderate risk of extinction throughout all of its range” (Gustafson 2010) based upon timing of runs and genetic distinctions (Hart and McHugh 1944, McLean et al. 1999, Hay and McCarter 2000, McLean and Taylor 2001, Beacham et al. 2005). Based on a number of data sources, the 2016 Status Review Update for eulachon reports that the spawning population has increased between 2011 and 2015 and that of the size of some sub-populations is larger than originally estimated in 2010 (Gustafson et al. 2016). The status update does not recommend a change in status because it is too early to tell whether recent improvements in the southern DPS of eulachon will persist. Recent poor ocean conditions taken with given variability inherent in wild populations suggest that population declines may again become widespread in the upcoming return years.

Life Cycle. Adult eulachon are found in coastal and offshore marine habitats (Allen et al. 1988, Hay and McCarter 2000, Willson et al. 2006). Larval and post larval eulachon prey upon phytoplankton, copepods, copepod eggs, mysids, barnacle larvae, worm larvae, and other eulachon larvae until they reach adult size (WDFW and ODFW 2001). The primary prey of adult eulachon are copepods and euphausiids, malacos, tracans, and cumaceans (Smith and Saalfeld 1955, Barraclough 1964, Drake and Wilson 1991, Sturdevant et al. 1999, Hay and McCarter 2000).

Although primarily marine, eulachon return to freshwater to spawn. Adult eulachon have been observed in several rivers along the west coast (Odemar 1964, Minckley et al. 1986, Emmett et al. 1991, Jennings 1996, Wright 1999, Hay and McCarter 2000, Larson and Belchik 2000, Musick et al. 2000, WDFW and ODFW 2001, Moyle 2002). For the southern population of Pacific eulachon, most spawning is believed to occur in the Columbia River and its tributaries as well as in other Oregonian and Washingtonian rivers (Emmett et al. 1991, Musick et al. 2000, WDFW and ODFW 2001). Eulachon take less time to mature and generally spawn earlier in southern portions of their range than do eulachon from more northerly rivers (Clarke et al. 2007).

Spawning is strongly influenced by water temperatures, so the timing of spawning depends upon the river system involved (Willson et al. 2006). In the Columbia River and further south, spawning occurs from late January to March, although river entry occurs as early as December (Hay and McCarter 2000). Further north, the peak of eulachon runs in Washington State is from February through March while Alaskan runs occur in May and river entry may extend into June (Hay and McCarter 2000). Females lay eggs over sand, course gravel or detritial substrate. Eggs attach to gravel or sand and incubate for 30 to 40 days after which larvae drift to estuaries and coastal marine waters (Wydoski and Whitney 1979).

Eulachon generally die following spawning (Scott and Crossman 1973). The maximum known lifespan is 9 years of age, but 20 to 30 percent of individuals live to 4 years and most individuals survive to 3 years of age, although spawning has been noted as early as 2 years of age (Wydoski and Whitney 1979, Barrett et al. 1984, Hugg 1996, Hay and McCarter 2000, WDFW and ODFW 2001). The age distribution of spawners varies between river and from year-to-year (Willson et al. 2006).

Threats. The Biological Review Team 2010 assessment of the status of the southern DPS of eulachon ranked climate change impacts on ocean conditions as the most serious threat to the persistence of eulachon in all four subareas of the DPS: Klamath River, Columbia River, Fraser River, and British Columbia coastal rivers south of the Nass River. Climate change impacts on freshwater habitat and eulachon bycatch in offshore shrimp fisheries were also ranked in the top four threats in all subareas of the DPS. Dams and water diversions in the Klamath and Columbia rivers and predation in the Fraser and British Columbia coastal rivers filled out the last of the top four threats (Gustafson 2010).

Designated Critical Habitat. The designated critical habitat for the southern population of Pacific eulachon includes freshwater creeks and rivers and their associated estuaries, comprising approximately 539 km (335 mi) of habitat. The physical or biological features potentially affected by the stressors of the action include water quality conditions supporting spawning and incubation, larval and adult mobility, and abundant prey items supporting larval feeding after the yolk sac is depleted, and nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. Eulachon prey on a wide variety of species including crustaceans such as copepods and euphausiids (Hay and McCarter 2000, WDFW and ODFW 2001), unidentified malacostracans (Sturdevant et al. 1999), cumaceans (Smith and Saalfeld 1955) mysids, barnacle larvae, and worm larvae (WDFW and ODFW 2001).

4.2 Shortnose Sturgeon

Status. We used information available in the Shortnose Sturgeon Recovery Plan (NMFS 1998), the 2010 NMFS Biological Assessment (SSSRT 2010), and the listing document to summarize the status of the species. Shortnose sturgeon were listed as endangered throughout its range on March 11, 1967 pursuant to the Endangered Species Preservation Act of 1966. Shortnose sturgeon remained on the list as endangered with enactment of the ESA in 1973. Shortnose sturgeon occur along the Atlantic Coast of North America, from the Saint John River in Canada to the Saint Johns River in Florida. The Shortnose Sturgeon Recovery Plan describes 19 shortnose sturgeon populations that are managed separately in the wild. Two additional geographically separated populations occur behind dams in the Connecticut River (above the Holyoke Dam) and in Lake Marion on the Santee-Cooper River system in South Carolina (above the Wilson and Pinopolis Dams). While shortnose sturgeon spawning has been documented in several rivers across its range (including but not limited to: Kennebec River, Maine, Connecticut River, Hudson River, Delaware River, Pee Dee River, South Carolina, Savannah, Ogeechee, and Altamaha rivers, Georgia), status for many other rivers remain unknown.

Life History. Sturgeon are a long-lived species, taking years to reach sexual maturity. Male shortnose sturgeon tend to sexually mature earlier than females, and sturgeon residing in more northern latitudes reach maturity later than those at southerly latitudes. Sturgeon are broadcast spawners, with females laying adhesive eggs on hard bottom, rocky substrate at upstream, freshwater sites. When the males arrive at the spawning site, they broadcast sperm into the water column to fertilize the eggs. Despite their high fecundity, sturgeon have low recruitment.

Spawning periodicity varies by species and sex, but there can be anywhere from 1 to 5 years between spawning, as individuals need to rebuild gonadal material. There is difficulty in definitively assessing where and how reliably spawning occurs. Presence of eggs, age-1 juveniles and capture of “ripe” adults moving upstream (i.e., likely on a spawning run) serve as strong indicators, but due to their life history and the impacts sturgeon populations have taken, there are additional hurdles to successful spawning. Because sturgeon are iteroparous, and populations in some areas so depleted, eggs deposited at the spawning grounds may not be fertilized if males do not arrive at the spawning grounds that year.

Hatching occurs approximately 94-140 hours after egg deposition, and larvae assume a bottom-dwelling existence. The yolksac larval stage is completed in about 8-12 days, during which time larvae move downstream to rearing grounds over a 6-12 day period. Size of larvae at hatching and at the juvenile stage varies by species. During the daytime, larvae use benthic structure (e.g., gravel matrix) as refugia. Juvenile sturgeon continue to move further downstream into brackish waters, and eventually become residents in estuarine waters for months or years.

Generally, sturgeon are benthic omnivores, feeding on benthic invertebrates that are abundant in the substrate in that area. Shortnose sturgeon forage over sandy bottom, and eat benthic invertebrates like amphipods.

Juvenile shortnose generally move upstream during spring and summer and downstream for fall and winter; however, these movements usually occur above the salt- and freshwater interface. During summer and winter, adult shortnose sturgeon inhabit freshwater reaches of rivers and streams influenced by tides. During summer, at the southern end of its range, shortnose sturgeon congregate in cool, deep, areas of rivers taking refuge from high temperatures. Adult shortnose sturgeon prefer deep, downstream areas with soft substrate and vegetated bottoms, if present. Because they rarely leave their natal rivers, shortnose sturgeon are considered to be freshwater amphidromous (i.e. adults spawn in freshwater but regularly enter saltwater habitats during their life).

Threats. The viability of sturgeon populations is highly sensitive to juvenile mortality resulting in lower numbers of sub-adults recruiting into the adult breeding population. This relationship caused Secor et al. (2002) to conclude sturgeon populations can be grouped into two demographic categories: populations having reliable (albeit periodic) natural recruitment and those that do not. The shortnose sturgeon populations without reliable natural recruitment are at more risk. Several authors have also demonstrated that sturgeon populations generally, and shortnose sturgeon populations in particular, are much more sensitive to adult mortality than other species of fish. Sturgeon populations cannot survive fishing related mortalities exceeding five percent of an adult spawning run and they are vulnerable to declines and local extinction if juveniles die from fishing related mortalities (Secor et al. 2002).

The 1998 recovery plan for shortnose sturgeon (NMFS 1998) identify Habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges), and mortality (for example, from impingement on cooling water intake screens, dredging, and incidental capture in other fisheries) as principal threats to the species' survival. Introductions and transfers of indigenous and nonindigenous sturgeon, intentional or accidental, may threaten wild shortnose sturgeon populations by imposing genetic threats, increasing competition for food or habitat, or spreading diseases. Sturgeon species are susceptible to viruses enzootic to the west coast and fish introductions could further spread these diseases. Shortnose sturgeon populations are at risk from incidental bycatch, loss of habitat, dams, dredging and pollution. These threats are likely to continue into the future. We conclude that the shortnose sturgeon's resilience to further perturbation is low.

Designated critical habitat. No critical habitat has been designated for shortnose sturgeon.

4.3 Atlantic Sturgeon

Status. The range of Atlantic sturgeon includes the St. John River in Canada, to St. Johns River in Florida. USEPA has NPDES permitting authority throughout New Hampshire, Massachusetts, the District of Columbia, Federally operated facilities in Delaware and Tribal lands in Connecticut, Rhode Island, New York, North Carolina, and Florida. Five DPSs of Atlantic sturgeon were designated and listed under the ESA on February 6, 2012 (Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic). The Gulf of Maine, New York Bight, and Chesapeake Bay DPSs are those potentially affected by the 2016 CGP.

Life history. Although the Atlantic sturgeon DPSs are genetically distinct, their life history characteristics are the same and are discussed together. As Acipensieriformes, Atlantic sturgeon are anadromous and iteroparus. Like shortnose sturgeon, male Atlantic sturgeon tend to sexually mature earlier than females, and sturgeon residing in more northern latitudes reach maturity later than those at southerly latitudes. Evidence of Atlantic sturgeon spawning has been found in many of the same rivers as shortnose sturgeon (see discussion above). Atlantic sturgeon eggs are between 2.5-3.0 mm, and larvae are about 7 mm long upon hatching. Generally, sturgeon are benthic omnivores, feeding on benthic invertebrates that are abundant in the substrate in that area. Atlantic sturgeon commonly eat polychaetes and isopods.

As juveniles, Atlantic sturgeon migrate downstream from the spawning grounds into brackish water. Unlike shortnose sturgeon, subadult Atlantic sturgeon (76-92cm) may move out of the estuaries and into coastal waters where they can undergo long range migrations. At this stage in the coastal waters, individual subadult and adult Atlantic sturgeon originating from different DPSs will mix, but adults return to their natal river to spawn.

Threats. Of the stressors evaluated in the 2007 status review (ASSRT 2007), bycatch mortality, water quality, lack of adequate state and/or Federal regulatory mechanisms, and dredging activities were most often identified as the most significant threats to the viability of Atlantic sturgeon populations. Additionally, some populations were affected by unique stressors, such as habitat impediments (e.g., Cape Fear and Santee-Cooper rivers) and apparent ship strikes (e.g., Delaware and James rivers).

Designated critical habitat. The proposed designated critical habitat for Atlantic sturgeon includes tidally-affected accessible waters of coastal estuaries where the species occurs. The essential features of the proposed designated critical habitat for the Atlantic sturgeon DPSs within these rivers do not include plant or animal life that may be affected by the stressors of the action.

From north to south, the rivers and waterways that make up the spatial extent of designated critical habitat are detailed in Table 3.

Table 4. River systems in the action area that are included in proposed designated critical habitat for Atlantic sturgeon.

Distinct Population Segment	River/Waterway		
Gulf of Maine	Penobscot Piscataqua	Kennebec Merrimack	Androscoggin
New York Bight	Connecticut Housatonic Delaware	Housatonic	Hudson
Chesapeake Bay	Susquehanna York James	Potomac Mattaponi	Rappahannock Pamunkey

4.4 Green Sturgeon

Status. We used information available in the 2002 Status Review and Status Review Updates (BRT 2005, Adams et al. 2007, NMFS 2015a), and the proposed and final listing rules to summarize the status of the species. The Southern DPS of green sturgeon is listed as threatened. On June 2, 2010, NMFS issued a 4 (d) Rule for the Southern DPS, applying certain take prohibitions. The most recent 5-year status review was published in August of 2015. Green sturgeon occur in coastal Pacific waters from San Francisco Bay to Canada. The Southern DPS of green sturgeon includes populations south of (and exclusive of) the Eel River, coastal and Central Valley populations, and the spawning population in the Sacramento River, California (Adams et al. 2007).

The 2015 status update indicates that DPS structure of the North American green sturgeon has not changed and that many of the principle factors considered when listing Southern DPS green sturgeon as threatened are relatively unchanged. Loss of spawning habitat and bycatch in the white sturgeon commercial fishery are two major causes for the species decline. Spawning in the Feather River is encouraging and the decommissioning of Red Bluff Diversion Dam and breach of Shanghai Bench makes spawning conditions more favorable. The prohibition of retention in commercial and recreational fisheries has eliminated a known threat and likely had a very positive effect on the overall population, although recruitment indices are not presently available.

Life history. As members of the family Acipenseridae, green sturgeon share similar reproductive strategies and life history patterns with other sturgeon species; see discussion for shortnose sturgeon above. The Sacramento River is the location of the single, known spawning population for the green sturgeon Southern DPS (Adams et al. 2007). Green sturgeon have relatively large eggs compared to other sturgeon species (4.34 mm) and grow rapidly, reaching 66 mm in three weeks. Generally, sturgeon are benthic omnivores, feeding on benthic invertebrates that are abundant in the substrate in that area. Little is known specifically about green sturgeon foraging habits; generally, adults feed upon invertebrates like shrimp, mollusks, amphipods and even small fish, while juveniles eat opossum shrimp and amphipods. Juvenile green sturgeon spend 1-3 years in freshwater, disperse widely in the ocean, and return to freshwater as adults to spawn (about age 15 for males, age 17 for females).

Threats. The 2015 status review (NMFS 2015a) for the southern DPS of green sturgeon indicates that many of the principle factors considered when listing Southern DPS green sturgeon as threatened are relatively unchanged. Current threats to the Southern DPS include entrainment by water projects, contaminants, incidental bycatch and poaching. Given the small population size, the species' life history traits (e.g., slow to reach sexual maturity), and that the threats to the population are likely to continue into the future, the Southern DPS is not resilient to further perturbations. The spawning area for the species is still small, as the species still encounters impassible barriers in the Sacramento, Feather and other rivers that limit their spawning range. Entrainment threat includes stranding in flood diversions during high water events.

Designated critical habitat. Designated critical habitat for the Southern DPS of green sturgeon was designated includes coastal U.S. marine waters within 60 fathoms deep from Monterey Bay, California to Cape Flattery, Washington, including the Strait of Juan de Fuca, and numerous coastal rivers and estuaries: see the Final Rule for a complete description. Essential features identified in this designation that may be affects by the stressors of the action include acceptably low levels of contaminants (e.g., pesticides, PAHs, heavy metals that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon) and abundant prey items (benthic invertebrates and fish) for subadults and adults.

4.5 Nassau Grouper

Status. The Nassau grouper (*Epinephelus striatus*) is primarily a shallow-water, insular fish species found from inshore to about 330 feet (100 m) depth. The species is distributed throughout the islands of the western Atlantic including Bermuda, the Bahamas, southern Florida and along the coasts of central and northern South America. It is not known from the Gulf of Mexico except at Campeche Bank off the coast of the Yucatan Peninsula, at Tortugas, and off Key West. Adults are generally found near coral reefs and rocky bottoms while juveniles are found in shallower waters in and around coral clumps covered with macroalgae and over seagrass beds. Their diet is mostly fishes and crabs, with diet varying by age/size. Juveniles feed mostly on crustaceans, while adults (>30 cm; 11.8 in) forage mainly on fish. The Nassau grouper usually forages alone and is not a specialized forager.

Under the authority of the Magnuson-Stevens Fisheries Act, NMFS classified the Nassau grouper as “overfished” in its October 1998 “Report to Congress on the status of Fisheries and Identification of overfished Stocks.”

Life History. Nassau grouper exhibit no sexual dimorphism in body shape or color. The species passes through a juvenile bisexual phase, with gonads consisting of both immature spermatogenic and immature ovarian tissue, before maturing directly as male or female. The minimum age at sexual maturity is between four and eight years when reaching a size of 400-500 mm standard length (Olsen and LaPlace 1979, Bush et al. 2006). The major determinant of maturity appears to be size rather than age, as fish raised in captivity reached maturity at 27-28 months (Tucker and Woodward 1994).

Nassau grouper reproduce in site-specific spawning aggregations. Spawning aggregations, of a few dozen up to perhaps thousands of individuals have been reported from the Bahamas, Jamaica, Cayman Islands, Belize, and the Virgin Islands. These aggregations occur in depths of 20-40 m (65.6-131.2 ft) at specific locations of the outer reef shelf edge. Spawning takes place in December and January, around the time of the full moon, in waters 25-26 degrees C (77-78.8 degrees F). Because Nassau grouper spawn in aggregations at historic areas and at very specific times, they are easily targeted during reproduction. Because Nassau grouper mature relatively late (4-8 years), many juveniles may be taken by the fishery before they have a chance to reproduce.

Designated critical habitat. Critical habitat has not been designated for this species.

5 *SEA TURTLES*

Sea turtles share the common threats described below.

Bycatch: Fishing is the primary anthropogenic threat to sea turtles in the ocean. Fishing gear entanglement potentially drowns or seriously injures sea turtles. Fishing dredges can crush and entrap turtles, causing death and serious injury. Infection of entanglement wounds can compromise health. The development and operation of marinas and docks in inshore waters can negatively impact nearshore habitats. Turtles swimming or feeding at or just beneath the surface of the water are particularly vulnerable to boat and vessel strikes, which can result in serious propeller injuries and death.

Marine Debris: Ingestion or entanglement in marine debris is a cause of morbidity and mortality for sea turtles in the pelagic (open ocean) environment (Stamper et al. 2009). Consumption of non-nutritive debris also reduces the amount of nutritive food ingested, which then may decrease somatic growth and reproduction (McCauley and Bjorndal 1999). Marine debris is especially problematic for turtles that spend all or significant portions of their life cycle in the pelagic environment (e.g., leatherbacks, juvenile loggerheads, and juvenile green turtles).

Habitat Disturbance: Sea turtle nesting and marine environments are facing increasing impacts through structural modifications, sand nourishment, and sand extraction to support widespread development and tourism (Lutcavage et al. 1997, Bouchard et al. 1998, Hamann et al. 2006, Maison 2006, Hernandez et al. 2007, Santidrián Tomillo et al. 2007, Patino-Martinez 2013).

These factors decrease the amount of nesting area available to nesting females, and may evoke a change in the natural behaviors of adults and hatchlings through direct loss of and indirect (e.g., altered temperatures, erosion) mechanisms (Ackerman 1997, Witherington et al. 2003, 2007). Lights from developments alter nesting adult behavior and are often fatal to emerging hatchlings as they are drawn to light sources and away from the sea (Witherington and Bjorndal 1991, Witherington 1992, Cowan et al. 2002, Deem et al. 2007, Bourgeois et al. 2009).

Beach nourishment also affects the incubation environment and nest success. Although the placement of sand on beaches may provide a greater quantity of nesting habitat, the quality of that habitat may be less suitable than pre-existing natural beaches. Constructed beaches tend to differ from natural beaches in several important ways. They are typically wider, flatter, more compact, and the sediments are more moist than those on natural beaches (Nelson et al. 1987) (Ackerman 1997, Ernest and Martin 1999). Nesting success typically declines for the first year or two following construction, even when more nesting area is available for turtles (Trindell et al. 1998, Ernest and Martin 1999, Herren 1999). Likely causes of reduced nesting success on constructed beaches include increased sand compaction, escarpment formation, and changes in beach profile (Nelson et al. 1987, Grain et al. 1995, Lutcavage et al. 1997, Steinitz et al. 1998, Ernest and Martin 1999, Rumbold et al. 2001). Compaction can inhibit nest construction or increase the amount of time it takes for turtles to construct nests, while escarpments often cause female turtles to return to the ocean without nesting or to deposit their nests seaward of the escarpment where they are more susceptible to frequent and prolonged tidal inundation. In short, sub-optimal nesting habitat may cause decreased nesting success, place an increased energy burden on nesting females, result in abnormal nest construction, and reduce the survivorship of eggs and hatchlings. In addition, sand used to nourish beaches may have a different composition than the original beach; thus introducing lighter or darker sand, consequently affecting the relative nest temperatures (Ackerman 1997, Milton et al. 1997).

In addition to effects on sea turtle nesting habitat, anthropogenic disturbances also threaten coastal foraging habitats, particularly areas rich in seagrass and marine algae. Coastal habitats are degraded by pollutants from coastal runoff, marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased under water noise and boat traffic, as well as structural degradation from excessive boat anchoring and dredging (Francour et al. 1999, Lee Long et al. 2000, Waycott et al. 2005).

Pollutants: Conant (2009) included a review of the impacts of marine pollutants on sea turtles: marine debris, oil spills, and bioaccumulative chemicals. Sea turtles at all life stages appear to be highly sensitive to oil spills, perhaps due to certain aspects of their biology and behavior, including a lack of avoidance behavior, indiscriminate feeding in convergence zones, and large pre-dive inhalations (Milton and Lutz 2003). Milton et al. (2003) state that the oil effects on turtles include increased egg mortality and developmental defects, direct mortality due to oiling in hatchlings, juveniles and adults, and impacts to the skin, blood, salt glands, and digestive and immune systems. Vargo et al. (1986) reported that sea turtles would be at substantial risk if they encountered an oil spill or large amounts of tar in the environment. In a review of available information on debris ingestion, Balazs (1985) reported that tar balls were the second most prevalent type of debris ingested by sea turtles. Physiological experiments showed that sea turtles exposed to petroleum products may suffer inflammatory dermatitis, ventilator disturbance, salt gland dysfunction or failure, red blood cell disturbances, immune response, and digestive disorders (Vargo et al. 1986, Lutcavage et al. 1995).

Natural Threats: A number of threats are common to all sea turtles.[1] Predation is a primary natural threat. While cold stunning is not a major concern for leatherback sea turtles, which can tolerate low water temperatures, it is considered a major natural threat to other sea turtle species. Disease is also a factor in sea turtle survival. Fibropapillomatosis (FP) tumors are a major threat to green turtles in some areas of the world and is particularly associated with degraded coastal habitat. Scientists have also documented FP in populations of loggerhead, olive ridley, and flatback turtles, but reports in green turtles are more common. Large tumors can interfere with feeding and essential behaviors, and tumors on the eyes can cause permanent blindness. FP was first described in green turtles in the Florida Keys in the 1930s. Since then it has been recorded in many green turtle populations around the world. The effects of FP at the population level are not well understood. The sand-borne fungal pathogens *Fusarium falciforme* and *F. keratoplasticum* capable of killing greater than 90 percent of sea turtle embryos they infect, threatening nesting productivity under some conditions. These pathogens can survive on decaying organic matter and embryo mortality rates attributed to fusarium were associated with clay/silt nesting areas compared to sandy areas (Sarmiento-Ramırez et al. 2014).

Climate Change. While impacts to sea turtle nesting habitat is under the jurisdiction of the USFWS, nesting impacts affect the size and structure of the breeding populations that occur in the sea, where NMFS has jurisdiction of the protection of sea turtle species. Conant's (2009) review describes the potentially extensive impacts of climate change on all aspects of a sea turtle's life cycle, as well as impact the abundance and distribution of prey items. Rising sea level is one of the most certain consequences of climate change (Titus and Narayanan 1995), and will result in increased erosion rates along nesting beaches. This could particularly affect areas with low-lying beaches where sand depth is a limiting factor, as the sea will inundate nesting sites and decrease available nesting habitat (Fish et al. 2005, Baker et al. 2006). The loss of habitat because of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Baker et al. 2006). On some undeveloped beaches, shoreline migration will have limited effects on the suitability of nesting habitat. The Bruun rule specifies that during a sea level rise, a typical beach profile will maintain its configuration but will be translated landward and upward (Rosati et al. 2013). However, along developed coastlines, and especially in areas where erosion control structures have been constructed to limit shoreline movement, rising sea levels will cause severe effects on nesting females and their eggs. Erosion control structures can result in the permanent loss of dry nesting beach or deter nesting females from reaching suitable nesting sites (Council 1990). Nesting females may deposit eggs seaward of the erosion control structures potentially subjecting them to repeated tidal inundation. Non-native vegetation often out competes native species, is usually less stabilizing, and can lead to increased erosion and degradation of suitable nesting habitat. Exotic vegetation may also form impenetrable root mats that can prevent proper nest cavity excavation, invade and desiccate eggs, or trap hatchlings.

5.1 Leatherback Sea Turtle

[1] See hyperlink to NMFS information on sea turtles: http://www.nmfs.noaa.gov/pr/species/turtles/threats.htm, updated June 16, 2014

Status. The leatherback sea turtle is unique among sea turtles for its large size, wide distribution (due to thermoregulatory systems and behavior), and lack of a hard, bony carapace. It ranges from tropical to subpolar latitudes, worldwide.

The global population of adult females has declined over 70 percent in less than one generation, from an estimated 115,000 adult females in 1980 to 34,500 adult females in 1995 (Pritchard 1982, Spotila et al. 1996). There may be as many as 34,000 – 94,000 adult leather backs in the North Atlantic, alone (TEWG 2007), but dramatic reductions (> 80 percent) have occurred in several populations in the Pacific, which was once considered the stronghold of the species (Sarti Martinez 2000). The 2013 five-year review (NMFS and USFWS 2013b) reports that the East Pacific and Malaysia leatherback populations have collapsed, yet Atlantic populations generally appear to be stable or increasing. Many explanations have been provided to explain the disparate population trends, including fecundity and foraging differences seen in the Pacific, Atlantic, and Indian Oceans. Since the last 5-year review, studies indicate that high reproductive output and consistent and high quality foraging areas in the Atlantic Ocean have contributed to the stable or recovering populations; whereas prey abundance and distribution may be more patchy in the Pacific Ocean, making it difficult for leatherbacks to meet their energetic demands and lowering their reproductive output. Both natural and anthropogenic threats to nesting and marine habitats continue to affect leatherback populations, including the 2004 tsunami in the Indian Ocean, 2010 oil spill in the U.S. Gulf of Mexico, logging practices, development, and tourism impacts on nesting beaches in several countries.

In 2015, NMFS announced a new program to focus and redouble its efforts to protect some of the species that are currently among the most at risk of extinction in the near future with the goal of reversing their declining trend so that the species will become a candidate for recovery in the future. The leatherback sea turtle is one of the eight species identified for this initiative (NMFS 2015b). These species were identified as among the most at-risk of extinction based on three criteria (1) endangered listing, (2) declining populations, and (3) are considered a recovery priority #1. A priority #1 species is one whose extinction is almost certain in the immediate future because of a rapid population decline or habitat destruction, whose limiting factors and threats are well understood and the needed management actions are known and have a high probability of success, and is a species that is in conflict with construction or other developmental projects or other forms of economic activity.

Life history. Estimates of age at maturity ranges from 5 to 29 years (Spotila et al. 1996, Avens et al. 2009). Females nest every 1 to 7 years. Natal homing, at least within an ocean basin, results in reproductive isolation between five broad geographic regions: eastern and western Pacific, eastern and western Atlantic, and Indian Ocean. Leatherback sea turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherbacks must consume large quantities to support their body weight (James et al. 2005, Wallace et al. 2006).

Designated critical habitat. On March 23, 1979, leatherback designated critical habitat was identified adjacent to Sandy Point, St. Croix, U.S. Virgin Islands from the 183 m isobath to mean high tide level between 17° 42’12” N and 65°50’00” W. This habitat is essential for nesting, which has been increasingly threatened since 1979, when tourism increased significantly, bringing nesting habitat and people into close and frequent proximity; however, studies do not support significant designated critical habitat deterioration. On January 20, 2012, NMFS issued a final rule to designate additional designated critical habitat for the leatherback sea turtle. This designation includes approximately 43,798 km^2 stretching along the California coast from Point Arena to Point Arguello east of the 3000 m depth contour; and 64,760 km^2 stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 m depth contour. The designated areas comprise approximately 108558 km^2 of marine habitat and include waters from the ocean surface down to a maximum depth of 80 m. They were designated specifically because of the occurrence of forage species, primarily jellyfish, of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

5.2 Hawksbill Sea Turtle

Status. The hawksbill sea turtle has a sharp, curved, beak-like mouth. It has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical oceans. The hawksbill turtle was once abundant in tropical and subtropical regions throughout the world. Over the last century, this species has declined in most areas and stands at only a fraction of its historical abundance. According to the 2013 status review (NMFS and USFWS 2013a), nesting populations in the eastern Pacific, and the Nicaragua nesting population in the western Caribbean appears to have improved. However, the trends and distribution of the species throughout the globe largely is unchanged. Although greatly depleted from historical levels, nesting populations in the Atlantic in general are doing better than in the Indian and Pacific Oceans. In the Atlantic, more population increases have been recorded in the insular Caribbean than along the western Caribbean mainland or the eastern Atlantic. In general, hawksbills are doing better in the Indian Ocean (especially the southwestern and northwestern Indian Ocean) than in the Pacific Ocean. The situation for hawksbills in the Pacific Ocean is particularly dire, despite the fact that it still has more nesting hawksbills than in either the Atlantic or Indian Oceans.

Life history. Hawksbill sea turtles reach sexual maturity at 20 to 40 years of age. Females return to their natal beaches every 2 to 5 years to nest (an average of 3 to 5 times per season). Clutch sizes are large (up to 250 eggs). Sex determination is temperature dependent, with warmer incubation producing more females. Hatchlings migrate to and remain in pelagic habitats until they reach approximately 22 to 25 cm in straight carapace length. As juveniles, they take up residency in coastal waters to forage and grow. As adults, hawksbills use their sharp beak-like mouths to feed on sponges and corals.

Designated critical habitat. On September 2, 1998, NMFS established designated critical habitat for hawksbill sea turtles around Mona and Monito Islands, Puerto Rico. Aspects of these areas that are important for hawksbill sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey.

5.3 Kemp's Ridley Sea Turtle

Status. The Kemp's ridley is the smallest of all sea turtle species and considered to be the most endangered sea turtle, internationally. The species was first listed under the Endangered Species Conservation Act and listed as endangered under the ESA since 1973.(Zwinenberg 1977, Groombridge 1982, TEWG 2000). According to the 2015 status review (NMFS and USFWS 2013a), population growth rate (as measured by numbers of nests) stopped abruptly after 2009. Given the recent lower nest numbers, the population is not projected to grow at former rates. An unprecedented mortality in subadult and adult females post-2009 nesting season may have altered the 2009 age structure and momentum of the population, which had a carryover impact on annual nest numbers in 2011-2014. The results indicate the population is not recovering and cannot meet recovery goals unless survival rates improve. The Deep Water Horizon oil spill that occurred at the onset of the 2010 nesting season and exposed Kemp's ridleys to oil in nearshore and offshore habitats may have been a factor in fewer females nesting in subsequent years, however this is still under evaluation. The long-term impacts from the Deep Water Horizon oil spill and response to the spill (e.g., dispersants) to sea turtles are not yet known. Given the Gulf of Mexico is an area of high-density offshore oil exploration and extraction, future oil spills are highly probable and Kemp's ridleys and their habitat may be exposed and injured. Commercial and recreational fisheries continue to pose a substantial threat to the Kemp's ridley despite measures to reduce bycatch. Kemp's ridleys have the highest rate of interaction with fisheries operating in the Gulf of Mexico and Atlantic Ocean than any other species of turtle.

Life history. Adult Kemp's ridley sea turtles have an average straight carapace length of 2.1 ft (65 cm). Females mature at 12 years of age. The average remigration is 2 years. Nesting occurs from April to July in large arribadas, primarily at Rancho Nuevo, Mexico. Females lay an average of 2.5 clutches per season. The annual average clutch size is 97 – 100 eggs per nest. The nesting location may be particularly important because hatchlings can more easily migrate to foraging grounds in deeper oceanic waters, where they remain for approximately 2 years before returning to nearshore coastal habitats. Juvenile Kemp's ridley sea turtles use these nearshore coastal habitats from April through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops. Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 ft (37 m) deep, although they can also be found in deeper offshore waters. As adults, Kemp's ridleys forage on swimming crabs, fish, jellyfish, mollusks, and tunicates.

Designated critical habitat. Critical habitat has not been designated for this species.

5.4 Olive Ridley Sea Turtle

Status. The olive ridley sea turtle is a small, mainly pelagic, sea turtle with a circumtropical distribution. The species was listed under the ESA on July 28, 1978. The species was separated into two listing designations: endangered for breeding populations on the Pacific coast of Mexico, and threatened wherever found except where listed as endangered (i.e., in all other areas throughout its range). The status review, indicates that, based on the current number of olive ridleys nesting in Mexico, three populations appear to be stable (Mismaloya, Tlacoyunque, and Moro Ayuta), two increasing (Ixtapilla, La Escobilla) and one decreasing (Chacahua). Elsewhere in the eastern Pacific, the large scale synchronized nesting populations (i.e., arribada) have declined since the 1970s. Nesting at some arribada beaches continues to decline (e.g., Nancite in Costa Rica) and is stable or increasing at others (e.g., Ostional in Costa Rica). There are too few data available from solitary nesting beaches to confirm the declining trend that has been described for numerous countries throughout the region including El Salvador, Guatemala, Costa Rica, and Panama. Recent at-sea estimates of density and abundance of the olive ridley in the Pacific show a yearly estimate of 1.39 million (Confidence Interval: 1.15 to 1.62 million), which is consistent with the increases seen on nesting beaches as a result of protection programs that began in the 1990s.

Western Atlantic arribada nesting populations are currently very small. The Suriname olive ridley population is currently small and has declined by more than 90 percent since the late

1960s. However, nesting is reported to be increasing in French Guiana. The other nesting population in Brazil, for which no long-term data are available, is small, but increasing. In the eastern Atlantic, long-term data are not available and thus the abundance and trends of this population cannot be assessed at this time. In the northern Indian Ocean, arribada nesting populations are still large, but trend data are ambiguous and major threats continue. Declines of solitary nesting olive ridleys have been reported in Bangladesh, Myanmar, Malaysia, Pakistan, and southwest India.

Designated critical habitat. Critical habitat has not been designated for this species.

5.5 Loggerhead Sea Turtle

Status. Based on the 2009 status review, the loggerhead sea turtle is distinguished from other turtles by its large head and powerful jaws. The North Pacific Ocean DPS ranges throughout tropical to temperate waters in the North Pacific. Based on the 2009 status review (Conant et al. 2009), for three of five DPSs with sufficient data (Northwest Atlantic Ocean, South Pacific Ocean, and North Pacific Ocean), analyses indicate a high likelihood of quasi-extinction. Similarly, threat matrix analysis indicated that all other DPSs have the potential for a severe decline in the future.

North Pacific Ocean Loggerhead sea turtle DPS life history. Mean age at first reproduction for female loggerhead sea turtles is 30 years (SD = 5). Females lay an average of three clutches per season. The annual average clutch size is 112 eggs per nest. The average remigration interval is 2.7 years. Nesting occurs primarily on Japanese beaches, where warm, humid sand temperatures incubate the eggs. Temperature determines the sex of the turtle during the middle of the incubation period. Turtles spend the post-hatchling stage in pelagic waters. The juvenile stage is spent first in the oceanic zone (Kuroshio Extension Bifurcation Region) and later in the neritic zone (i.e., coastal waters) in the eastern and central Pacific. Coastal waters in the eastern and western North Pacific provide important foraging habitat, inter-nesting habitat, and migratory habitat for adult loggerheads.

Northwest Atlantic Ocean Loggerhead sea turtle DPS Life History. Mean age at first reproduction for female loggerhead sea turtles is 30 years (SD = 5). Mating occurs in the spring, and eggs are laid throughout the summer. Northwest Atlantic females lay an average of five clutches per season. The annual average clutch size is 115 eggs per nest. The average remigration interval is 3.7 years (Tucker 2010). Nesting occurs primarily on beaches along the Southeastern Coast of the United States, from southern Virginia to Alabama. Additional nesting occurs on beaches throughout the Gulf of Mexico and Caribbean Sea. Temperature determines the sex of the turtle during the middle of the incubation period. Post- hatchling loggerheads from southeast United States nesting beaches may linger for months in waters just off the nesting beach or become transported by ocean currents within the Gulf of Mexico and North Atlantic, where they become associated with Sargassum habitats, driftlines, and other convergence zones. The juvenile stage is spent first in the oceanic zone (e.g., waters around the Azores, Madeira, Morocco, and the Grand Banks off Newfoundland) and later in the neritic zone (i.e., continental shelf waters) from Cape Cod Bay, Massachusetts, south through Florida, the Caribbean, and the Gulf of Mexico. Neritic stage juveniles often inhabit relatively enclosed, shallow water estuarine habitats with limited ocean access. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish and vegetation at or near the surface (Dodd 1988). Adults inhabit shallow water habitats with large expanses of open ocean access, as well as continental shelf waters. Sub-adult and adult loggerheads prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom, coastal habitats.

Northwest Atlantic Ocean Loggerhead sea turtle DPS Designated Ccritical Habitat. The final designated critical habitat for the Northwest Atlantic Ocean loggerhead DPS within the Atlantic Ocean and the Gulf of Mexico includes 36 occupied marine areas within the range of the Northwest Atlantic Ocean DPS. These areas contain one or a combination of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors.

5.6 Green Sea Turtle

Status. The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 lb (159 kg) and a straight carapace length of greater than 3.3 ft (1 m). It has a circumglobal distribution, occurring throughout nearshore tropical, subtropical, and, to a lesser extent, temperate waters. The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico, and threatened in all other areas throughout its range. On August 1, 2012, NMFS found that a petition to identify the Hawaiian population of green turtle as a DPS, and to delist the DPS, may be warranted. In April 2016, we removed the range-wide and breeding population listings of the green sea turtle, and in their place, listed eight DPSs as threatened and 3 DPSs as endangered. Among these, only the North Atlantic DPS occurs in waters where USEPA has permitting authority.

Life history throughout range. Age at first reproduction for females is 20 - 40 years. They lay an average of three nests per season with an average of 100 eggs per nest. The remigration interval (i.e., return to natal beaches) is 2 – 5 years. Nesting occurs primarily on beaches with intact dune structure, native vegetation, and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges, and other invertebrate prey.

Status. Once abundant in tropical and subtropical waters, globally, green sea turtles exist at a fraction of their historical abundance, as a result of over-exploitation. The North Atlantic DPS is characterized by geographically widespread nesting with eight sites having high levels of abundance (i.e., <1,000 nesters). Nesting is reported in 16 countries and/or U.S. Territories at 73 sites. This region is data rich and has some of the longest running studies on nesting and foraging turtles anywhere in the world. All major nesting populations demonstrate long-term increases in abundance. The prevalence of FP has reached epidemic proportions in some parts of the North Atlantic DPS.

The extent to which this will affect the long-term outlook for green turtles in the North Atlantic DPS is unknown and remains a concern, although nesting trends across the DPS continue to increase despite the high incidence of the disease. There are still concerns about future risks, including habitat degradation (particularly coastal development), bycatch in fishing gear, continued turtle and egg harvesting, and climate change.

Designated critical habitat. On September 2, 1998, NMFS designated critical habitat for green sea turtles, which include coastal waters surrounding Culebra Island, Puerto Rico. Seagrass beds surrounding Culebra provide important foraging resources for juvenile, subadult, and adult green sea turtles. Additionally, coral reefs surrounding the island provide resting shelter and protection from predators. This area provides important developmental habitat for the species.

6 *CORALS*

Status. There are currently 22 coral species listed as threatened under the ESA, 16 of which occur in the action area (Table 3). Information from the listings and status reports (ABRT 2005) were used to summarize the status of these species

Table 3: Threatened coral species occurring in the CGP action area.

Threatened Corals	Currently Known in These U.S. Geographic Areas			
Caribbean Waters: Puerto Rico				
Acropora cervicornis (Staghorn)*and designated critical habitat*	X			
Acropora palmata (Elkhorn) *and designated critical habitat*	X			
Mycetophyllia ferox	X			
Dendrogyra cylindrus	X			
Orbicella annularis	X			
Orbicella faveolata	X			
Orbicella franksi	X			
Pacific Waters				
	Guam	**Northern Mariana Islands**	**Pacific Remote Island Areas**	**American Samoa**
Acropora globiceps	X	X	X	X
Acropora jacquelineae				X
Acropora retusa	X		X	X
Acropora rudis				X
Acropora speciosa			X	X
Euphyllia paradivisa				X
Isopora crateriformis				X
Pavona diffluens	X	X		X
Seriatopora aculeata	X			

Life history. The threatened coral species include true stony corals (class Anthozoa, order Scleractinia), the blue coral (class Anthozoa, order Helioporacea), and fire corals (class Hydrozoa, order Milleporina). All threatened species are reef-building corals, because they secrete massive calcium carbonate skeletons that form the physical structure of coral reefs.

Reef-building coral species are capable of rapid calcification rates because of their symbiotic relationship with single-celled dinoflagellate algae, zooxanthellae, which occur in great numbers within the host coral tissues. Zooxanthellae photosynthesize during the daytime, producing an abundant source of energy for the host coral that enables rapid growth. At night, polyps extend their tentacles to filter-feed on microscopic particles in the water column such as zooplankton, providing additional nutrients for the host coral. In this way, reef-building corals obtain nutrients autotrophically (i.e., via photosynthesis) during the day, and heterotrophically (i.e., via predation) at night.

Most coral species use both sexual and asexual propagation. Sexual reproduction in corals is primarily through gametogenesis (i.e., development of eggs and sperm within the polyps near the base). Some coral species have separate sexes (gonochoric), while others are hermaphroditic. Strategies for fertilization are by either “brooding” or “broadcast spawning” (i.e., internal or external fertilization, respectively). Brooding is relatively more common in the Caribbean, where nearly 50 percent of the species are brooders, compared to less than 20 percent of species in the Indo-Pacific. Asexual reproduction in coral species most commonly involves fragmentation, where colony pieces or fragments are dislodged from larger colonies to establish new colonies, although the budding of new polyps within a colony can also be considered asexual reproduction. In many species of branching corals, fragmentation is a common and sometimes dominant means of propagation.

Reef-building corals do not thrive outside of an area characterized by a fairly narrow mean temperature range (typically 25 °C-30 °C). Two other important factors influencing suitability of habitat are light and water quality.

Threats. Massive mortality events from disease conditions of corals and the keystone grazing urchin *Diadema antillarum* have precipitated widespread and dramatic changes in reef community structure. Large-scale coral bleaching reduces population viability. Coral growth rates in many areas have been declining over decades. Such reductions prevent successful recruitment as a result of reduced density. In addition, continuing coral mortality from periodic acute events such as hurricanes, disease outbreaks, and bleaching events from ocean warming have added to the poor state of coral populations and yielded a remnant coral community with increased dominance by weedy brooding species, decreased overall coral cover, and increased macroalgal cover. Iron enrichment may predispose the basin to algal growth. Finally, climate change is likely to result in the endangerment of many species as a result of temperature increases (and resultant bleaching), sea level rises, and ocean acidification.

Designated Critical Habitat. On November 26, 2008, NMFS designated critical habitat for elkhorn and staghorn coral. They designated marine habitat in four specific areas: Florida (1,329 square miles), Puerto Rico (1,383 square miles), St. John/St. Thomas (121 square miles), and St. Croix (126 square miles). These areas support the following physical or biological features that are essential to the conservation of the species: substrate of suitable quality and availability to support successful larval settlement and recruitment and reattachment and recruitment of fragments.

Literature Cited

ABRT. 2005. Atlantic *Acropora* Status Review Report to National Marine Fisheries Service, Southeast Regional Office.

Ackerman, R. A. 1997. The nest environment, and the embryonic development of sea turtles. Pages 83-106 in P. L. Lutz and J. A. Musick, editors. The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Adams, P. B., C. Grimes, J. E. Hightower, S. T. Lindley, M. L. Moser, and M. J. Parsley. 2007. Population status of North American green sturgeon, *Acipenser medirostris*. Environmental Biology of Fishes 79:339-356.

Allen, M. J., G. B. Smith, and U. States. 1988. Atlas and zoogeography of common fishes in the Bering Sea and Northeastern Pacific. May be obtained from United States Dept. of Commerce, National Technical Information Service, Seattle, WA :.

ASSRT. 2007. Status Review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). National Marine Fisheries Service, Northeast Regional Office.

Avens, L., J. C. Taylor, L. R. Goshe, T. T. Jones, and M. Hastings. 2009. Use of skeletochronological analysis to estimate the age of leatherback sea turtles *Dermochelys coriacea* in the western North Atlantic. Endangered Species Research 8:165-177.

Baker, J. D., C. L. Littnan, and D. W. Johnston. 2006. Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. Endangered Species Research 4:1-10.

Balazs, G. 1985. Impact of ocean debris on marine turtles: Entanglement and ingestion. Pages 397-429 in The Fate and Impact of Marine Debris. NOAA Tech. Memo., NMFS. NOAA-TM-NMFSSWFC-54, Honolulu, Hawaii

Barnhart, R. A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest): steelhead. TR-EL-82-4/872-11-60, US Army Corps of Engineers, Arcada, California.

Barraclough, W. E. 1964. Contribution to the marine life history of the eulachon *Thaleichthys pacificus*. Journal of the Fisheries Research Board of Canada 21:1333-1337.

Barrett, B. M., F. M. Thompson, and S. N. Wick. 1984. Adult anadromous investigations: May-October 1983. Alaska Department of Fish and Game.

Beacham, T. D., D. E. Hay, and K. D. Le. 2005. Population structure and stock identification of eulachon (*Thaleichthys pacificus*), an anadromous smelt, in the Pacific northwest. Marine Biotechnology 7:363-372.

Bigler, B. 1985. Kotzebue Sound chum salmon (*Oncorhynchus keta*) escapement and return data, 1962-1984. Page 112, Alaska Department of Fish Game (ADF&G) Technical Data Report no. 149.

Bouchard, S., K. Moran, M. Tiwari, D. Wood, A. Bolten, P. Eliazar, and K. Bjorndal. 1998. Effects of exposed pilings on sea turtle nesting activity at Melbourne Beach, Florida. Journal of Coastal Research 14:1343-1347.

Bourgeois, S., E. Gilot-Fromont, A. Viallefont, F. Boussamba, and S. L. Deem. 2009. Influence of artificial lights, logs and erosion on leatherback sea turtle hatchling orientation at Pongara National Park, Gabon. Biological Conservation 142:85-93.

BRT. 2005. Green Sturgeon (*Acipenser medirostris*) Status Review Update. Biological Review Team. NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA.

Burgner, R. L. 1991. Life history of sockeye salmon.in C. Groot and L. Margolis, editors. Pacific Salmon Life Histories. UBC Press, Vancouver, Canada.

Burgner, R. L., S. T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. International North Pacific Fisheries Commission, Vancouver, Canada.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsine. 1996. Status review of steelhead from Washington, Oregon, and California. NMFS-NWFSC-27, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Bush, P., D. Lane, G. Ebanks-Petrie, K. Luke, B. Johnson, C. McCoy, J. Bothwell, and Parsons E. 2006. The Nassau grouper spawning aggregation fishery of the Cayman Islands - an historical and management perspective. Proceedings of the Gulf and Caribbean Fisheries Institute 57:515-524.

Clarke, A. D., A. Lewis, K. H. Telmer, and J. M. Shrimpton. 2007. Life history and age at maturity of an anadromous smelt, the eulachon *Thaleichthys pacificus* (Richardson). Journal of Fish Biology 71:1479-1493.

Conant, T. A., P. H. Dutton, T. Eguchi, S. P. Epperly, C. C. Fahy, M. H. Godfrey, S. L. MacPherson, E. E. Possardt, B. A. Schroeder, J. A. Seminoff, M. L. Snover, C. M. Upite, and B. E. Witherington. 2009. Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the United States Endangered Species Act. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Council, N. R. 1990. Decline of the Sea Turtles: Causes and Prevention. Page 259, National Academy Press, Washington, DC.

Cowan, E., J. Pennell, M. Salmon, J. Wyneken, C. Cowan, and A. Broadwell. 2002. Influence of filtered roadway lighting on the seaward orientation of hatchling sea turtles. Pages 295-298 in Twentieth Annual Symposium on Sea Turtle Biology and Conservation.

Deem, S. L., F. Boussamba, A. Z. Nguema, G. Sounguet, S. Bourgeois, J. Cianciolo, and A. Formia. 2007. Artificial lights as asignificant cause of morbidity of leatherback sea turtles in Pongara National Park, Gabon. Marine Turtle Newsletter 116:15-17.

Dodd, C. K. J. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). 88(14), United States Fish and Wildlife Service.

Drake, A., and L. Wilson. 1991. Eulachon, a fish to cure humanity.in U. M. o. Anthropology, editor.

Emmett, R. L., S. L. Stone, S. A. Hinton, and M. E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in West Coast estuaries. National Oceanic and Atmospheric

Administration, National Ocean Service, Strategic Environmental Assessments Division, Rockville, Maryland.

Ernest, R., and R. Martin. 1999. Martin County beach nourishment project sea turtle monitoring and studies, 1997 annual report and final assessment.

Eschmeyer, W. N., E. S. Herald, and H. Hammann. 1983. A Field Guide to Pacific Coast Fishes of North America. Houghton Mifflin Company, Boston, Massachusetts.

Fay, C., M. Bartron, S. Craig, A. Hecht, J. Pruden, R. Saunders, T. Sheehan, and J. Trial. 2006. Status review of anadromous Atlantic salmon (*Salmo salar*) in the United States. National Marine Fisheries Service and United States Fish and Wildlife Service.

Fish, M. R., I. M. Cote, J. A. Gill, A. P. Jones, S. Renshoff, and A. R. Watkinson. 2005. Predicting the impact of sea-level rise on Caribbean sea turtle nesting habitat. Conservation Biology 19:482-491.

Francour, P., A. Ganteaume, and M. Poulain. 1999. Effects of boat anchoring in Posidonia oceanica seagrass beds in the Port-Cros National Park (north-western Mediterranean Sea). Aquatic Conservation: Marine and Freshwater Ecosystems 9:391-400.

Geist, D. R., C. J. Murray, T. P. Hanrahan, and Y. L. Xie. 2008. A Model of the Effects of Flow Fluctuations on Fall Chinook Salmon Spawning Habitat Availability in the Columbia River. North American Journal of Fisheries Management 28:1894-1910.

Grain, D. A., A. B. Bolten, and K. A. Bjorndal. 1995. Effects of Beach Nourishment on Sea Turtles: Review and Research Initiatives. Restoration Ecology 3:95-104.

Groombridge, B. 1982. Testudines, Crocodylia, Rhynchocephalia. Page 426 in I. U. f. C. o. Nature, editor. The IUCN Amphibia-Reptilia Red Data Book. IUCN.

Gustafson, R. G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. Page 360, United States Department of Commerce.

Gustafson, R. G., L. Weitkamp, Y. W. Lee, W. Ward, K. Somers, V. Tuttle, and J. J. 2016. Status Review Update of Eulachon (*Thaleichthys pacificus*) Listed under the Endangered Species Act: Southern Distinct Population Segment. Page 111, Conservation Biology Division Northwest Fisheries Science Center, Fisheries Observation Science Program Fishery Resource Analysis and Monitoring Division, National Marine Fisheries Service.

Hamann, M., C. Limpus, G. Hughes, J. Mortimer, and N. Pilcher. 2006. Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South East Asia, including consideration of the impacts of the December 2004 tsunami on turtles and turtle habitats. IOSEA Marine Turtle MoU Secretariat, Bangkok.

Hanson, M. B., R. W. Baird, J. K. B. Ford, J. Hempelmann-Halos, D. M. Van Doornik, J. R. Candy, , G. S. S. C. K. Emmons, B. Gisborne, K. L. Ayres, S. K. Wasser, K. C. Balcomb, , and J. G. S. K. Balcomb-Bartok, and M. J. Ford. 2010. Species and stock identification of prey consumed by endangered Southern Resident killer whales in their summer range. Endangered Species Research 11:69–82.

Hart, J. L., and J. L. McHugh. 1944. The smelts (Osmeridae) of British Columbia. Bulletin of the Fisheries Research Board of Canada 64.

Hatten, J. R., K. F. Tiffan, D. R. Anglin, S. L. Haeseker, J. J. Skalicky, and H. Schaller. 2009. A Spatial Model to Assess the Effects of Hydropower Operations on Columbia River Fall Chinook Salmon Spawning Habitat. North American Journal of Fisheries Management 29:1379-1405.

Hay, D., and P. B. McCarter. 2000. Status of the eulachon *Thaleichthys pacificus* in Canada. 1480-4883, Department of Fisheries and Oceans Canada, Canadian Stock Assessment Secretariat, Ottawa, Canada.

Healey, M. 1991. The life history of chinook salmon (Oncorhynchus tshawytscha). Pages 311-393 in C. Groot and L. Margolis, editors. Life history of Pacific salmon. University of British Columbia Press Vancouver, BC.

Hernandez, R., J. Buitrago, H. Guada, H. Hernandez-Hamon, and M. Llano. 2007. Nesting distribution and hatching success of the leatherback, *Dermochelys coriacea*, in relation to human pressures at Playa Parguito, Margarita Island, Venezuela. Chelonian Conservation and Biology 6:79-86.

Herren, R. 1999. The Effect of Beach Nourishment on Loggerhead Nesting and Reproductive Success at Sebastian Inlet, Florida.in Proceedings of the nineteenth annual symposium on sea turtle conservation and biology, South Padre Island, Texas, USA.

Hugg, D. O. 1996. MAPFISH georeferenced mapping database. Life Science Software, Edgewater, Maryland.

James, M. C., A. C. Ottensmeyer, and M. R.A. 2005. Identification of high-use habitat and threats to leatherback sea turtles in northern waters: new directions for conservation. Ecology Letters 8:195-201.

Jennings, M. R. 1996. Past occurrence of eulachon, *Thaleichthys pacificus*, in streams tributary to Humboldt Bay, California. California Fish and Game 82:147-148.

Larson, Z. S., and M. R. Belchik. 2000. A preliminary status review of eulachon and Pacific lamprey in the Klamath River Basin. Yurok Tribal Fisheries Program, Klamath, California.

Lee Long, W. J., R. G. Coles, and L. J. McKenzie. 2000. Issues for seagrass conservation management in Queensland. Pacific Conservation Biology 5:321-328.

Light, J. T. 1985. Food and feeding of steelhead trout in the epipelagic waters of the North Pacific Ocean.in Annual meeting of the International North Pacific Fisheries Commission, Tokyo, Japan.

Lutcavage, M. E., P. L. Lutz, G. D. Bossart, and D. M. Hudson. 1995. Physiologic and clinicopathologic effects of crude oil on loggerhead sea turtles. Arch Environ Contam Toxicol 28:417-422.

Lutcavage, M. E., P. Plotkin, B. E. Witherington, and P. L. Lutz. 1997. Human impacts on sea turtle survival. Pages 387-409 in P. L. Lutz and J. A. Musick, editors. The Biology of Sea Turtles. CRC Press, New York, New York.

Maison, K. 2006. Do turtles move with the beach? Beach profiling and possible effects of development on a leatherback (*Dermochelys coriacea*) nesting beach in Grenada. Page 145 in Twenty-Sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

McCauley, S. J., and K. A. Bjorndal. 1999. Conservation implications of dietary dilution from debris ingestion: Sublethal effects in post-hatchling loggerhead sea turtles. Conservation Biology 13:925-929.

McLean, J. E., D. E. Hay, and E. B. Taylor. 1999. Marine population structure in an anadromous fish: Life history influences patterns of mitochondrial DNA variation in the eulachon, *Thaleichthys pacificus*. Molecular Ecology 8:S143-S158.

McLean, J. E., and E. B. Taylor. 2001. Resolution of population structure in a species with high gene flow: Microsatellite variation in the eulachon (Osmeridae: *Thaleichthys pacificus*). Marine Biology 139:411-420.

Merz, J. 2002. Seasonal feeding habits, growth, and movement of steelhead trout in the lower Moklumne River, California. California Fish and Game 88:95-111.

Miller, B. A., and S. Sadro. 2003. Residence time and seasonal movements of juvenile coho salmon in the ecotone and lower estuary of Winchester Creek, South Slough, Oregon. Transactions of the American Fisheries Society 132:546-559.

Miller, B. S., and S. F. Borton. 1980. Geographical distribution of Puget Sound fishes: Maps and data source sheets. University of Washington Fisheries Research Institute.

Milton, S. L., A. A. Schulman, and P. L. Lutz. 1997. The effect of beach nourishment with aragonite versus silicate sand on beach temperature and loggerhead sea turtle nesting success. Journal of Coastal Research 13:904-915.

Minckley, W. L., D. A. Hendrickson, and C. E. Bond. 1986. Geography of western North American freshwater fishes: Description and relationship to intercontinental tectonism. Pages 519-613 in C. H. Hocutt and E. O. Wiley, editors. The Zoogeography of North American Freshwater Fishes. John Wiley and Sons, New York, New York.

Moyle, P. B. 2002. Inland Fishes of California. University of California Press, Berkley and Los Angeles, California.

Musick, J. A., M. M. Harbin, S. A. Berkeley, G. H. Burgess, A. M. Eklund, L. Findley, R. G. Gilmore, J. T. Golden, D. S. Ha, G. R. Huntsman, J. C. McGovern, S. J. Parker, S. G. Poss, E. Sala, T. W. Schmidt, G. R. Sedberry, H. Weeks, and S. G. Wright. 2000. Marine, estuarine, and diadromous fish stocks at risk of extinction in North America (exclusive of Pacific salmonids). Fisheries 25:6-30.

Nelson, D. A., K. A. Mack, and J. Fletemeyer. 1987. Physical effects of beach nourishment on sea turtle nesting, Delray Beach, Florida Environmental Laboratory, Department of the Army, Waterways Experiment Station, Corps of Engineers, PO Box 631, Vicksburg, Mississippi 39180-0631

Nickelson, T. E., J. W. Nicholas, A. M. McGie, R. B. Lindsay, D. L. Bottom, R. J. Kaiser, and S. E. Jacobs. 1992. Status of anadromous salmonids in Oregon coastal basins. Oregon Department of Fish and Wildlife, Corvallis, Oregon.

NMFS. 1998. Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*). Page 104 in Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, editor., Silver Spring, Maryland.

NMFS. 2013. Status review update of Southern Resident killer whales. Conservation Biology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA.

NMFS. 2014. Killer whale (*Orcinus orca*): Eastern North Pacific Southern Resident Stock. National Marine Fisheries Service.

NMFS. 2015a. Southern Distinct Population Segment of the North American Green Sturgeon (*Acipenser medirostris*) 5-Year Review: Summary and Evaluation. Office of Protected Resources, West Coast Region, Long Beach, CA.

NMFS. 2015b. Species in the Spotlight Priority Actions: 2016-2020 Atlantic Salmon Salmo salar. Office of Protected Resources, Silver Spring, MD.

NMFS, and USFWS. 2013a. Hawksbill Sea Turtle (*Eretmochelys Imbricata*) 5-Year Review: Summary and Evaluation. Page 92, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland and United States Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Office, Jacksonville, Florida.

NMFS, and USFWS. 2013b. Leatherback sea turtle (*Dermochelys coriacea*) 5-year review: Summary and evaluation. Page 93, National Marine Fisheries Service Office of Protected Resources, Silver Spring, Maryland and United States Fish And Wildlife Service, Southeast Region Jacksonville Ecological Services Office, Jacksonville, Florida.

Odemar, M. W. 1964. Southern range extension of the eulachon, *Thaleichthys pacificus*. California Fish and Game 50:305-307.

Olegario, A. O. 2006. Over-wintering diet, growth, and prey availability to juvenile coho salmon (*Onchorhynchus kisutch*) in the West Fork Smith Riever, Oregon. Master of Science. Oregon State University, Corvallis.

Olsen, D., and J. LaPlace. 1979. A study of a Virgin Islands grouper fishery based on a breeding aggregation. Proceedings of the Gulf and Caribbean Fisheries Institute 31:130–144.

Parsons, K. M., K. C. Balcomb, J. K. B. Ford, and J. W. Durban. 2009. The social dynamics of southern resident killer whales and conservation implications for this endangered population. Animal Behaviour 77:963-971.

Patino-Martinez, J. 2013. Global change and sea turtles. Munibe Monographs 2013:99-105.

Pert, H. A. 1993 Winter Food Habits of Coastal Juvenile Steelhead and Coho Salmon in Pudding Creek, Northern California University of California at Berkeley.

Pilot, M., M. E. Dahlheim, and A. R. Hoelzel. 2010. Social cohesion among kin, gene flow without dispersal and the evolution of population genetic structure in the killer whale (Orcinus orca). Journal of Evolutionary Biology 23:20-31.

Pritchard, P. C. H. 1982. Nesting of the leatherback turtle, *Dermochelys coriacea*, in Pacific México, with a new estimate of the world population status. Copeia 1982:741-747.

Rosati, J., R. Dean, and T. Walton. 2013 The modified Bruun Rule extended for landward transport. US Army Research Paper 219 http://digitalcommons.unl.edu/usarmyresearch/219.

Rumbold, D. G., P. W. Davis, and C. Perretta. 2001. Estimating the Effect of Beach Nourishment on *Caretta caretta* (Loggerhead Sea Turtle) Nesting. Restoration Ecology 9:304-310.

Santidrián Tomillo, P., E. Vélez, R. D. Reina, R. Piedra, F. V. Paladino, and J. R. Spotila. 2007. Reassessment of the leatherback turtle (*Dermochelys coriacea*) nesting population at Parque Nacional Marino Las Baulas, Costa Rica: Effects of conservation efforts. Chelonian Conservation and Biology 6:54-62.

Sarmiento-Ramırez, J. M., E. Abella-Perez, A. D. Phillott, J. Sim, P. v. West, M. P. Martın, A. Marco, and J. Dieguez-Uribeondo. 2014. Global distribution of two fungal pathogens threatening endangered sea turtles. Plos One 9:e85853.

Sarti Martinez, A. L. 2000. *Dermochelys coriacea*. 2006 IUCN Red List of Threatened Species. International Union for Conservation of Nature and Natural Resources.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Bulletin of the Fisheries Research Board of Canada 184:1-966.

Secor, D., P. Anders, V. W. Webster, and D. Dixon. 2002. Can we study sturgeon to extinction? What we do and don't know about the conservation of North American sturgeon. American Fisheries Society Symposium 28:183-189.

Shapovalov, L., and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game Bulletin 98:375.

Smith, W. E., and R. W. Saalfeld. 1955. Studies on Columbia River smelt *Thaleichthys pacificus* (Richardson). Washington Department of Fisheries, Fisheries Research Paper 1:3-26.

Spotila, J. R., A. E. Dunham, A. J. Leslie, A. C. Steyermark, P. T. Plotkin, and F. V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: Are leatherback turtles going extinct? Chelonian Conservation and Biology 2:209-222.

SSSRT. 2010. A Biological Assessment of shortnose sturgeon (*Acipenser brevirostrum*). Shortnose Sturgeon Status Review Team Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.

Stamper, M. A., C. W. Spicer, D. L. Neiffer, K. S. Mathews, and G. J. Fleming. 2009. Morbidity in a juvenile green sea turtle (*Chelonia mydas*) due to ocean-borne plastic. Journal of Zoo and Wildlife Medicine 40:196-198.

Steinitz, M., M. Salmon, and J. Wyneken. 1998. Beach Renourishment and Loggerhead Turtle Reproduction: A Seven Year Study at Jupiter Island, Florida. Journal of Coastal Research 14:1000-1013.

Sturdevant, M. V., T. M. Willette, S. Jewett, and E. Deberec. 1999. Diet composition, diet overlap, and size of 14 species of forage fish collected monthly in PWS, Alaska, 1994-1995.

TEWG. 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NMFS-SEFSC-444, Turtle Expert Working Group (TEWG).

TEWG. 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NMFS-SEFSC-555, Turtle Expert Working Group, Department of Commerce.

Thorpe, J. E. 1994. Salmonid fishes and the estuarine environment. Estuaries 17:76-93.

Titus, J., and V. Narayanan. 1995 Page 186, United States Environmental Protection Agency, Climate Change Division, Office of Policy, Planning, and Evaluation, Climate Change Division, Adaptation Branch.

Trindell, R., A. Moody, and B. Morford. 1998. Postconstruction marine turtle nesting monitoring on nourished beaches. Pages 77–92 in L. S. Tait, compiler. Proceedings of the 11th Beach Preservation Technology Conference. February 2–6, Florida Shore and Beach Preservation Association, Silver Spring, Maryland.

Tucker, A. D. 2010. Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. Journal of Experimental Marine Biology and Ecology 383:48-55.

Tucker, J., Jr., and P. Woodward. 1994. Growth and development of domestic Nassau groupers. Proceedings of the Gulf and Caribbean Fisheries Institute 43:389-391.

Vargo, S., P. Lutz, D. Odell, E. Van Vleet, and G. D. Bossart. 1986. Study of the effects of oil on marine turtles. Prepared for the USDOI, Minerals Management Service, 3 volumes.

Wallace, B. P., S. S. Kilham, F. V. Paladino, and J. R. Spotila. 2006. Energy budget calculations indicate resource limitation in Eastern Pacific leatherback turtles. Marine Ecology Progress Series 318:263-270.

Waycott, M. B., J. Longstaff, and J. Mellors. 2005. Seagrass population dynamics and water quality in the Great Barrier Reef region: A review and future research directions. Marine Pollution Bulletin 51:343-350.

WDFW, and ODFW. 2001. Washington and Oregon eulachon management plan. Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife.

Wedemeyer, G. A., R. L. Saunders, and W. C. Clarke. 1980. Environmental factors affecting smoltification and early marine survival of anadromous salmonids. Marine Fisheries Review 42:1-14.

Willson, M. F., R. H. Armstrong, M. C. Hermans, and K. Koski. 2006. Eulachon: a review of biology and an annotated bibliography. Auke Bay Laboratory, Alaska Fisheries Science Center, Juneau, Alaska.

Witherington, B. E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48:31-39.

Witherington, B. E., and K. A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles *Caretta caretta*. Biological Conservation 55:139-149.

Witherington, B., S. Hirama, and A. Mosier. 2003. Effects of beach armoring structures on marine turtle nesting. Florida Fish and Wildlife Conservation Commission.

Witherington, B., S. Hirama, and A. Mosier. 2007. Change to armoring and other barriers to sea turtle nesting following severe hurricanes striking Florida beaches. Florida Fish and Wildlife Conservation Commission.

Wright, S. 1999. Petition to list eulachon *Thaleichthys pacificus* as threatened or endangered under the Endangered Species Act.

Wydoski, R. S., and R. R. Whitney. 1979. Inland Fishes of Washington. University of Washington Press, Seattle, Washington.

Zedonis, P. A. 1992. The biology of steelhead (*Onchorynchus mykiss*) in the Mattole River estuary/lagoon, California. Humboldt State University, Arcata, California.

Zwinenberg, A. J. 1977. Kemp's ridley, *Lepidochelys kempii* (Garman, 1880), undoubtedly the most endangered marine turtle today (with notes on the current status of *Lepidochelys olivacea*). Bulletin Maryland Herpetological Society 13:170-192.