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3.7 FISH

This section provides an overview of the species, distribution, and occurrence of fishes that are either resident or migratory through the Northwest Training Range Complex (NWTRC) Study Area. Many of the finfish species that occur in the affected areas are managed on a region-wide (*e.g.*, Puget Sound), State-wide (Washington), or larger (Pacific Northwest [PACNW]) basis for their importance as both commercial and recreational fisheries.

The Navy will consult, as appropriate, with the National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS), as part of the EIS/OEIS process. As such, additional documentation has been prepared: a Biological Evaluation (BE) for use in consultation regarding federally-listed threatened and endangered species protected under the Endangered Species Act (ESA), and an Essential Fish Habitat (EFH) Assessment for species protected under the Magnuson-Stevens Fishery Conservation and Management Act. A brief discussion of EFH is provided in Section 3.7.1.3 of this EIS/OEIS; a brief discussion of federally-listed threatened and endangered fish species and fish Species of Concern in the NWTRC is provided in Section 3.7.1.4.

3.7.1 Affected Environment

The NWTRC Study Area is located in a region of diverse and highly productive fisheries (Leet et al. 2001). Predominant ecosystems found in the NWTRC include nearshore coastal, continental shelf, and oceanic systems. Important marine species include salmonids (*e.g.*, chinook salmon, trout), coastal pelagic and forage (*e.g.*, mackerels, anchovies, herrings, and jacks), groundfish (*e.g.*, halibut, flounder, rockfish), and highly migratory species (*e.g.*, tuna) (NMFS 2005h, 2005c).

The marine environment off the coasts of Washington, Oregon, and northern California, are part of what is collectively known as the Coastal Upwelling Domain (NMFS-Northwest Regional Office [NWR] 2005). The Coastal Upwelling Domain is part of the California Coastal System. This system can be described as a broad, meandering, southward-flowing current that extends from the northern tip of Vancouver Island (50°N latitude) to Baja California (25°N latitude) and extends westward from the shore to several hundred miles out (NMFS-NWR 2005).

Although the coastal upwelling along the Pacific coast produces high plankton biomass, unique conditions are associated with this environment. The upwelling process transports surface waters and their associated plankton, larval, and juvenile fishes away from the coast and to the south, moving them from nutrient-rich waters to nutrient-poor conditions. As an adaptation to this condition, fish species may spawn during winter months before upwelling occurs (*e.g.*, Dover sole *[Microstomus pacificus]*), migrate to areas where upwelling does not occur (*e.g.*, Pacific hake *[Merluccius productus]* and English sole *[Parophyrus vetulus]*), spawn in rivers (salmonids and eulachon), or give birth to live young (NMFS-NWR 2005).

3.7.1.1 Existing Conditions

The following discussion provides an overview of the predominant fish species and types of habitat known to occur in the NTWRC. Fish are categorized as: salmonids; coastal pelagic and forage; groundfish; and highly migratory species. Habitat is categorized as nearshore, offshore, and Puget Sound.

<u>Salmonids</u>

Pacific salmon are arguably the most important living marine resource within the NWTRC. Salmonid species with known or potential occurrence within the NWTRC include five species of Pacific salmon: the chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), coho (*O. kisutch*), pink (*O. gorbuscha*), and sockeye (*O. nerka*); and three species of trout: the cutthroat (*O. clarkii*), steelhead (*O. mykiss*), and bull

(*Salvelinus confluentus*). Salmonids found in the NWTRC are anadromous fish species that spend at least part of their adult life in the ocean but return to freshwater environments to spawn. Salmon habitat includes streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon. Salmon habitat extends from the nearshore and tidal submerged environments within State territorial waters out to the full extent of the Exclusive Economic Zone (EEZ), 200 nm offshore (Pacific Fisheries Management Council [PFMC] 2000). Three species of salmon have essential fish habitat in the NWTRC: Chinook, coho, and Puget Sound pink salmon.

In 1993, Washington and western Washington Treaty Tribes published the first state-wide comprehensive inventory of salmon and steelhead stocks. In total, the inventory identified 435 different stocks of salmon and steelhead, and the current status of each stock was reported. Based on these and other data, NMFS and USFWS have listed several salmonid species as threatened. ESA-designated salmonid species with known or potential occurrence in the NWTRC include: Chinook, coho, and chum salmon, and steelhead and bull trout. NMFS has jurisdiction over the salmon and steelhead trout species; USFWS has jurisdiction over the bull trout. Pacific salmon are discussed in more detail in Sections 3.7.1.3 and Section 3.7.1.4.

Coastal Pelagic and Forage Fish

The shorelines of Puget Sound provide habitat for forage fish. These fish and their eggs are an important food source for many organisms (*e.g*., marine mammals, sea birds, and fishes including salmonids) within the Puget Sound ecosystem (Bargmann and Schweigert 2005, Herrera Environmental Consultants Inc. 2005). Forage fish species that are found within Puget Sound include: Pacific herring *(Clupea harengus pallasi)*, northern anchovy *(Engraulis mordax)*, Pacific sardine *(Sardinops sagax)*, surf smelt *(Hypomesus pretiosus)*, eulachon *(Thalichthys pacificus)* (also called Columbia River smelt, or oil fish), and Pacific sand lance *(Ammodytes hexapterus)*. Three Puget Sound forage fish species: Pacific herring, Pacific sand lance, and surf smelt, have documented spawning sites within the NWTRC Study Area. In addition, surf smelt utilizes spawning areas along the Pacific coast (Bargmann 1998) which include W-237A.

Coastal pelagic species in the NWTRC include finfish (*e.g*., northern anchovy, Pacific sardine, Pacific [chub] mackerel [*Scomber japonicus*], and jack mackerel [*Trachurus symmetricus*]), and invertebrates (*e.g*., market squid [*Loligo opalescens*], and krill [*Euphausia pacifica* and *Thysanoessa spinifera*]) (PFMC 2005). Coastal pelagic species inhabit the open, upper portion (surface to approximately 3,280 feet [ft.] (1,000 meters [m])) of marine waters rather than waters adjacent to the land or near the seafloor.

Coastal pelagic species are harvested directly and incidentally (as bycatch) in other fisheries. Usually targeted with “round-haul” gear including purse seines, drum seines, lampara nets, and dip nets, they are also taken as bycatch in midwater trawls, pelagic trawls, gillnets, trammel nets, trolls, pots, hook-and-line, and jigs. Market squid are fished nocturnally using bright lights to attract the squid to the surface. They are pumped directly from the sea into the hold of the boat, or taken with an encircling net (PFMC 2005).

Coastal pelagic species with EFH in the NWTRC include: northern anchovy, Pacific mackerel, jack mackerel, Pacific sardine, market squid, and krill, these species are discussed in more detail in Section 3.7.1.3.

Pacific Coast Groundfish Species

Pacific coast groundfish species (i.e., flatfish, rockfish, thornyheads, roundfish, skates, sharks and chimeras) support important commercial, recreational, and Tribal usual and customary fisheries. Many species of groundfish have EFH in the NWTRC. EFH is discussed in more detail in Section 3.7.1.3.

Most flatfish are demersal species associated with shallow, soft-bottom (sand and mud) habitats in Puget Sound and Washington coast waters (Emmett et al. 1991). They spawn offshore between September and

April (Kruse and Tyler 1983). Larvae are found in nearshore habitats between March and May. Juveniles are found throughout the year in gravel, sand-eelgrass, and mud-eelgrass habitats. English sole is the most numerous flatfish in Puget Sound.

Rockfish on the Pacific coast typically inhabit the continental shelf and upper slope regions and are sometimes described as nearshore, shelf, or slope rockfish. As adults, rockfish inhabit rocky reef habitats, slopes, pinnacles, pilings, or submerged debris and typically remain within 100 to 164 ft (30 to 50 m) of their preferred habitat (Matthews 1990). Rockfish are long-lived and sexual maturity is attained between 5 and 20 years of age. Spawning for most species generally takes place in the early spring (April) or late fall. Once hatched (late winter to mid-summer) the juvenile larvae form part of the pelagic community for up to 3 years and use nearshore habitats. Due to their long lives and late sexual maturity, rockfish are extremely susceptible to over harvest and stock depletion.

Other roundfish of interest are the rock greenling *(Hexagrammos lagocephalus)*, typically caught by recreational fishers, and walleye pollock *(Theragra chalcogramma)*, commonly caught by commercial trawlers (www.wdfw.wa.gov). The Washington Department of Fish and Wildlife (WDFW) recognizes two stocks of walleye pollock in Puget Sound (North Sound and South Sound) which are differentiated by spawning location, growth rates, and other biological characteristics (Palsson et al. 1998). Walleye pollock reportedly form spawning aggregations on localized grounds in Puget Sound during March and April at depths of 361 to 476 ft (110 to 145 m) (Pedersen and DiDonato 1982). Larvae and small juveniles are pelagic, and are generally found in the upper water column to depths of 197 ft (60 m) (Garrison and Miller 1982, Bailey et al. 1999). Juvenile pollock have been found in a variety of habitat types, including eelgrass (over sand and mud), gravel, and cobble (Miller et al. 1976).

Species of sharks and skates that are known to occur in Puget Sound include spiny dogfish, big skate, and longnose skate. Sharks and skates form part of the benthic and near-bottom fish communities in Puget Sound and are not classified as food fish. These species are often caught as bycatch in groundfish fisheries. Stock status of these species in Washington is unknown.

Groundfish range throughout the EEZ and occupy diverse habitats at all stages in their life histories. Some species are broadly dispersed during specific life stages, especially those with pelagic eggs and larvae. The distribution of other species and/or life stages may be relatively limited, as with adults of many nearshore rockfish which show strong affinities to a particular location or substrate type.

While the majority of groundfish on the west coast of Washington are harvested in the commercial trawl fishery, both recreational and Tribal usual and accustomed fisheries also harvest groundfish. Washington coastal treaty Indian tribes (Makah, Quileute, Hoh and the Quinault Indian Nation) hold formal allocations in their “usual and accustomed” fishing areas for sablefish *(Anoplopoma fimbria)*, Pacific hake, and black rockfish *(Sebastes melanops)*.

Highly Migratory Species

The term “highly migratory species” (HMS) derives from Article 64 of the United Nations Convention on the Law of the Sea. Although the Convention does not provide an operational definition of the term, an annex to it lists species considered highly migratory by parties to the Convention. In general, these species have a wide geographic distribution, both inside and outside the 200-nm zones, and undertake migrations of significant but variable distances across oceans for feeding or reproduction. They are pelagic species, which means they do not live near the sea floor, and mostly live in the open ocean, although they may spend part of their life cycle in nearshore waters. Highly migratory species are harvested by U.S. commercial and recreational fishers and by foreign fishing fleets. Only a small fraction of the total harvest is taken within U.S. waters. In the NWTRC, HMS include sharks, tunas, and swordfish, as discussed in more detail in Section 3.7.1.3.

Fish Habitat in the Northwest Training Range Complex

Habitat characteristics include geomorphic, physical, biological, and chemical parameters. Interactions between environmental parameters make up habitat and determine the biological niche of a species. Habitat types along the west coast can be separated into two large provinces: the Oregonian (north of Point Conception) and the Californian (south of Point Conception) (Allen and Smith 1988). The OPAREA and Puget Sound Study Area fall entirely within the Oregonian Province. The Oregonian province can further be defined by physical characteristics (depth, substrate, temperature, salinity) and habitat types utilized by managed fishes (NMFS-NWR 2005).

Nearshore (Estuarine and Intertidal Habitats)

Estuaries

Estuaries include bays and inlets influenced by both the ocean and river and serve as the transitional zone between fresh and saltwater. These habitats fulfill fish/invertebrate needs for reproduction, feeding, refuge, and other physiological necessities. Major estuaries include Puget Sound, Gray's Harbor, Columbia River, and Yaquina Bay.

Nearshore biogenic habitats

Nearshore biogenic habitats include kelp, seagrass, and sponges. The biological component (kelp, seagrass, or sponges) associated with the habitat is generally the feature that makes that habitat suitable for a particular species or life stage (*e.g*., groundfish).

Nearshore unconsolidated bottom (silt, mud, gravel, or mixed)

Composed of small particles (gravel, sand, mud, silt, or mixtures of these particles), these areas contain little to no vegetation due to the lack of stable surfaces for attachment.

Nearshore hardbottom

Nearshore hardbottom is composed of bedrock, boulders, cobble, or gravel/cobble. Nearshore hardbottom is one of the least abundant benthic habitats, but one of the most important for fishes, especially rockfish (*e.g*., *Sebastes* spp.), lingcod, and sculpins. Most Washington State Pacific herring stocks spawn in intertidal and shallow sub-tidal hardbottom.

Nearshore water column

The nearshore water column, or coastal epipelagic zone, includes egg, juvenile, and larval stages of groundfish commonly associated with macrophyte canopies or drift algae. The green sturgeon (*Acipenser medirostris*) is a widely distributed sturgeon found in nearshore marine waters.

Offshore (Shelf and Slope Habitats)

Offshore biogenic habitats (corals, sponges, etc.)

Biogenic habitats include structure-forming invertebrates such as corals, basketstars, brittlestars, demosponges, gooseneck barnacles, sea anemones, sea lilies, sea urchins, sea whips, tube worms, and vase sponges.

Offshore unconsolidated bottom (silt, mud, sand, gravel, or mixed)

Unconsolidated bottom is composed of small particles (gravel, sand, mud, silt, or mixtures of these particles), which contains little to no vegetation due to the lack of stable surfaces for attachment.

Offshore hardbottom

The hardbottom is composed of bedrock, boulders, cobble, or gravel/cobble. Large, mobile, nektobenthic fishes (*e.g*., rockfish, sablefish, Pacific hake, spotted ratfish, spiny dogfish) are typically associated with this habitat.

Offshore artificial structures

Artificial structures include artificial reefs utilized by rockfish. Artificial reefs are often composed of concrete, tires, or sunken ships; these features create habitat for sea life.

Offshore water column: pelagic zone

The pelagic zone is home to the highly migratory species, other relatively large pelagics, and early life stages of groundfish inhabiting the epipelagic/mesopelagic area or that are in association with fronts, current systems, and macrophyte canopies or drift algae.

Puget Sound

Estuaries are among the most productive natural systems and important nursery areas that provide food, refuge from predation, and valuable habitat in supporting commercial and recreational fisheries including salmonids, groundfish, shellfish, and bivalves along the west coast (Emmett et al. 1991, Monaco et al. 1992). Most species utilizing this inshore habitat fall into four categories: (1) diadromous species which use estuaries as migration corridors and in some instances, nurseries; (2) species that use estuaries for spawning, often at specific salinities; (3) species that spawn offshore near the mouth of estuaries and depend on tidal- and wind-driven currents to carry eggs, larvae, or early juveniles into estuarine nursery areas; and (4) species that enter estuaries during certain times of the year to feed on abundant prey (Monaco et al. 1990).

Nearshore marine environments along Puget Sound's inland waters such as Hood Canal exhibit higher species diversity, density, and production than the deeper water marine habitats (Shaffer 2002). Nearshore vegetated habitats consisting of kelp, eelgrass, algae, and salt marsh-salt tolerant, emergent wetlands along with a rocky/cobble shoreline, provide food (infaunal and bottom-dwelling organisms) and/or shelter for several species of fish, invertebrates (mollusks and crustaceans), and seabirds (Berry and Ritter 1995, Shaffer 1998, Frankenstein 2000, Shaffer 2001, Anchor Environmental L.L.C. and People for Puget Sound 2002).

This nearshore habitat functions as a critical feeding, refuge, and migration corridor for many fish species including salmon, forage fish, and rockfish (Triangle Associates Inc. 2004). Adult fish use nearshore marine waters for migration and feeding; whereas juveniles are known to depend upon these nearshore waters for migrations, feeding, and refuge (Brennan and Higgins 2003). Adult salmon use kelp beds extensively as feeding and staging areas before heading into natal streams to spawn. Juvenile salmon require nearshore healthy wetlands as they transition from freshwater to marine water and from eelgrass/kelp beds during their outward migration once they reach marine waters (Shaffer 2003). Forage or bait fish utilize nearshore areas heavily for spawning, feeding, and migration (Meyer 1997, Bargmann 1998). Forage species, such as the surf smelt and Pacific sand lance spawn in sandy gravel on intertidal beaches; whereas Pacific herring spawn on littoral zone plants, mainly native eelgrass and red algae (Penttila 1997, Moulton 2000, Moulton and Penttila 2000, Moriarity et al. 2002a 2002b, Sikes et al. 2002). Adult and juvenile rockfish (*e.g*., brown, black, quillback, copper, yellowtail, and Puget Sound) depend on rocky reef, eelgrass and kelp beds, and drift algae for food and refuge (Love et al. 2002). Rockfish also rely on drift mats, possibly as transportation between nearshore and benthic habitats (Love et al. 2002; Shaffer 2003).

The inshore marine basins of Puget Sound support 230 species of fish representing 71 families with pelagic fishes (*e.g*., salmonids, myctophids, etc.), and fish found near or at the bottom (*e.g*., forage fish and groundfish) being the most abundant groups (DeLacy et al. 1972, Somerton and Murray 1976, Miller and Borton 1980, Garrison and Miller 1982, Buckworth 1996, Venier and Kelson 1996, Anchor Environmental L.L.C. and People for Puget Sound 2002, Brennan and Higgins 2003, Palsson et al. 2003b). Pacific salmonids are represented by nine species of salmon and/or trout (Somerton and Murray 1976). Forage or bait fish, consisting of nine small schooling fish species (*e.g*., anchovies, sand lances, herrings, sardines, and smelts), are a significant prey base for marine mammals, seabirds, and fish populations including salmonids and groundfish (Bargmann 1998). Groundfish or bottomfish are represented by 86 species dominated by flatfish (15 species), rockfish (26 species), roundfish (including greenlings, sculpins [35 species], sablefish, and cods), and skates, sharks, and chimeras (DeLacy et al. 1972, Somerton and Murray 1976, Miller and Borton 1980, Garrison and Miller 1982, Palsson et al. 1998, Palsson 2001, Palsson et al. 2003b).

3.7.1.2 Socioeconomic Value of Northwest Training Range Complex Fish

The economic values of commercial fishing, sport fishing, and recreational diving are addressed in Section 3.14.

3.7.1.3 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 United States Code [U.S.C.] §1801 et seq.), mandates identification and conservation of EFH. The MSFCMA defines EFH as those waters and substrates necessary (required to support a sustainable fishery and the managed species) to fish for spawning, breeding, feeding, or growth to maturity (i.e., full life cycle). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hard bottom, structures underlying the waters, and associated biological communities.

Federal agencies are required to consult with NMFS and to prepare an EFH Assessment describing potential adverse affects of their activities on EFH. A detailed EFH Assessment has been prepared for the NWTRC.

NMFS and the Fishery Management Council have developed Fishery Management Plans (FMPs) to manage the fishery and address fish habitat issues, specifically the principle that there will be no net loss of the productive capacity of habitats that sustain commercial, recreational, and native fisheries. Fish with designated EFH in the NWTRC are grouped into the Pacific Salmon Species, Coastal Pelagic Species, Pacific Coast Groundfish Species, and Highly Migratory Species, as listed in Table 3.7-1.

Habitat Areas of Particular Concern (HAPCs) are a subset of EFH. Fishery Management Councils are encouraged to designate HAPCs under the MSFCMA. HAPCs are identified based on habitat level considerations rather than species life stages as are identified with EFH. EFH guidelines published in federal regulations identify HAPCs as types or areas of habitat within EFH that are identified based on one or more of the following considerations:

- The importance of the ecological function provided by the habitat.
- The extent to which the habitat is sensitive to human-induced environmental degradation.
- Whether, and to what extent, development activities are or will be stressing the habitat type.
- The rarity of the habitat type (50 CFR 600.815(a)(8))

Based on these considerations, the PFMC has designated both ‘areas’ and ‘habitat types’ as HAPCs. In some cases, HAPCs identified by means of specific habitat type may overlap with the designation of a specific area. Designating HAPCs facilitates the consultation process by identifying ecologically important, sensitive, stressed, or rare habitats that should be given particular attention when considering potential nonfishing impacts. Their identification is the principal way in which the PFMC can address these impacts (PFMC 2005).

Table 3.7-1: The Fish and Invertebrate Species with EFH Designated in the Pacific Northwest OPAREA and Puget Sound Study Area.

PFMC Managed Species by Management Plan	
Pacific Salmon Species	
Chinook salmon (*Oncorhynchus tshawytscha*)	Puget Sound pink salmon (*Oncorhynchus gorbuscha*)
Coho salmon (*Oncorhynchus kisutch*)	
Coastal Pelagic Species	
Northern anchovy (*Engraulis mordax*)	Pacific mackerel (*Scomber japonicus*)
Jack mackerel (*Trachurus symmetricus*)	Market squid (*Loligo opalescens*)
Pacific sardine (*Sardinops sagax*)	
Krill	
Euphausia pacifica	*Thysanoessa spinifera*
Pacific Coast Groundfish Species	
Flatfish	
Arrowtooth flounder (*Atheresthes stomias*)	Petrale sole (*Eopsetta jordani*)
Butter sole (*Isopsetta isolepis*)	Rex sole (*Glyptocephalus zachirus*)
Curlfin sole (*Pleuronichthys decurrens*)	Rock sole (*Lepidopsetta polyxstra*)
Dover sole (*Microstomus pacificus*)	Sand sole (*Psettichthys melanostictus*)
English sole (*Parophrys vetulus*)	Starry flounder (*Platichthys stellatus*)
Flathead sole (*Hippoglossoides elassodon*)	Pacific sanddab (*Citharichthys sordidus*)
Rockfish	
Aurora rockfish (*Sebastes aurora*)	Olive rockfish (*Sebastes serranoides*)
Bank rockfish (*Sebastes rufus*)	Pacific ocean perch (*Sebastes alutus*)
Black rockfish (*Sebastes melanops*)	Pink rockfish (*Sebastes eos*)
Black-and-yellow rockfish (*Sebastes chrysomelas*)	Quillback rockfish (*Sebastes maliger*)
Blackgill rockfish (*Sebastes melanostomus*)	Redbanded rockfish (*Sebastes babcocki*)
Blue rockfish (*Sebastes mystinus*)	Redstripe rockfish (*Sebastes proriger*)
Bocaccio (*Sebastes paucispinis*)	Rosethorn rockfish (*Sebastes helvomaculatus*)
Bronzespotted rockfish (*Sebastes gilli*)	Rosy rockfish (*Sebastes rosaceus*)
Brown rockfish (*Sebastes auriculatus*)	Rougheye rockfish (*Sebastes aleutianus*)
Canary rockfish (*Sebastes pinniger*)	Sharpchin rockfish (*Sebastes zacentrus*)
Chilipepper (*Sebastes goodei*)	Shortbelly rockfish (*Sebastes jordani*)
China rockfish (*Sebastes nebulosus*)	Shortraker rockfish (*Sebastes borealis*)
Copper rockfish (*Sebastes caurinus*)	Silvergray rockfish (*Sebastes brevispinis*)
Cowcod (*Sebastes levis*)	Speckled rockfish (*Sebastes ovalis*)
Darkblotched rockfish (*Sebastes crameri*)	Splitnose rockfish (*Sebastes diploproa*)
Dusky rockfish (*Sebastes variabilis*)	Squarespot rockfish (*Sebastes hopkinsi*)
Flag rockfish (*Sebastes rubrivinctus*)	Stripetail rockfish (*Sebastes saxicola*)
Gopher rockfish (*Sebastes carnatus*)	Tiger rockfish (*Sebastes nigrocinctus*)
Grass rockfish (*Sebastes rastrelliger*)	Vermilion rockfish (*Sebastes miniatus*)
Greenblotched rockfish (*Sebastes rosenblatti*)	Widow rockfish (*Sebastes entomelas*)
Greenspotted rockfish (*Sebastes chlorostictus*)	Yelloweye rockfish (*Sebastes ruberrimus*)
Greenstriped rockfish (*Sebastes elongatus*)	Yellowmouth rockfish (*Sebastes reedi*)
Harlequin rockfish (*Sebastes variegatus*)	Yellowtail rockfish (*Sebastes flavidus*)

Table 3.7-1: The Fish and Invertebrate Species with EFH Designated in the Pacific Northwest OPAREA and Puget Sound Study Area (cont'd)

PFMC Managed Species by Management Plan	
Thornyhead	
Longspine thornyhead (*Sebastolobus altivelis*)	Shortspine thornyhead (*Sebastolobus alascanus*)
Roundfish	
Cabezon (*Scorpaenichthys marmoratus*)	Pacific cod (*Gadus macrocephalus*)
Kelp greenling (*Hexagrammos decagrammus*)	Pacific hake (*Merluccius productus*)
Lingcod (*Ophiodon elongatus*)	Sablefish (*Anoplopoma fimbria*)
Skates, Sharks, and Chimeras	
Big skate (*Raja binoculata*)	Soupfin shark (*Galeorhinus zyopterus*)
California skate (*Raja inornata*)	Spiny dogfish (*Squalus acanthias*)
Longnose skate (*Raja rhina*)	Spotted ratfish (*Hydrolagus colliei*)
Leopard Shark (*Triakis semifasciata*)	
Highly Migratory Species	
Sharks	
Common thresher shark (*Alopias vulpinus*)	Shortfin mako shark (*Isurus oxyrinchus*)
Bigeye thresher shark (*Alopias superciliosus*)	Blue shark (*Prionace glauca*)
Tunas	
Albacore tuna (*Thunnus alalunga*)	Northern bluefin tuna (*Thunnus orientalis*)
Swordfish	
Broadbill swordfish (*Xiphias gladius*)	

SOURCE: TURGEON ET AL. (1998); NELSON ET AL. (2004); MCLAUGHLIN (2005)

Pacific Coast Salmon Plan

Pacific salmon species are managed under the Pacific Coast Salmon Plan. The geographic extent of marine EFH for Pacific salmon extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the EEZ, 200 nautical miles (nm) offshore (PFMC 2000). Freshwater EFH includes all streams, lakes, ponds, wetlands, tributaries, and other water bodies currently viable and historically accessible to salmon. Pacific salmon in the NWTRC are also protected under the ESA, as discussed in Section 3.7.1.4.

Coastal Pelagic Species Fishery Management Plan

Coastal pelagic species fish are managed under the Coastal Pelagic Species FMP and include several species within six families (anchovies, jacks, herrings, mackerels, squids, and krill). All coastal pelagic species have EFH designated within the NWTRC Study Area. Coastal pelagic species with designated EFH in Puget Sound include: northern anchovy, Pacific sardine, Pacific mackerel, and market squid.

Pacific Coast Groundfish Fishery Management Plan

The Pacific Coast Groundfish FMP divides EFH into seven composite habitats including their waters, substrates, and biological communities, and includes:

- Rocky Shelf – includes waters, substrate and associated biological communities living on or within 33 ft (10 m) overlying rocky areas on the continental shelf, excluding canyons, from the high tide line to the continental shelf break;
- Non-Rocky Shelf – includes waters, substrate and associated biological communities living on or within 33 ft (10 m) overlying substrates of the continental shelf, excluding rocky shelf and canyons, from the high tide line to the continental shelf;

- Canyon – submarine canyons;
- Continental Slope/Basin – includes waters, substrate and associated biological communities living in the deepest 66 ft (20 m) of the water column over the continental slope and basin, seaward of the shelf break extending to the westward boundary of the EEZ. The shelf break occurs at an approximate depth of 656 ft (200 m);
- Neritic Zone – includes waters and biological communities living in the water column more than 33 ft (10 m) above the continental shelf; and
- Oceanic Zone – includes waters and biological communities living in the water column more than 66 ft (20 m) above the continental slope and abyssal plain, extending to the westward boundary of the EEZ (PFMC 2006).

The groundfish species, managed by the Pacific Coast Groundfish FMP range throughout the EEZ, occupy diverse habitats at all stages in their life histories. Some species are broadly dispersed during specific life stages, especially those with pelagic eggs and larvae. The distribution of other species and/or life stages may be relatively limited, as with adults of many nearshore rockfish which show strong affinities to a particular location or substrate type. Estuaries, sea grass beds, canopy kelp, rocky reefs, and other "areas of interest" (*e.g.*, seamounts, offshore banks, canyons) are designated HAPC for managed groundfish species.

The Pacific halibut (*Hippoglossus stenolepis*) is managed by the United States and Canada in a bilateral commission known as the International Pacific Halibut Commission. Each year, this Commission sets total allowable catch levels for halibut that will be caught in the U.S. and Canadian EEZs in the northeastern Pacific Ocean. The Commission refers to U.S. waters off the States of Washington, Oregon and California collectively as "Area 2A." Regulations for Area 2A are set by the Northwest Regional Office of NMFS. Halibut catch in Area 2A is divided between Tribal and non-Tribal fisheries; within non-tribal fisheries, halibut catch is further divided between commercial and recreational fisheries; within recreational fisheries, halibut catch is also divided between recreational fisheries in different states (Washington, Oregon, and California). The PFMC describes this halibut catch division each year in a catch-sharing plan.

Three species of groundfish: cowcod *(Sebastes levis)*, bocaccio *(S. paucispinis)*, and Pacific hake (also called whiting), are Species of Concern, as discussed in Section 1.7.1.4. A preliminary 2002 assessment of groundfish stocks has shown that over half of key groundfish stocks in South Puget Sound are at or below average abundance (Table 3.7-2) (Puget Sound Water Quality Action Team [PSWQAT] 2002). Some of the species that once dominated the catches of recreational and commercial fishers are now at depressed or critical abundances, resulting in historic low catches and reduced fisheries (Palsson et al. 1998). According to NMFS (2004f from Marine Resource Assessment [MRA]) and PFMC (2003b from MRA), the following groundfish within the Study Area are designated as overfished: widow rockfish (*S. entomelus*), canary rockfish (*S. pinniger*), yelloweye rockfish (S. *ruberrimus*), darkblotched rockfish (*S. crameri*), bocaccio (*S. paucispinis*), and Pacific ocean perch (*S. alutus*).

Table 3.7-2: Status of South Puget Sound Groundfish Stocks (2002).

Species	Status**
Dover sole	Depressed
English sole	Below average
Greenlings	Above average
Lingcod	Above average
Pacific cod	Critical
Pacific whiting (hake)	Critical
Pacific halibut	Above average
Rock sole	Average
Rockfishes	Depressed
Sablefish	Below average
Sand sole	Above average
Sculpins	Above average
Skates	Depressed
Spiny dogfish	Depressed
Spotted ratfish	Above average
Starry flounder	Average
Surfperches	Depressed
Walleye pollock	Critical
Wolf eel	Average
Other groundfish	Below Average

Notes: South Sound includes Hood Canal, Central Sound, Whidbey Basin, and Southern Sound (south of Tacoma Narrows).
**A comparison of the most recent 2-year average indicators was made to historical or long-term averages of the indicators. Percent changes were categorized into five measures of stock status:
• Above average (change greater than 6 percent above average),
• Average (within 5 percent of average),
• Below average (6 to35 percent less than average),
• Depressed (36 to75 percent less than average), and
• Critical (at least 76 percent less than average)
Source: PSWQAT 2002

Highly Migratory Species Fishery Management Plan

EFH for HMS includes all marine waters from the shoreline to 200 nm (370 km) offshore. The HMS FMP authorizes the Fishery Management Council to actively manage the following species in the NWTRC:

- Sharks: common thresher, bigeye thresher, shortfin mako, and blue shark;
- Tunas: albacore and northern bluefin tuna; and
- Billfish/swordfish: broadbill swordfish.

Under the FMP, the Fishery Management Council monitors other species for informational purposes, and some species including great white sharks, megamouth sharks, basking sharks, Pacific halibut, and Pacific salmon are designated as prohibited. If fishers targeting highly migratory species catch these species, they must release them immediately.

3.7.1.4 Threatened and Endangered Species and Species of Concern

A Biological Evaluation (BE) has been prepared for the NWTRC; the BE provides detailed species descriptions and analysis of potential impacts to all threatened or endangered species and critical habitats protected under the ESA.

Federally-listed species of fish are identified by Evolutionarily Significant Units (ESUs) or Distinct Population Segments (DPSs). This policy indicates that one or more naturally reproducing populations will be considered to be distinct population segments and, hence, a species under the ESA, if they represent an ESU or DPS of the biological species. To be considered an ESU, a population must satisfy two criteria: (1) It must be reproductively isolated from other population units of the same species, and (2) it must represent an important component in the evolutionary legacy of the biological species. The first criterion, reproductive isolation, need not be absolute but must have been strong enough to permit evolutionarily important differences to occur in different population units. The second criterion is met if the population contributes substantially to the ecological or genetic diversity of the species as a whole (NMFS 1999). The DPS policy adopts criteria similar to, but somewhat different from, those in the ESU policy for determining when a group of vertebrates constitutes a DPS: the group must be discrete from other populations and it must be significant to its taxon (NMFS 2006b).

Federally-listed species, critical habitat, and Species of Concern that may occur within the NWTRC are listed in Table 3.7-3. A general description of these species, their distribution and occurrence follows Table 3.7-5. The NWTRC BE contains additional information related to ESA-designated fish species.

Chinook Salmon (*Oncorhynchus tshawytscha)*

Chinook salmon are common throughout the PACNW. The California Coastal ESU, Lower Columbia River Washington/Oregon ESU, and Puget Sound ESU are threatened and have critical habitat in the NWTRC Study Area. Individual fish from these ESUs inhabit or migrate through one or more of the action areas. Juvenile Chinook salmon from the Washington coast emigrate to saltwater primarily as subyearlings and use the productive estuary and coastal areas as rearing habitat in part because of the limited size of many coastal watersheds, high summer water temperatures within natal streams, and low flow conditions that may be responsible for early emigration (Myers et al. 1998). Juvenile migration from the freshwater to marine environment occurs anywhere from April through September (Washington Department of Fisheries [WDF] 1993; Quileute Tribe Natural Resources [QTNR] 1995). Ocean-type Chinook salmon reside in estuaries for longer periods as fry and fingerlings than do yearling, stream-type Chinook salmon (Reimers 1973, Kjelson et al. 1982, Healey 1991). Marine tag recoveries for Washington coastal Chinook stocks show an oceanic migration pattern that takes them into British Columbia and Alaskan waters. Returning stocks of Chinook salmon from the Washington coast are primarily composed of 4- and 5-year old fish, with a small proportion of 6-year olds (Myers et al. 1998).

The Puget Sound ESU includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, rivers and streams flowing into Hood Canal, South Sound, North Sound, and the Strait of Georgia in Washington, as well as 26 artificial propagation programs. Critical habitat designated for the Puget Sound ESU includes all marine, estuarine, and river reaches accessible to listed Chinook salmon in Puget Sound (NMFS 2005d).

Table 3.7-3: ESA Designated Fish Species with Known or Potential Occurrence in the Northwest Training Range Study Area

Taxon Group	Scientific Name	ESA Status[a]
Chinook salmon	*Oncorhynchus tshawytscha*	T/CH[b]
Coho salmon	*Oncorhynchus kisutch*	T/CH/C[c]
Chum salmon	*Oncorhynchus keta*	T/CH[d]
Steelhead trout	*Oncorhynchus mykiss*	T/CH/C[e]
Bull trout	*Salvelinus confluentus*	T/CH[f]
Green sturgeon	*Acipenser medirostris*	T/proposed CH/ C[g]
Bocaccio	*Sebastes paucispinus*	C[h]
Pacific hake	*Merluccius productus*	C[i]
Cowcod	*Sebastes levis*	C[j]

[a] E = Endangered, T = Threatened, CH = Critical Habitat, C = Species of Concern.
[b] Chinook salmon: California Coastal, Lower Columbia River Washington/Oregon, and Puget Sound ESUs are threatened and have critical habitat in the NWTRC study area.
[c] Coho salmon: Oregon Coast, and Northern California-Southern Oregon Coasts ESUs are threatened and have critical habitat in the NWTRC Study Area. The Puget Sound/Strait of Georgia ESU is a Species of Concern in the NWTRC Study Area.
[d] Chum salmon: Hood Canal Summer-run and Columbia River ESUs are threatened and have critical habitat in the NWTRC Study Area.
[e] Steelhead trout: Puget Sound DPS is threatened in the NWTRC Study Area. Lower Columbia River and Northern California ESUs are threatened and have critical habitat in the NWTRC Study Area. The Central California Coastal ESU also has critical habitat in the study area. The Oregon Coast DPS is a Species of Concern in the NWTRC study area.
[f] Bull trout: Coastal-Puget Sound ESU is threatened and has critical habitat in the NWTRC (critical habitat units 27 and 28).
[g] Green sturgeon: Southern DPS is threatened and has proposed critical habitat in the NWTRC. The Northern DPS is a Species of Concern along the U.S. Pacific coast.
[h] Bocaccio is a Species of Concern along the California coast.
[i] Pacific hake: Georgia Basin DPS is a Species of Concern in regions of the U.S. Pacific coast.
[j] Cowcod is a Species of Concern along the Oregon and California coast.

SOURCE DON 2006, WWW.NWR.NOAA.GOV

Fisheries catch data for Puget Sound Chinook salmon show that the ocean migration range extends as far north as northern British Columbia and Alaska for some populations. Some apparently spend their entire marine life within Puget Sound, but most migrate to the open ocean and north along the Canadian coast. The majority are caught inside the Strait of Juan de Fuca, the Strait of Georgia, Puget Sound, and off the west coast of Vancouver Island. Less than 1 percent are caught off the west coasts of Washington and Oregon (NMFS 2004a).

Puget Sound adult Chinook are present in nearshore marine waters from mid-July to the end of October for summer/fall-run stocks and from mid-May to late August for spring-run stocks. The majority of populations in the Puget Sound Chinook salmon migrate to the ocean within their first year following emergence, and rear within Puget Sound marine waters for several months. Spring-run juveniles tend to reside longer in natal streams before their ocean migration, and to have different ocean migration patterns than do fall-run juveniles (NMFS 2004b). Chinook stocks in Puget Sound are classified as either early river entry or later river entry depending upon their timing into the river to spawn. Early river entry stocks enter the rivers from April to mid-August and spawn from September to October and later river entry stocks enter rivers from September to late November and spawn from October to December (WDFW 2003).

Many of the rivers in Puget Sound have well-developed estuaries that are important rearing areas for emigrating ocean-type smolts (*i.e.,* juvenile fish) (NMFS 1997). Stream-type Chinook salmon move quickly through the estuary into coastal waters and ultimately to the open ocean (Healey 1991). Very limited data is available concerning the ocean migration of stream-type Chinook salmon; they apparently move quickly offshore and into the central North Pacific, where they make up a disproportionately high percentage of the commercial catch relative to ocean-type fish (Healey 1991, Myers et al. 1987). The majority of Puget Sound Chinook salmon emigrate to the ocean as subyearlings (Myers et al. 1998).

Coho Salmon (*Oncorhynchus kisutch)*

Oregon Coast, and Northern California-Southern Oregon Coasts ESUs are threatened and have critical habitat in the NWTRC. The Puget Sound/Strait of Georgia ESU is a Species of Concern in the NWTRC. The vast majority of adult coho salmon, from central British Columbia south, are 3-year-old fish, having spent approximately 18 months in fresh water and 18 months in salt water. Coded-wire tag recovery information has shown that coho salmon released from Washington coastal hatcheries are recovered primarily in British Columbia (37 to74 percent) and Washington (18 to 53 percent), with few recoveries from Oregon (three to 16 percent) and almost none (less than one percent) from California or Alaska (Weitkamp et al. 1995). Coho adults from coastal Washington rivers return to their natal rivers to spawn from September to January, but have been observed as early as late-July and as late as mid-January (WDF et al. 1993). Approximate timing through nearshore marine waters for juvenile coho from coastal Washington is May through June. Most juvenile coho rear in the freshwater environment for up to two years before migrating to the ocean between mid-February and mid-July.

Chum Salmon (*Oncorhynchus keta)*

Chum salmon are also common throughout the PACNW. The Hood Canal Summer-run ESU and Columbia River ESU are threatened and have critical habitat in the NWTRC.

Chum salmon from rivers draining the western Olympic Peninsula display an early- and late-fall return pattern coincident with increasing fall/winter river flows. In general, river entry occurs from September through December with spawning from October (late October in Grays Harbor) to January. Spawning tends to peak in mid-November. Juvenile chum seaward migration in Washington streams takes place from late January to May (Johnson et al. 1997). Chum salmon usually spawn in coastal areas, and juveniles move to seawater almost immediately after emerging from the gravel that covers their spawning beds (Salo 1991). Chum salmon, along with ocean-type Chinook salmon, usually have longer residence times in estuaries than do other anadromous salmonids (Dorcey et al. 1978, Healey 1991).

The Hood Canal Summer-run ESU includes summer-run chum salmon populations in Hood Canal, Discovery Bay, and Sequim Bay within the Strait of Juan de Fuca region. The Hood Canal Summer-run ESU may also include summer-run chum salmon in the Dungeness River, but the existence of that run is uncertain at this time. Critical habitat was designated for the Hood Canal ESU and includes nearshore areas and various streams in Hood Canal and along the coast of northern Kitsap County (NMFS 2005d).

Puget Sound fall-run adult chum salmon are present in nearshore marine waters from August through January with the peak of migration taking place from October through November. Spawning takes place from November through January. Upon hatching, the juvenile chum salmon migrate rapidly to the ocean environment and spend anywhere from two to seven years in the ocean before returning to their natal streams to spawn and die.

Steelhead Trout (*Oncorhynchus mykiss)*

The Lower Columbia River, and Northern California ESUs and Puget Sound ESU are threatened and have critical habitat in the NWTRC. The Central California Coastal ESU also has critical habitat in the NWTRC. The Oregon Coast DPS is a Species of Concern in the NWTRC.

Steelhead trout range from southern California to the Alaskan Peninsula. Unlike salmon, steelhead may spawn more than once during their lifetime. Life history strategies can be broadly divided into two categories depending upon the season in which they return to spawn: summer-run or winter-run steelhead. Spawning stocks of summer-run and winter-run fish are present within the action area. Puget Sound summer-run fish enter fresh water between May and October and spawning occurs anywhere from December to April of the following year. Puget Sound winter-run fish enter freshwater from December through May with peak spawning occurring between March and May of the following year. Steelhead smolts can be found in the nearshore marine environment from April to June (Busby et al. 1996).

Bull Trout (*Salvelinus confluentus*)

The Coastal/Puget Sound ESU is threatened and has critical habitat in the NWTRC. Bull trout are native to waters of western North America and are found in many streams within Washington. Bull trout can exhibit a number of different life-history strategies. Stream-resident bull trout complete their entire life history in the tributary streams in which they rear and spawn. Some bull trout are migratory, spawning in tributary streams, where juvenile fish usually rear from one to four years before migrating to either a larger river or lake where they spend their adult life, returning to the tributary stream to spawn. Anadromous bull trout, which are reported to only occur in Puget Sound, rear in natal streams for a period of time, migrate to marine environments to mature, and then return to mountain tributaries to spawn. While in marine waters, anadromous bull trout primarily occupy productive estuarine and nearshore habitat. Subadults use marine habitat to forage, generally from late spring to early fall. At maturity, anadromous bull trout begin re-entering mainstream rivers in late spring and early summer to migrate to their spawning tributaries.

Green sturgeon (*Acipenser medirostris*)

The green sturgeon is an anadromous fish species that occupy freshwater rivers from the Sacramento River up through British Columbia. Two distinct populations have been defined for the green sturgeon: a northern DPS, a Species of Concern with spawning populations in the Klamath and Rogue Rivers; and a southern DPS, the threatened population spawning in the Sacramento River. Both Northern and Southern DPS green sturgeon occupy coastal estuaries and coastal marine waters from southern California to Alaska. As such, green sturgeon observed in coastal bays, estuaries, and coastal marine waters outside of natal rivers may belong to either DPS.

On September 8, 2008, NMFS issued a Proposed Rulemaking to designate critical habitat for the Southern DPS (73 Federal Register 52084). Proposed critical habitat includes coastal U.S. marine waters within 360 ft (110 m) depth from Monterey Bay, California north to Cape Flattery, Washington, including the Strait of Juan de Fuca, but excludes Puget Sound.

Green sturgeon spawning occurs in the spring in deep pools below large, turbulent river mainstreams. Individuals spawn every few years beginning about 15 years of age. Adults migrate to the north in spring (generally north of Vancouver Island, Canada). Green sturgeon congregate in coastal waters and estuaries where they are vulnerable to capture in salmon gillnet and other fisheries. They enter estuaries in Washington during summer when estuary water temperatures are warmer than adjacent coastal waters. Green sturgeon have many life history characteristics that make them vulnerable to habitat degradation and overexploitation: large size, late maturity, low productivity, long life span, and an anadromous life history.

Bocaccio (*Sebastes paucispinus*)

Bocaccio is a rockfish thought to consist of two partially isolated populations: the Southern DPS, a Species of Concern off the California coast; and a Northern population off Washington and British Columbia. Bocaccio prefer rocky habitats from 130 to 980 ft (40 to 300 m) deep, but may occur in nearly all marine habitats. Young (one to three years) bocaccio are relatively pelagic, and become more demersal with age (maximum age 45 to 50 years). Adults and large juveniles transition between midwater pelagic and benthic habitats over shelf and slope (Garrison and Miller 1982) in association with kelp beds, eelgrass beds, rocky substrate, and artificial structures (MBC 1987, Love et al. 1990, Sakuma and Ralston 1995, Yoklavich et al. 2000, Love et al. 2005).

Bocaccio school with widow, yellowtail, vermillion, and speckled rockfishes (Love et al. 2002) and occur in large aggregations under drifting kelp beds and over firm sand-mud bottoms (MBC 1987). Bocaccio are ovoviviparous (Hart 1973, Garrison and Miller 1982) with a spawning season that lasts more than 10 months (Love et al. 1990). Parturition *(i.e.,* birthing) occurs off northern and central California from November to March (MBC 1987) with the production of two or more broods (Hart 1973, Love et al. 1990) and off British Columbia and Washington from January to April (MBC 1987).

Bocaccio prey upon small fish, including other species of rockfish, hake, sablefish, northern anchovy, and lanternfish associated with kelp and squid (Sumida and Moser 1984, MBC 1987, Thomas and MacCall 2001). The primary reason for population decline is overfishing that occurred prior to the late 1990s.

Pacific hake (*Merluccius productus)*

Pacific hake or whiting range from the Gulf of California to the Gulf of Alaska (Hart 1973). The offshore stock of Pacific hake is migratory and inhabits the continental slope and shelf within the California current system from Baja California to British Columbia (Quirollo 1992). There are three smaller inshore stocks with much smaller ranges: a Puget Sound stock, a Strait of Georgia stock, and a dwarf stock limited to waters off Baja California (Bailey et al. 1982, Stauffer 1985). In the Strait of Georgia and Puget Sound, Pacific hake are the most abundant resident fish. Inshore stocks spawn in locations near major sources of freshwater inflow and spend their entire lives in these estuaries (McFarlane and Beamish 1985, 1986, Pedersen 1985, Shaw et al. 1990). Pelagic eggs of Puget Sound Pacific hake are found at depths of 164 to 246 ft (50 to 75 m) (Bailey 1982, Moser et al. 1997). Juveniles reside in shallow coastal waters, bays, and estuaries (Bailey 1981, Bailey et al. 1982) and move to deeper water as they get older (NOAA 1990).

Pacific hake biomass in U.S. coastal waters increased to a historical high in 1987, declined for several years after, stabilized briefly between 1995 and 1997, but then declined continuously to its lowest point in 2001 (Helser et al. 2004). Since 2001, stock biomass has increased substantially and rebuilt to the target level of abundance.

Cowcod (*Sebastes levis)*

Cowcod range from Ranger Bank and Guadalupe Island, Baja California to Mendocino County, California and may infrequently occur as far north as Newport, Oregon (Love et al. 2002), but their preferred habitat is located in the Southern California Bight (Barnes 2001). Cowcod can be found between midwater pelagic and benthic habitats in water depths between 130 and 1,600 ft (40 and 490 m) (Love et al. 2005). Adults are common at depths of 235 to 1,600 ft (72 to 490 m) (Orr et al. 1998, 2000) over high-relief rocky areas, in association with large white sea anemones (Casillas et al. 1998), submarine canyons, under ledges, and in crevices of isolated rock outcrops surrounded by mud (Yoklavich et al. 2000). Juveniles occur in waters 130 to 330 ft (40 to 100 m) over sandy and clay (low-relief) bottoms and near oil platforms (Love et al. 2002, Butler et al. 2003, Love et al. 2005). Larvae are almost exclusively found in southern California adjacent to the northern Channel Islands at depths less than 650 ft (200 m) (MacGregor 1983, Moser et al. 2000), but may occur 200 miles (320 kilometers) offshore over the continental shelf from northern California to northern Baja California (Love et al. 2002).

Cowcod are not migratory but may move to some extent to follow food (McCain 2003). They are generally solitary, but occasionally aggregate (Love et al. 1990). Cowcod are ovoviviparous with large females producing up to three broods per season (Love et al. 1990). In central and northern California, a single brood is produced from December to February peaking in December (Love et al. 2002). Cowcod prey upon fish, octopus, and squid (McCain 2003).

3.7.1.5 Hearing in Fish

All fish have two sensory systems that are used to detect sound in the water including the inner ear, which functions very much like the inner ear found in other vertebrates, and the lateral line, which consists of a series of receptors along the body of the fish (Popper 2008). The inner ear generally detects higher frequency sounds while the lateral line detects water motion at low frequencies (below a few hundred Hz) (Hastings and Popper 2005). A sound source produces both a pressure wave and motion of the medium particles (water molecules in this case), both of which may be important to fish. Fish detect particle motion with the inner ear. Pressure signals are initially detected by the gas-filled swim bladder or other air pockets in the body, which then re-radiate the signal to the inner ear (Popper 2008). Because particle motion attenuates relatively quickly, the pressure component of sound usually dominates as distance from the source increases.

The lateral line system of a fish allows for sensitivity to sound (Hastings and Popper 2005). This system is a series of receptors along the body of the fish that detects water motion relative to the fish that arise from sources within a few body lengths of the animal. The sensitivity of the lateral line system is generally from below 1 Hz to a few hundred Hz (Coombs and Montgomery 1999, Webb et al. 2008). The only study on the effect of exposure to sound on the lateral line system (conducted on one freshwater species) suggests no effect on these sensory cells by intense pure tone signals (Hastings et al. 1996). While studies on the effect of sound on the lateral line are limited, Hasting et al.'s (1996) work, showing limited sensitivity to within a few body lengths and to sounds below a few hundred Hz, make the effect of the mid-frequency sonar of the Proposed Action unlikely to affect a fish's lateral line system. Therefore, further discussion of the lateral line in this analysis in unwarranted.

Broadly, fishes can be categorized as either hearing specialists or hearing generalists (Scholik and Yan 2002). Fishes in the hearing specialist category have a broad frequency range with a low auditory threshold due to a mechanical connection between an air filled cavity, such as a swimbladder, and the inner ear. Specialists detect both the particle motion and pressure components of sound and can hear at levels above 1 kHz. Generalists are limited to detection of the particle motion component of low-frequency sounds at relatively high sound intensities (Amoser and Ladich 2005). It is possible that a species will exhibit characteristics of generalists and specialists and will sometimes be referred to as an "intermediate" hearing specialist. For example, most damselfish are typically categorized as generalists, but because some larger damselfish have demonstrated the ability to hear higher frequencies expected of specialists, they are sometimes categorized as intermediate.

Of the fish species with distributions overlapping the NWTRC Study Area for which hearing sensitivities are known, most are hearing generalists.

Although hearing capability data only exists for fewer than 100 of the 29,000 fish species (Popper 2008), current data suggest that most species of fish detect sounds from 0.05 to 1.0 kHz, with few fish hearing sounds above 4 kHz (Popper 2008, NRC 2003). Moreover, studies indicate that hearing specializations in marine species are quite rare and that most marine fish are considered hearing generalists (Popper 2003, Amoser and Ladich 2005). Specifically, the following species are all believed to be hearing generalists: elasmobranchs (i.e., sharks and rays) (Casper et al. 2003, Casper and Mann 2006, Myrberg 2001), scorpaeniforms (i.e., scorpionfishes, searobins, sculpins) (Lovell et al. 2005), scombrids (i.e., albacores, bonitos, mackerels, tunas) (Iversen 1967, Iversen 1969, Popper 1981, Song et al. 2006), damselfishes (Egner and Mann 2005, Kenyon 1996, Wright et al. 2005, Wright et al. 2007), and more specifically, midshipman fish (*Porichthys notatus*) (Sisneros and Bass 2003), Atlantic salmon (*Salmo salar*) (Hawkins and Johnstone 1978), and Gulf toadfish (*Opsanus beta*) (Remage-Healey et al. 2006). Moreover, it is believed that the majority of marine fish have their best hearing sensitivity at or below 0.3 kHz (Popper 2003). However, it has been demonstrated that marine hearing specialists, such as some Clupeidae, can detect sounds above 100 kHz. A list of fish hearing sensitivities is presented in Table 3.7-4.

In contrast to marine fish, several thousand freshwater species are thought to be hearing specialists. Nelson (1994) estimates that 6,600 of 10,000 freshwater species are otophysans (catfish and minnows), which are hearing specialists. Interestingly, many generalist freshwater species, such as perciforms (percids, gobiids) and scorpaeniforms (sculpins) are thought to have derived from marine habitats (Amoser and Ladich 2005). It is also thought that Clupeidae may have evolved from freshwater habitats (Popper et al. 2004). This supports the theory that hearing specializations likely evolved in quiet habitats common to freshwater and the deep sea because only in such habitats can hearing specialists use their excellent hearing abilities (Amoser and Ladich 2005).

Some investigators (e.g., Amoser and Ladich 2005) hypothesize that, within a family of fish, different species can live under different ambient noise conditions, which requires them to adapt their hearing abilities. Under this scenario, a species' probability of survival would be greater if it increased the range over which the acoustic environment, consisting of various biotic (sounds from other aquatic animals) and abiotic (wind, waves, precipitation) sources, could be detected. For the marine environment, Amoser and Ladich (2005) cite the differences in the hearing ability of two species of Holocentridae as a possible example of such environmentally-derived specialization. Both the shoulderbar soldierfish (*Myripristis kuntee*) and the Hawaiian squirrelfish (*Adioryx xantherythrus*) can detect sounds at 0.1 kHz. However, the high-frequency end of the auditory range extends towards 3 kHz for the shoulderbar soldierfish but only to 0.8 kHz for the Hawaiian squirrelfish (Coombs and Popper 1979). Though these two species live in close proximity on the same reefs, it is not certain that differing environmental conditions cause the hearing variations (Popper 2008). Generally, a clear correlation between hearing capability and the environment cannot be asserted or refuted due to limited knowledge of ambient noise levels in marine habitats and a lack of comparative studies.

Susceptibility to the effects of anthropogenic sounds has been shown to be influenced by developmental and genetic differences in the same species of fish. In an exposure experiment, Popper et al. (2007) found that experimental groups of rainbow trout had substantial differences in hearing thresholds. While fish were attained from the same supplier, it is possible different husbandry techniques may be the reason for the differences in hearing sensitivity. These results emphasize that caution should be used in extrapolating data beyond their intent.

Among all fishes studied to date, perhaps the greatest variability is found within the family Sciaenidae (i.e., drumfish, weakfish, croaker), where there is extensive diversity in inner ear structure and the relationship between the swim bladder and the inner ear. Specifically, the Atlantic croaker's (*Micropogonias undulatus*) swim bladder has forwardly directed diverticulae that come near the ear but do not actually touch it. However, the swim bladders in the spot (*Leiostomus xanthurus*) and black drum (*Pogonias cromis*) are further from the ear and lack anterior horns or diverticulae. These differences are associated with variation in both sound production and hearing capabilities (Ladich and Popper 2004, Ramcharitar et al. 2006). Ramcharitar and Popper (2004) discovered that the black drum responded to sounds from 0.1 to 0.8 kHz and was most sensitive between 0.1 and 0.5 kHz, while the Atlantic croaker responded to sounds from 0.1 to 1 kHz and was most sensitive at 0.3 kHz. Additional sciaenid research by Ramcharitar et al. (2006) investigated the hearing sensitivity of weakfish (*Cynoscion regalis*) and spot. Weakfish were found to detect frequencies up to 2 kHz, while spot detected frequencies only up to 0.7 kHz.

Table 3.7-4: Marine Fish Hearing Sensitivities

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification
				Low	High		
Albulidae	Bonefishes	Bonefish	*Albula vulpes*	0.1	0.7	0.3	generalist
Anguillidae	Eels	European eel	*Anguilla anguilla*	0.01	0.3	0.04-0.1	generalist
Ariidae	Catfish	Hardhead sea catfish	*Ariopsis felis*	0.05	1	0.1	generalist
Batrachoididae	Toadfishes	Midshipman	*Porichthys notatus*	.065	0.385		generalist
		Gulf toadfish	*Opsanus beta*			<1	generalist
Clupeidae	Herrings, shads, menhadens, sardines	Alewife	*Alosa pseudoharengus*		0.12		specialist
		Blueback herring	*Alosa aestivalis*		0.12		specialist
		American shad	*Alosa sapidissima*	0.1	0.18	0.2-0.8 and 0.025-0.15	specialist
		Gulf menhaden	*Brevoortia patronus*		0.1		specialist
		Bay anchovy	*Anchoa mitchilli*		4		specialist
		Scaled sardine	*Harengula jaguana*		4		specialist
		Spanish sardine	*Sardinella aurita*		4		specialist
		Pacific herring	*Clupea pallasii*	0.1	5		specialist
Chondrichthyes [Class]	Cartilaginous fishes, rays, sharks, skates			0.2	1		generalist
Gadidae	Cods, gadiforms, grenadiers, hakes	Cod	*Gadus morhua*	0.002	0.5	0.02	generalist
Gobidae	Gobies	Black goby	*Gobius niger*	0.1	0.8		generalist
Holocentridae	Squirrelfish and soldierfish	Shoulderbar soldierfish	*Myripristis kuntee*	0.1	3.0	0.4-0.5	specialist
		Hawaiian squirrelfish	*Adioryx xantherythrus*	0.1	0.8		generalist
Labridae	Wrasses	Tautog	*Tautoga onitis*	0.01	0.5	0.037-0.050	generalist
		Blue-head wrasse	*Thalassoma bifasciatum*	0.1	1.3	0.3-0.6	generalist
Lutjanidae	Snappers	Schoolmaster snapper	*Lutjanus apodus*	0.1	1.0	0.3	generalist
Myctophidae	Lanternfishes	Warming's lanternfish	*Ceratoscopelus warmingii*				specialist
Pleuronectidae	Flatfish	Dab	*Limanda limanda*	0.03	0.27	0.1	generalist
		European plaice	*Pleuronectes platessa*	0.03	0.2	0.11	generalist

Table 3.7-4: Marine Fish Hearing Sensitivities (cont'd)

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification
				Low	High		
Pomadasyidae	Grunts	Blue striped grunts	*Haemulon sciurus*	0.1	1.0		generalist
Pomacentridae	Damselfish	Sergeant major damselfish	*Abudefduf saxatilis*	0.1	1.6	0.1-0.4	generalist/ intermediate
		Bicolor damselfish	*Stegastes partitus*	0.1	1.0	0.5	generalist/ intermediate
		Nagasaki damselfish	*Pomacentrus nagasakiensis*	0.1	2.0	<0.3	generalist/ intermediate
Salmonidae	Salmons	Atlantic salmon	*Salmo salar*	<0.1	0.58		generalist
Sciaenidae	Drums, weakfish, croakers	Atlantic croaker	*Micropogonias undulatus*	0.1	1.0	0.3	generalist
		Spotted sea trout	*Cynoscion nebulosus*				generalist
		Kingfish	*Menticirrhus americanus*				generalist
		Spot	*Leiostomus xanthurus*	0.2	0.7	0.4	generalist
		Black drum	*Pogonias cromis*	0.1	0.8	0.1-0.5	generalist
		Weakfish	*Cynoscion regalis*	0.2	2.0	0.5	specialist
		Silver perch	*Bairdiella chrysoura*	0.1	4.0	0.6-0.8	specialist
Scombridae	Albacores, bonitos, mackerels, tunas	Bluefin tuna	*Thunnus thynnus*		1.0		generalist
		Yellowfin tuna	*Thunnus albacares*	0.5	1.1		generalist
		Kawakawa	*Euthynnus affinis*	0.1	1.1	0.5	generalist
		Skipjack tuna	*Katsuwonus pelamis*				generalist
Scorpaenidae	Scorpionfishes, searobins, sculpins	Sea scorpion	*Taurulus bubalis*				generalist
Serranidae	Seabasses, groupers	Red hind	*Epinephelus guttatus*	0.1	1.1	0.2	generalist
Sparidae	Porgies	Pinfish	*Lagodon rhomboides*	0.1	1.0	0.3	generalist
Triglidae	Scorpionfish, searobins, sculpins	Leopard searobin	*Prionotus scitulus*	0.1	0.8	0.39	generalist

Sources: Astrup 1999; Astrup and Mohl 1993; Casper and Mann 2006; Casper et al. 2003; Coombs and Popper 1979; Dunning et al. 1992; Egner and Mann 2005; Gregory and Clabburn 2003; Hawkins and Johnstone 1978; Higgs et al. 2004; Iversen 1967, 1969; Jorgensen et al. 2005; Kenyon 1996; Lovell et al. 2005; Mann et al. 1997, 2001, 2005; Myrberg 2001; Nestler et al. 2002; Popper 1981; Popper and Carlson 1998; Popper and Tavolga 1981; Ramcharitar and Popper 2004; Ramcharitar et al. 2001, 2004, 2006, Remage-Healey et al. 2006; Ross et al. 1996; Sisneros and Bass 2003; Song et al. 2006; Wright et al. 2005, 2007; Popper 2008

The sciaenid with the greatest hearing sensitivity discovered thus far is the silver perch (*Bairdiella chrysoura*), which has demonstrated auditory thresholds similar to goldfish, responding to sounds up to 4 kHz (Ramcharitar et al. 2004). Silver perch swim bladders have anterior horns that terminate close to the ear. The Ramcharitar et al. (2004) research supports the suggestion that the swim bladder can potentially expand the frequency range of sound detection. Furthermore, Sprague and Luczkovich (2004) calculated silver perch are capable of producing drumming sounds ranging from 128 to 135 dB. Since drumming sounds are produced by males during courtship, it can be inferred that silver perch detect sounds within this range.

The most widely noted hearing specialists are otophysans (*i.e.,* members of the super order Ostariophysi), which have bony Weberian ossicles (bones that connect the swim bladder to the ear), along which vibrations are transmitted from the swim bladder to the inner ear (Amoser and Ladich 2003). However, only a few otophysans inhabit marine waters. In an investigation of a marine otophysan, the hardhead sea catfish (*Ariopsis felis*), Popper and Tavolga (1981) determined that this species was able to detect sounds from 0.05 to 1 kHz, which is considered a much lower and narrower frequency range than that common to freshwater otophysans (i.e., above 3 kHz) (Ladich and Bass 2003). The difference in hearing capabilities in the respective freshwater and marine catfish appears to be related to the inner ear structure (Popper and Tavolga 1981).

Experiments on marine fish have obtained responses to frequencies up to the range of ultrasound; that is, sounds between 40 to 180 kHz (University of South Florida 2007). These responses were from several species of the Clupeidae (i.e., herrings, shads, and menhadens) (Astrup 1999); however, not all clupeid species tested have responded to ultrasound. Astrup (1999) and Mann et al. (1998) hypothesized that these ultrasound detecting species may have developed such high sensitivities to avoid predation by odontocetes (*i.e.,* members of the sub-order of cetaceans that have teeth). Studies conducted on the following species showed avoidance to sound at frequencies over 100 kHz: alewife (*Alosa pseudoharengus*) (Dunning et al. 1992, Ross et al. 1996), blueback herring (*A. aestivalis*) (Nestler et al. 2002), Gulf menhaden (*Brevoortia patronus*) (Mann et al. 2001) and American shad (*A. sapidissima*) (Popper and Carlson 1998). The highest frequency to solicit a response in any marine fish was 180 kHz for the American shad (Gregory and Clabburn 2003, Higgs et al. 2004). The *Alosa* species have relatively low thresholds (about 145 dB re 1 µPa), which should enable the fish to detect odontocete clicks at distances up to about 200 m (656 ft) (Mann et al. 1997). For example, echolocation clicks ranging from 200 to 220 dB could be detected by shad with a hearing threshold of 170 dB at distances from 25 to 180 m (82 to 591 ft) (University of South Florida 2007). In contrast, the Clupeidae bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), and Spanish sardine (*Sardinella aurita*) did not respond to frequencies over 4 kHz (Gregory and Clabburn 2003, Mann et al. 2001).

Wilson and Dill (2002) demonstrated that there was a behavioral response seen in Pacific herring (*Clupea pallasii*) to energy levels associated with frequencies from 1.3 to 140 kHz, although it was not clear whether the herring were responding to the lower frequency components of the experiment or to the ultrasound. However, Mann et al. (2005) advised that acoustic signals used in the Wilson and Dill (2002) study were broadband and contained energy of less than 4 kHz to ultrasonic frequencies. Mann et al. (2005) found that Pacific herring could not detect ultrasonic signals at received levels up to 185 dB re 1 µPa. Pacific herring had hearing thresholds (0.1 to 5 kHz) that are typical of Clupeidae that do not detect ultrasound signals.

Species that can detect ultrasound do not perceive sound equally well at all detectable frequencies. Mann et al. (1998) reported that the American shad can detect sounds from 0.1 to 180 kHz with two regions of best sensitivity: one from 0.2 to 0.8 kHz, and the other from 25 to 150 kHz. The poorest sensitivity was found from 3.2 to 12.5 kHz.

Although few non-clupeid species have been tested for ultrasound (Mann et al. 2001), the only other non-clupeid species shown to possibly be able to detect ultrasound is the cod (*Gadus morhua*) (Astrup and Mohl 1993). However, in Astrup and Moh's (1993) study it is feasible that the cod was detecting the stimulus using touch receptors that were over driven by very intense fish-finding sonar emissions (Astrup 1999, Ladich and Popper 2004). Nevertheless, Astrup and Mohl (1993) indicated that cod have ultrasound thresholds of up to 38 kHz at 185 to 200 dB re 1 µPa, which likely only allows for detection of odontocete's clicks at distances no greater than 10 to 30 m (33 to 98 ft) (Astrup 1999).

As mentioned above, investigations into the hearing ability of marine fishes have most often yielded results exhibiting poor hearing sensitivity. Experiments on elasmobranch fish (i.e., sharks and rays) have demonstrated poor hearing abilities and frequency sensitivity from 0.02 to 1 kHz, with best sensitivity at lower ranges (Casper et al. 2003, Casper and Mann 2006, Myrberg 2001). Though only five elasmobranch species have been tested for hearing thresholds, it is believed that all elasmobranchs will only detect low-frequency sounds because they lack a swim bladder, which resonates sound to the inner ear. Theoretically, fishes without an air-filled cavity are limited to detecting particle motion and not pressure and, therefore have poor hearing abilities (Casper and Mann 2006).

By examining the morphology of the inner ear of bluefin tuna (*Thunnus thynnus*), Song et al. (2006) hypothesized that bluefin tuna probably do not detect sounds to much over 1 kHz (if that high). This research concurred with the few other studies conducted on tuna species. Iversen (1967) found that yellowfin tuna (T. al*bacares*) can detect sounds from 0.05 to 1.1 kHz, with best sensitivity of 89 dB (re 1 µPa) at 0.5 kHz. Kawakawa (*Euthynnus affinus*) appear to be able to detect sounds from 0.1 to 1.1 kHz but with best sensitivity of 107 dB (re 1 µPa) at 0.5 kHz (Iversen 1969). Additionally, Popper (1981) looked at the inner ear structure of a skipjack tuna (*Katsuwonus pelamis*) and found it to be typical of a hearing generalist. While only a few species of tuna have been studied, and in a number of fish groups both generalists and specialists exist, it is reasonable to suggest that unless bluefin tuna are exposed to very high intensity sounds from which they cannot swim away, short- and long-term effects may be minimal or nonexistent (Song et al. 2006).

Some damselfish have been shown to be able to hear frequencies of up to 2 kHz, with best sensitivity well below 1 kHz. Egner and Mann (2005) found that juvenile sergeant major damselfish (*Abudefduf saxatilis*) were most sensitive to lower frequencies (0.1 to 0.4 kHz); however, larger fish (greater than 50 millimeters) responded to sounds up to 1.6 kHz. Still, the sergeant major damselfish is considered to have poor sensitivity in comparison even to other hearing generalists (Egner and Mann 2005). Kenyon (1996) studied another marine generalist, the bicolor damselfish (*Stegastes partitus*), and found the bicolor damselfish responded to sounds up to 1.6 kHz with the most sensitive frequency at 0.5 kHz. Further, larval and juvenile Nagasaki damselfish (*Pomacentrus nagasakiensis*) have been found to hear at frequencies between 0.1 and 2 kHz, however, they are most sensitive to frequencies less than 0.3 kHz (Wright et al. 2005, Wright et al. 2007). Thus, damselfish appear to be primarily generalists with some ability to hear slightly higher frequencies expected of specialists (Popper 2008).

Female midshipman fish apparently use the auditory sense to detect and locate vocalizing males during the breeding season. Interestingly, female midshipman fish go through a shift in hearing sensitivity depending on their reproductive status. Reproductive females showed temporal encoding up to 0.34 kHz, while nonreproductive females showed comparable encoding only up to 0.1 kHz (Sisneros and Bass 2003).

The hearing capability of Atlantic salmon (*Samo salar*), a hearing generalist, indicates a rather low sensitivity to sound (Hawkins and Johnstone 1978). Laboratory experiments yielded responses only to 0.58 kHz and only at high sound levels. Salmon's poor hearing is likely due to the lack of a link between the swim bladder and inner ear (Jorgensen et al. 2004).

Furthermore, investigations into the inner ear structure of fishes belonging to the order Scorpaeniformes have suggested that these fishes have generalist hearing abilities (Lovell et al. 2005). Although an audiogram (which provides a measure of hearing sensitivity) has yet to be performed, the lack of a swimbladder is indicative of these species having poor hearing ability (Lovell et al. 2005). However, studies of the leopard robin (*Prionotus scitulus*), another species in this order that do contain swim bladders, indicated that they are hearing generalists as well (Tavolga and Wodinski 1963) which makes extrapolation on hearing from this species to all members of the group very difficult to do (Popper 2008).

3.7.1.6 Current Requirements and Practices

Mitigation measures for activities involving underwater detonations, implemented for marine mammals and sea turtles, also offer protections to habitats associated with fish communities. Mitigation is discussed in more detail in Chapter 5. General conservation measures that help minimize impacts to fish include reducing explosive charge size during juvenile salmonid migration season.

3.7.2 Environmental Consequences

This section describes potential environmental effects on fish associated with conducting naval activities for three alternative scenarios in the NWTRC. The activities include active sonar activities; surface vessel, submarine, and aircraft warfare training activities; weapons firing and non-explosives ordnance use; electronic combat; discharges of expendable materials; and mine countermeasure training. These activities are configured in various combinations to define eight warfare areas, as previously described in Section 3.

This section distinguishes between United States territorial waters (shoreline to 12 nm) and non-territorial waters, (seaward of 12 nm) for the purposes of applying the appropriate regulations (National Environmental Policy Act [NEPA] or Executive Order [EO] 12114) to analyze potential environmental effects.

The effects on fish could include direct physical injury, such as potential for death, injury, or failure to reach (or an increase in the time needed to reach) the next developmental stage. Potential effects of fish eggs, larvae, and adult fish were evaluated in the analysis and results presented in the following subsections.

3.7.2.1 Approach to Analysis

In this section, the approach to the assessment of effects on fish is presented, as well as a review of the literature regarding potential effects on fish common to most activities. These include: warfare areas and environmental stressors; acoustic effects of underwater sounds to fish; effects of underwater impulsive sounds; non-explosive ordnance; and expended materials.

Effects on fish and the distances at which behavioral effects can occur depend on the nature of the sound, the hearing ability of the fish, and species-specific behavioral responses to sound. Changes in fish behavior can, at times, reduce their catchability and thus affect fisheries.

Regulatory Framework

The primary laws that make up the regulatory framework for fish and EFH include the MSFCMA and the ESA. These, along with other applicable laws, are briefly described below:

Magnuson-Stevens Fishery Conservation and Management Act

The MSFCMA (Public Law 94-265) (previously the Fishery Conservation and Management Act), established a 200 nm fishery conservation zone in U.S. waters and a network of regional FMC to describe and identify EFH for all species that are federally managed. "EFH" is defined as those waters and the substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The FMCs are comprised of federal and state officials, including the USFWS, which oversee fishing activities within the fishery management zone. In 1977, exclusive federal management authority over U.S. domestic fisheries resources was vested in the NMFS. The MSFCMA requires federal agencies to consult with NMFS on activities that may adversely affect EFH. The MSFCMA defines an adverse effect as "any impact which reduces quality and/or quantity of EFH [and] may include direct (*e.g.,* contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 CFR 600.810).

The PFMC manages the fisheries for Groundfish, CPS, and Pacific Salmon through the associated Fisheries Management Plans and has defined EFH for these three groups. All waters that support anadromous fish are considered EFH by NMFS (PFMC 2006c).

EFH located within the Study Area includes: estuarine, rocky shelf, non-rocky shelf, canyon, continental shelf/basin, neritic and oceanic habitats. For the purpose of this analysis, potential effects were considered to determine adverse impacts to EFH. An EFH Assessment has been prepared for the NWTRC.

Sustainable Fisheries Act

In 1996 (later amended in 2002 and 2006), the MSFCMA was reauthorized and amended by the Sustainable Fisheries Act (SFA). The SFA provides a new habitat conservation tool in the form of the EFH mandate. The EFH mandate requires that the regional FMCs, through federal FMP, describe and identify EFH for each federally managed species, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitats. Authority to implement the SFA is given to the Secretary of Commerce through the NMFS. The SFA requires that the EFH be identified and described for each federally managed species. The SFA requires federal agencies to consult with the NMFS on activities that may adversely affect EFH. For actions that affect a threatened or endangered species, its critical habitat, and its EFH, federal agencies must initiate ESA and EFH consultations.

Endangered Species Act

The ESA (16 USC §§ 1531 to 1543) established protection over and conservation of threatened and endangered species. The ESA applies to federal actions in two separate respects: the ESA requires that federal agencies, in consultation with the responsible wildlife agency, ensure that Proposed Actions are not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of a critical habitat. Regulations implementing the ESA expand the consultation requirement to include those actions that "may affect" a listed species or adversely modify critical habitat.

If an agency's Proposed Action would take a listed species, the agency must obtain an incidental take statement from the responsible wildlife agency. The ESA defines the term "take" to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt any such conduct." A BE has been prepared for the NWTRC; the BE provides detailed species descriptions and analysis of potential impacts to all threatened or endangered species and critical habitats protected under the ESA with known or potential occurrence in the NWTRC Study Area.

Executive Order 12114

EO 12114 directs federal agencies to provide for informed decision making for major federal actions outside the United States, including the global commons, the environment of a non participating foreign nation, or impacts on protected global resources. An OEIS is required when an action has the potential to significantly harm the environment of the global commons. "Global commons" are defined as "geographical areas that are outside of the jurisdiction of any nation, and include the oceans outside territorial limits (outside 12 nm from the coast) and Antarctica. Global commons do not include contiguous zones and fisheries zones of foreign nations" (32 CFR 187.3).

Unlike NEPA, EO 12114 does not require a scoping process. However, the EIS and OEIS have been combined into one document, as permitted under NEPA and EO 12114, in order to reduce duplication. Therefore, the scoping requirements found in NEPA were implemented with respect to actions occurring seaward of U.S. territorial waters, and discussions regarding scoping requirements will reference the combined NWTRC EIS/OEIS.

Executive Order 12962

EO 12962 on Recreational Fisheries (60 Federal Register 30769) was enacted in 1995 to ensure that federal agencies strive to improve the "quantity, function, sustainable productivity, and distribution of U.S. aquatic resources" so that recreational fishing opportunities nationwide can increase. The primary goal of this order is to promote the conservation, restoration, and enhancement of aquatic systems and fish populations by increasing fishing access, education and outreach, and multi-agency partnerships. The National Recreational Fisheries Coordination Council, co-chaired by the Secretaries of the Interior and Commerce, is charged with overseeing federal actions and programs that are mandated by this order.

Northern Pacific Halibut Act

The Northern Pacific Halibut Act of 1982 (16 USC §§ 773-773k) calls for the U.S. and Canada to implement the 1979 Protocol for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and the Bering Sea. The Act provides for the appointment of U.S. Commissioners to the International Pacific Halibut Commission. In addition, the Act authorizes the PFMC to develop regulations to limit access and govern the Pacific halibut catch in waters off Washington, Oregon, and California. All Council action must be approved and implemented by the U.S. Secretary of Commerce.

National Fishery Enhancement Act

In 1984, Congress passed the National Fishery Enhancement Act (NFEA) (33 USC §§ 2101 et seq.) in recognition of the social and economic value of artificial reefs in enhancing fishery resources. Under this act, the Secretary of Commerce and the U.S. Army Corps of Engineers are charged with the responsibility for encouraging and regulating artificial reefs in the navigable waters of the U.S. One of the primary directives of the NFEA was the preparation of a long-term National Artificial Reef Plan (33 USC §§ 2103).

Pacific Salmon Treaty

The Pacific Salmon Treaty (PST) of 1985 (16 USC §§ 3631 et seq.) was established between Canada and the U.S. to establish a framework for managing salmon populations between the two countries. The Treaty principles were to (a) prevent overfishing and provide for optimum production; and (b) provide equivalent production benefits from salmon originating from the respective country's waters. The Treaty requires the U.S. and Canada to meet international conservation and allocation objectives by taking into account ways of reducing interceptions and avoiding disruption of existing fisheries and stock abundances.

This Treaty also called for the establishment of the Pacific Salmon Commission (PSC), to oversee the implementation of the Treaty. The PSC is comprised of representatives of both countries to provide regulatory and technical advice. Fisheries regulation is a shared responsibility of the U.S. and Canada.

On June 30, 1999, the following PST provisions were implemented: (a) establish abundance-based fishing regimes for Pacific salmon fisheries under the jurisdiction of the PSC; (b) create two bilaterally-based funds to promote cooperation, improve fishery management, and aid stock and habitat enhancement.

Additionally, the PST includes provisions to enhance bilateral cooperation, improve the scientific basis for salmon management, and apply institutional changes to the PSC.

Washington State Laws

Washington Administrative Code 232-12-297 is the primary law for the protection and management of endangered species in Washington State. It aims to identify and classify native wildlife species that are in need of protection and/or management and to define the process by which listing, management, recovery, and delisting of those species can be achieved. This law was established to ensure that consistent procedures and criteria are followed when classifying wildlife as endangered, threatened, or sensitive. In many ways, this law mirrors the federal ESA.

Revised Code of Washington 77.110.030 is Washington State's policy for the management of natural resources. It declares that conservation, enhancement, and proper utilization of the State's natural resources, including but not limited to lands, waters, timber, fish, and game, are responsibilities of the State of Washington and shall remain within the express domain of the State of Washington.

The Wild Salmonid Policy was developed in response to the depressed status of wild salmonid populations in Washington. The purpose is to protect, restore, and enhance the productivity, production, and diversity of wild salmonids and their ecosystems to sustain ceremonial, subsistence, commercial, and recreational fisheries; non-consumptive fish benefits; and other related cultural and ecological values.

Oregon State Laws

The Oregon Ocean Resources Management Act of 1991 designated the Oregon Department of Land Conservation and Development as the lead agency for ocean planning and created the Oregon Ocean Resources Management Program to ensure the conservation and development of Oregon's ocean resources.

California State Laws

The California Endangered Species Act of 1970, amended in 1984, is part of the California Fish and Game Code and is administered by the California Department of Fish and Game. The provisions generally parallel those in the federal ESA although, unlike its federal counterpart, the California Endangered Species Act also applies take prohibitions to state candidate species petitioned for listing.

The California Coastal Act of 1976 created a unique partnership between the state's coastal management agency, the California Coastal Commission, and local governments (the state's 15 coastal counties and 58 coastal cities) to manage the conservation and development of coastal resources through a comprehensive planning and regulatory program.

Study Area

The Study Area for fish and EFH includes the marine environments of the NWTRC.

Data Sources

A comprehensive and systematic review of relevant literature and data has been conducted in order to complete this analysis for fish and EFH. Of the available scientific literature (both published and unpublished), the following types of documents were utilized in the assessment: journals, books, periodicals, bulletins, Department of Defense operations reports, EISs, and other technical reports published by government agencies, private businesses, consulting firms, or non-governmental conservation organizations. The scientific literature was also consulted during the search for geographic location data on the occurrence of resources within the Study Area. The primary sources of information used to describe the affected environment for fish and EFH were in the U.S. Pacific Fleet MRA for the

Pacific Northwest Operating Area (DoN 2006), and the Biological Assessment of U.S. Navy Explosive Ordnance Disposal Operations, Puget Sound, Washington (DoN 2000). The MRA report provides compilations of the most recent data and information on the occurrence of marine resources in the Study Area.

3.7.2.2 Assessment Methods

The following methods were used to assess potential effects of noise on fish. Received noise levels that correspond to the various types of effects on fish were evaluated. Effects include physical damage to fish, short-term behavioral reactions, and long-term behavioral reactions.

There are two types of sound sources that are of major concern to fish and fisheries: (1) strong underwater shock pulses that can cause physical damage to fish, and (2) underwater sounds that could cause disturbance to fish and affect their behavior.

Impact Thresholds

This EIS/OEIS analyzes potential effects to fish and EFH in the context of the MSFCMA (federally managed species and EFH), ESA (species listed under the ESA only), NEPA, and EO 12114. The factors used to assess the significance of effects vary under these Acts. Under the MSFCMA an "adverse effect" is defined as any impact that reduces the quality and/or quantity of EFH (NMFS 2004a, 2004b). The EFH regulations in 50 CFR 600.815(a)(2)(ii) (NMFS 2002a) establish a threshold for determining adverse effects (NMFS 2002b). Adverse effects are more than minimal and not temporary in nature. Temporary effects are those that are limited in duration and allow the particular environment to recover without measurable impact (NMFS 2002b). Minimal effects are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions. To help identify Navy activities falling within the adverse effect determination, the Navy has determined that temporary or minimal impacts are not considered to "adversely affect" EFH. The EFH Final Rule (67 Federal Register 2354) and 50 CFR 600.815(a)(2)(ii) were used as guidance for this determination, as they highlight activities with impacts that are more than minimal and not temporary in nature, as opposed to those activities resulting in inconsequential changes to habitat. Whether an impact is minimal will depend on a number of factors:

- The intensity of the impact at the specific site being affected;
- The spatial extent of the impact relative to the availability of the habitat type affected;
- The sensitivity/vulnerability of the habitat to the impact;
- The habitat functions that may be altered by the impact (*e.g.*, shelter from predators); and
- The timing of the impact relative to when the species or life stage needs the habitat.

The factors outlined above were also considered in determining the significance of effects under NEPA and EO 12114. For purposes of ESA compliance, effects of the action were analyzed to make the Navy's determination of effect for listed species. The definitions used in making the determination of effect under Section 7 of the ESA are based on the USFWS and NMFS *Endangered Species Consultation Handbook* (USFWS 1998).

Warfare Areas and Associated Environmental Stressors

The Navy used a screening process to identify aspects of the Proposed Action that could act as stressors to fish and EFH. Navy subject matter experts de-constructed the warfare areas and activities included in the Proposed Action to identify specific activities that could act as stressors. Public and agency scoping comments, previous environmental analyses, previous agency consultations, laws, regulations, Executive Orders, and resource-specific information were also evaluated. This process was used to focus the information presented and analyzed in the affected environment and environmental consequences sections of this EIS/OEIS. Potential stressors to fish and EFH include: vessel movements (disturbance and collisions); aircraft overflights (disturbance); underwater detonations and explosive ordnance; sonar training (disturbance); weapons firing/non-explosive ordnance use (disturbance and strikes); and expended materials (ordnance related materials, targets, sonobuoys, and marine markers).

Acoustic Effects of Underwater Sounds to Fish

There have been very few studies on the effects that human-generated sound may have on fish; these have been reviewed in a number of places (*e.g.*, NRC, 1994, 2003, Popper 2003, Popper et al. 2004, Hastings and Popper 2005, Popper 2008), and some more recent experimental studies have provided additional insight into the issues (*e.g.*, Govoni et al. 2003, McCauley et al. 2003, Popper et al. 2005, 2007, Song et al., submitted). Most investigations, however, have been in the gray literature (non peer-reviewed reports – see Hastings and Popper 2005, and Popper 2008 for extensive critical reviews of this material). While some of these studies provide insight into effects of sound on fish, the majority of the gray literature studies often lack appropriate controls, statistical rigor, and/or expert analysis of the results.

There are a wide range of potential effects on fish that range from no effect at all (*e.g.*, the fish does not detect the sound or it "ignores" the sound) to immediate mortality. In between these extremes are a range of potential effects that parallel the potential effects on marine mammals that were illustrated by Richardson et al. (1995). These include, but may not be limited to:

- No effect behaviorally or physiologically: The animal may not detect the signal, or the signal is not one that would elicit any response from the fish.
- Small and inconsequential behavioral effects: Fish may show a temporary "awareness" of the presence of the sound but soon return to normal activities.
- Behavioral changes that result in the fish moving from its current site: This may involve leaving a feeding or breeding ground. This affect may be temporary, in that the fish return to the site after some period of time (perhaps after a period of acclimation or when the sound terminates), or permanent.
- Temporary loss of hearing (often called Temporary Threshold Shift – TTS): This recovers over minutes, hours, or days.
- Physical damage to auditory or non-auditory tissues (*e.g.*, swim bladder, blood vessels, brain): The damage may be only temporary, and the tissue "heals" with little impact on fish survival, or it may be more long-term, permanent, or may result in death. Death from physical damage could be a direct effect of the tissue damage or the result of the fish being more subject to predation than a healthy individual.

Studies on effects on hearing have generally been of two types. In one set of studies, the investigators exposed fish to long-term increases in background noise to determine if there are changes in hearing, growth, or survival of the fish. While data are limited to a few freshwater species, it appears that some increase in ambient noise level, even to above 170 dB re 1 µPa does not permanently alter the hearing ability of the hearing generalist species studied, even if the increase in sound level is for an extended period of time. However, this may not be the case for all hearing generalists, though it is likely that any temporary hearing loss in such species would be considerably less than for specialists receiving the same noise exposure. It is critical to note that more extensive data are needed on additional species, and if there are places where the ambient levels exceed 170 to 180 dB, it would be important to do a quantitative study of effects of long-term sound exposure at these levels. It is also clear that there is a larger temporary hearing loss in hearing specialists. Again, however, extrapolation from the few freshwater species to other species (freshwater or marine) must be done with caution until there are data for a wider range of species, and especially species with other types of hearing specializations than those found in the species studied to date (all of which are otophysan fishes and have the same specializations to enhance hearing).

In the second type of studies, fish were exposed to short duration but high intensity signals such as might be found near a high intensity sonar, pile driving, or seismic air gun survey. The investigators in such studies were examining whether there was not only hearing loss and other long-term effects, but also short-term effects that could result in death to the exposed fish. Because study results vary, it is difficult to speculate why there are many differences in the studies, including species, precise sound source, and spectrum of the sound (Popper 2008).

One study tested effects of seismic air guns, a highly impulsive and intense sound source. This study demonstrated differences in the effects of air guns on the hearing thresholds of different species. In effect, these results substantiate the argument made by Hastings et al. (1996) and McCauley et al. (2003) that it is difficult to extrapolate between species with regard to the effects of intense sounds.

Another study examined the effects of Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) sonar; this study determined there was no effect on ear tissue (Popper et al. 2007).

Other earlier studies suggested that there may be some loss of sensory hair cells due to high intensity sources. However, these studies did not concurrently investigate effects on hearing or non-auditory tissues (Enger 1981, Hastings et al. 1996). In neither study was the hair cell loss more than a relatively small percent of the total sensory hair cells in the hearing organs (Popper 2008).

Effects of Underwater Impulsive Sounds

Air gun studies on very few species resulted in a small hearing loss in several species, with complete recovery within 18 hours (Popper et al. 2005). Other species showed no hearing loss with the same exposure. There appeared to be no effects on the structure of the ear (Song et al., submitted), and a limited examination of non-auditory tissues, including the swim bladder, showed no apparent damage (Popper et al. 2005). One other study of effects of an air gun exposure showed some damage to the sensory cells of the ear (McCauley et al. 2003); it is difficult to differentiate these two studies. However, the two studies employed different methods of exposing fish, and used different species. Other studies have demonstrated some behavioral effects on fish during air gun exposure used in seismic exploration (*e.g.*, Pearson et al. 1987, 1992, Engås et al. 1996, Engås and Løkkeborg 2002, Slotte et al. 2004), but the data are limited and it would be very difficult to extrapolate to other species, as well as to other sound sources.

Explosive Sources

A number of studies have examined the effects of explosives on fish; these are reviewed in detail in Hastings and Popper (2005). However, these studies are often variable, so extrapolation from one study to another, or to other sources, such as those used by the Navy, is not really possible. While many of these studies show that fish are killed if they are near the source, and there are some suggestions that there is a correlation between size of the fish and death (Yelverton et al. 1975), little is known about the very important issues of non-mortality damage in the short- and long-term, and nothing is known about effects on behavior of fish.

The major issue in explosives is that the gas oscillations induced in the swim bladder or other air bubble in fishes caused by high sound pressure levels can potentially result in tearing or rupturing of the chamber. This has been suggested to occur in some (but not all) species in several gray literature unpublished reports on effects of explosives (*e.g.*, Aplin, 1947, Coker and Hollis, 1950, Gaspin, 1975, Yelverton et al. 1975), whereas other published studies do not show such rupture (*e.g.*, the peer reviewed study by Govoni et al. 2003). Key variables that appear to control the physical interaction of sound with fishes include the size of the fish relative to the wavelength of sound, mass of the fish, anatomical variation, and location of the fish in the water column relative to the sound source (*e.g*., Yelverton et al. 1975, Govoni et al. 2003).

Explosive blast pressure waves consist of an extremely high peak pressure with very rapid rise times (< 1 ms). Yelverton et al. (1975) exposed eight different species of freshwater fish to blasts of 1-lb spheres of Pentolite (high explosive) in an artificial pond. The test specimens ranged from 0.02 g (guppy) to 744 g (large carp) body mass and included small and large animals from each species. The fish were exposed to blasts having extremely high peak overpressures with varying impulse lengths. The investigators found what appears to be a direct correlation between body mass and the magnitude of the "impulse," characterized by the product of peak overpressure and the time it took the overpressure to rise and fall back to zero (units in psi-ms), which caused 50 percent mortality (see Hastings and Popper 2005 for detailed analysis).

One issue raised by Yelverton et al. (1975) was whether there was a difference in lethality between fish which have their swim bladders connected by a duct to the gut and fish which do not have such an opening. The issue is that it is possible that a fish with such a connection could rapidly release gas from the swim bladder on compression, thereby not increasing its internal pressure. However, Yelverton et al. (1975) found no correlation between lethal effects on fish and the presence or lack of connection to the gut.

While these data suggest that fishes with both types of swim bladders are affected in the same way by explosive blasts, this may not be the case for other types of sounds, and especially those with longer rise or fall times that would allow time for a biomechanical response of the swim bladder (Hastings and Popper 2005). Moreover, there is some evidence that the effects of explosives on fishes without a swim bladder are less than those on fishes with a swim bladder (*e.g*., Gaspin 1975, Goertner et al. 1994, Keevin et al. 1997). Thus, if internal damage is, even in part, an indirect result of swim bladder (or other air bubble) damage, fishes without this organ may show very different secondary effects after exposure to high sound pressure levels. Still, it must be understood that the data on effects of impulsive sources and explosives on fish are limited in number and quality of the studies, and in the diversity of fish species studied. Thus, extrapolation from the few studies available to other species or other devices must be done with the utmost caution.

In a more recent published report, Govoni et al. (2003) found damage to a number of organs in juvenile pinfish (*Lagodon rhomboids*) and spot (*Leiostomus xanthurus*) when they were exposed to submarine detonations at a distance of 11.8 ft (3.6 m), and most of the effects, according to the authors, were sublethal. Effects on other organ systems that would be considered irreversible (and presumably lethal) only occurred in a small percentage of fish exposed to the explosives. Moreover, there was virtually no effect on the same sized animals when they were at a distance of 24.6 ft (7.5 m), and more pinfish than spot were affected.

Based upon currently available data it is not possible to predict specific effects of Navy impulsive sources on fish. At the same time, there are several results that are at least suggestive of potential effects that result in death or damage. First, there are data from impulsive sources such as pile driving and seismic air guns that indicate that any mortality declines with distance, presumably because of lower signal levels. Second, there is also evidence from studies of explosives (Yelverton et al. 1975) that smaller animals are more affected than larger animals. Finally, there is also some evidence that fish without an air bubble, such as flatfish and sharks and rays, are less likely to be affected by explosives and other sources than are fish with a swim bladder or other air bubble.

Yet, as indicated for other sources, the evidence of short- and long-term behavioral effects, as defined by changes in fish movement, etc., is non-existent. Thus, it is unknown if the presence of an explosion or an impulsive source at some distance, while not physically harming a fish, will alter its behavior in any significant way.

Non-explosive Ordnance

Mines, inert bombs, and intact missiles and targets could impact the water with great force and produce a large impulse and loud noise. Physical disruption of the water column by the shock wave and bubble pulse is a localized, temporary effect, and would be limited to within tens of meters of the impact area and would persist for a matter of minutes. Physical and chemical properties would be temporarily affected (*e.g*., increased oxygen concentrations due to turbulent mixing with the atmosphere), but there would be no lasting adverse effect on the water column habitat from this physical disruption. Large objects hitting the water produce noises with source levels on the order of 240 to 271 dB re 1 µPa and pulse durations of 0.1 to 2 milliseconds, depending on the size of the object (McLennan 1997). A remote possibility exists that some individual fish at or near the surface may be directly impacted (*i.e.,* direct strike) if they are in the target area at the point of physical impact at the time of non-explosive ordnance delivery. Therefore, effects of shock waves from mines, inert bombs, and intact missiles and targets hitting the water surface on fish are expected to be localized and minimal.

Expended Materials

Falling Debris and Small Arms Rounds

Most missiles hit their target or are disabled before hitting the water. Thus, most of these missiles and targets hit the water as fragments, which quickly dissipate their kinetic energy within a short distance from the surface. Similarly, expended small-arms rounds may also strike the water surface with sufficient force to cause injury. Most fish swim some distance below the surface of the water. Therefore, fewer fish are exposed to mortality from falling fragments whose effects are limited to the near surface, than mortality from intact missiles and targets whose effects can extend well below the water surface.

Hazardous Materials

Hazardous materials can be released from sonobuoys, submarine targets, torpedoes, missiles, aerial targets, and underwater explosions. Petroleum hydrocarbons released during an accident are harmful to fish. Jet fuel is toxic to fish but floats and vaporizes very quickly. Assuming that a target disintegrates on contact with the water, any residual unburned fuel may be spread over a large area and dissipate quickly. In addition, fuel spills and material released from weapons and targets could occur at different locations and at different times.

Potential impacts from Navy explosives training include degradation of substrate and introduction of toxic chemicals into the water column. Combustion products from the detonation of high explosives – carbon monoxide (CO), carbon dioxide (CO_2), hydrogen (H_2), water (H_2O), nitrogen (N_2), and ammonia (NH_3) - are commonly found in sea water. The primary constituents that would be released from explosives training are nitroaromatic compounds such as trinitrotoluene (TNT), cyclonite (Royal Demolition Explosive or RDX), and octogen (High Melting Explosive or HMX) (URS 2000). Initial concentrations of explosion by-products are not expected to be hazardous to marine life (DoN 2001a) and would not accumulate in the training area because exercises are spread out over time and the chemicals disperse in the ocean. The water quality effects of the explosions would be infrequent, temporary, and localized, and would have no long-term adverse effect on water quality. Furthermore, charges at the Crescent Harbor Underwater EOD Range are raised off the bottom to minimize impacts to the sea floor. Effects on marine fish associated with the release of hazardous materials, carbon, and Kevlar pieces and other materials are expected to be minimal.

3.7.2.3 No Action Alternative

Under the No Action Alternative, baseline levels of activities would remain unchanged from current conditions. Fish would have the potential to be affected by vessel movement, aircraft overflights, underwater detonations and explosive ordnance, sonar, non-explosive ordnance use, weapons firing disturbance, and expended materials.

Vessel Movements

Many of the ongoing and proposed activities within the Study Area involve maneuvers by various types of surface ships and submarines (collectively referred to as vessels). Currently, the number of Navy vessels operating in the NWTRC Study Area varies based on training schedules. Most activities include up to 2 vessels, with an average of one vessel per activity. During a year of activities, 6,940 steaming hours occur in the NWTRC, with 4,320 of those in transit, and 2,610 during training activities. Speeds for activities and training typically range from 10 to 14 knots. Activities involving vessel movements occur intermittently and are short in duration, generally a few hours in duration. These activities are widely dispersed throughout the OPAREA, which is a vast area encompassing 122,400 square nautical miles (approximately 430,000 square kilometers) of surface/subsurface ocean. The Navy logs about 289 total vessel days within the Study Area during a typical year (approximately 0.06 hours of steaming per square nautical mile).

Vessel movements have the potential to expose fish to noise and general disturbance, which could result in short-term behavioral and/or physiological responses (swimming away, increased heart rate). Such responses would not be expected to compromise the general health or condition of individual fish. The probability of collisions between vessels and adult fish, which could result in injury or mortality, would be extremely low because this life stage is highly mobile and Navy vessel density in the Study Area is low. Vessel movements would result in short-term and localized disturbances to the water column, but benthic habitats would not be affected. Ichthyoplankton (fish eggs and larvae) in the upper portions of the water column could be displaced, injured, or killed by vessel and propeller movements. However, no measurable effects on fish recruitment would occur because the number of eggs and larvae exposed to vessel movements would be low relative to total ichthyoplankton biomass. Vessel movements under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, vessel movements in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from vessel movements in non-territorial waters would be minimal in accordance with EO 11214.

Aircraft Overflights

Under the No Action Alternative, 6,855 overflights occur in the NWTRC annually. Of these, 84 would be helicopter flights, conducted primarily over land. The majority of the remaining non-helicopter overflights would occur over marine environments of the NWTRC at elevations in excess of 3,000 ft above sea level, and over 3 nm from shore.

Aircraft overflights produce airborne noise and some of this energy would be transmitted into the water. However, sound does not transmit well from air to water. Predicted sound levels resulting from HC-130 aircraft flying at 1,000 ft and 250 ft were 110 and 121 dB re 1 µPa, respectively, directly under the flight path at a depth of 1 ft (maximum one-third octave level for frequencies 20 Hz–5 kHz). The same sound levels resulting from an HH-60 helicopter flying at 1,000 ft, flying at 100 ft, and hovering 10 ft were 110, 129, and 143 dB re 1 µPa (respectively) directly under the helicopter at a depth of 1 ft (USAF 1999). The sound levels would decline at increasing lateral distances from the aircraft's track or location and with increasing depth in the water, and the underwater sounds originating from the aircraft would decline rapidly after the aircraft has passed. It is unlikely that these sound levels would cause physical damage or even behavioral effects in fish based on the sound levels that have been found to cause such effects.

Such responses would not compromise the general health or condition of individual fish. Aircraft overflights under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under MSFCMA. In accordance with NEPA, aircraft overflights in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from aircraft overflights movements in non-territorial waters would be minimal in accordance with EO 11214.

Underwater Detonations and Explosive Ordnance

Explosions that occur in the offshore portions of the Study Area are associated with training exercises that use explosive ordnance, including bombs (BOMBEX), missiles (MISSILEX), sink exercises (SINKEX) and naval gun shells (GUNEX, 5-inch high explosive rounds), as well as underwater detonations associated with EOD training.

As shown in Table 2-9, under the No Action Alternative approximately 108 bombs, 10 missiles, and 9,132 sonobuoys (includes 124 explosive sonobuoys) would be used in the OPAREA training area each year. This would produce a very low density of offshore explosions per year in the Study Area of 0.002 explosions per nm^2.

Underwater detonation is limited to a few specific training areas: Crescent Harbor Underwater EOD range, Floral Point Underwater EOD Range, and Indian Island Underwater EOD Range. As discussed in Chapter 2, the No Action Alternative represents baseline conditions. With respect to EOD activities, the No Action Alternative represents approximately 60 annual EOD activities in nearshore environments (Table 3.7-5).

Table 3.7-5: Mine Countermeasure Training Activities Under the No Action Alternative

Location	Charge Size Net Explosive Weight (NEW)	Number	Number of Activities
Crescent Harbor Underwater EOD Range	< 2.5 lb .	3	
	2.5 lb.	45	
	5 lb	1	
	20 lb	4	
	Subtotal	**53**	**53**
Floral Point Underwater EOD Range		0	
	2.5 lb.	3	
	Subtotal	**3**	**3**
Indian Island Underwater EOD Range	2.5 lb.	3	
	20 lb.	1	
	Subtotal	**4**	**4**
	TOTAL	**60**	**60**

In April 2008, the Navy made the decision to relocate EOD Mobile Unit Eleven (EODMU Eleven) forces out of the NWTRC Study Area to a new homebase in Imperial Beach, CA. This move is planned to be completed in the fall of 2009. Two EOD Shore Detachments (Bangor and Northwest) will remain in the NWTRC. As a result of the EODMU Eleven relocation, mine warfare underwater detonation training will significantly decrease from a yearly maximum of 60 underwater detonations as analyzed in the No Action Alternative (the baseline) to no more than four annual underwater detonations as analyzed in Alternatives 1 and 2.

Fish exposed to underwater explosions would suffer temporary effects, sub-lethal or lethal injuries, or direct mortality, in proportion to the proximity to the explosion and size of the detonation. For example, based on the analysis methods presented in Section 3.7.2.4, physical injury to fish could occur within the following distances of a detonation site for detonation of 20-lb. and 5-lb. charges, as shown in Table 3.7-6. These distances should be used to define "not properly functioning habitat" for noise/impulse conditions.

Table 3.7-6: Distances from Detonation Resulting in No Injury or 1% Mortality to Fish

Fish	Weight	Approximate No Effects (no injury) Distance (m)	
		20-lb. Charge	5-lb. Charge
Juvenile chum	0.011 lb (0.005 kg)	850	580
Juvenile chinook	0.022 lb (0.01 kg)	780	527
Adult chum	11 lb (5kg)	350	235
Adult chinook	22 lb (10kg)	320	216

During their migration and rearing, juvenile salmon occur almost exclusively in shallow water directly adjacent to the shoreline. Therefore, the potential for injury effects on juveniles depends on the size of the charge and the distance from the EOD training area at any site to the nearest shoreline. This distance indicates that there is a potential for injury or mortality of juvenile fish at both of the underwater detonation sites, if detonations occur when juvenile fish are present along the nearest shorelines. The number of juveniles potentially affected would be small, because of the infrequent nature of the detonations. For some detonations, it is possible that no fish would be injured, because none would be closer than the no-effects distances.

As shown above, the distances over which adult Chinook or chum salmon could be injured or killed are considerably smaller than the injury distances for juveniles. When adults are in the general vicinity of the training areas, they could be injured or killed as a result. The number of adult salmon expected to be affected depends on the frequency of the detonations, and the likelihood of adult salmon to be present at the sites. The Crescent Harbor Underwater EOD Range is outside the major migration corridor for river systems in the area. The Indian Island Underwater EOD Range lies on a migration corridor for Chinook, chum, and other salmon species in the Hood Canal system. As such, the Indian Island Underwater EOD Range area is expected to support larger numbers of adult salmon than Crescent Harbor Underwater EOD Range area. Resident Chinook (blackmouth) may occur in low densities. At any time of the year, small numbers of adult salmon are expected to occur within the injury distances of the detonation sites at the time of detonation. Therefore, juvenile and adult salmon could be injured or killed by EOD detonations.

Effects to steelhead or bull trout would be similar to those described for salmon. Regarding the potential for physical injury, Table 3.7-7 shows "safe distances," based on no injury and 90 percent survival for adult and juvenile bull trout, using the method of Young (1991). As with juvenile salmon, juvenile bull or steelhead trout could be injured by explosions of the largest charges at the detonations sites, if the juveniles were present at nearby shorelines when an explosion occurred. However, juvenile bull or steelhead trout are less likely to be present near the explosion sites than juvenile salmon. Anadromous juvenile trout are most likely to stay within their natal estuaries (none of which are near the detonation sites) to feed and mature before moving back upriver. Anadromous juvenile trout are much less likely than juvenile salmon to migrate long distances in the marine environment, which would bring them into the vicinity of the EOD training areas. Therefore, juvenile and adult trout could be injured or killed by EOD explosions; trout injury is expected to be less than salmon, as discussed above.

Table 3.7-7: Approximate Distances from Detonation Resulting in No Injury or 90% Survival to Bull Trout

Fish	Weight	No Effects (no injury) Distance (m)		90% Survival Distance (m)	
		5-lb. Charge	20-lb. Charge	5-lb. Charge	20-lb. Charge
Juvenile bull trout	0.44 lb (0.02 kg)	480	710	161	237
Adult bull trout	6 lb (2.7 kg)	250	375	85	125
Note: Based on method of Young (1991). Assumes charge is at a depth of 50 ft and fish are in "shallow" water. No injury distances are estimated from 90% survival distances.					

The evidence of short- and long-term behavioral effects, as defined by changes in fish movement, etc., is non-existent (Popper 2008). It is unknown if the presence of an explosion or impulsive source at some distance, while not physically harming a fish, will alter its behavior in any significant way (Popper 2008).

Impacts to fish from explosions would be possible, but have a low potential for occurrence. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of underwater detonations and high explosive ordnance use, explosions under the No Action Alternative would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from explosions would be short-term and localized. The Navy conducts a limited number of training activities over a large area (112,241 nm^2 [430,000 km^2]). Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6.

Sonar

Effects to fish populations and EFH from sonar use could potentially result from acoustic impacts. Antisubmarine warfare (ASW) and mine warfare (MIW) exercises include training sonar operators to detect, classify, and track underwater objects and targets. There are two basic types of sonar: passive and active. Passive sonars only listen to incoming sounds and, since they do not emit sound energy in the water, lack the potential to acoustically affect the environment. Active sonars emit acoustic energy to obtain information about a distant object from the reflected sound energy. Active sonars are the most effective detection systems against modern, ultra-quiet submarines and sea mines in shallow water.

Modern sonar technology has developed a multitude of sonar sensor and processing systems. In concept, the simplest active sonars emit acoustic pulses ("pings") and time the arrival of the reflected echoes from the target object to determine range. More sophisticated active sonars emit a ping and then scan the received beam to provide directional as well as range information. Only about half of the Navy's ships are equipped with active sonar and their use is generally limited to training and maintenance activities - 90 percent of sonar activity by the Navy is passive (DoN 2007).

Active sonars operate at different frequencies, depending on their purpose. High-frequency sonar (>10 kHz) is mainly used for establishing water depth, detecting mines, and guiding torpedoes. At higher frequencies, sound energy is greatly attenuated by scattering and absorption as it travels through the water. This results in shorter ranges, typically less than five nautical miles. Mid-frequency sonar is the primary tool for identifying and tracking submarines. Mid-frequency sonar (1 kHz - 10 kHz) suffers moderate attenuation and has typical ranges of 1-10 nautical miles. Low-frequency sonar (<1 kHz) has the least attenuation, achieving ranges over 100 nautical miles. Low-frequency sonars are primarily used for long-range search and surveillance of submarines. Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) is the U.S. Navy's low-frequency sonar system (DoN 2001b), it employs a vertical array of 18 projectors using the 100-500 Hz frequency range.

Sonars used in ASW are predominantly in the mid-frequency range (DoN 2007). ASW sonar systems may be deployed from surface ships, submarines, and rotary and fixed wing aircraft. The surface ships are typically equipped with hull mounted sonar but may tow sonar arrays as well. Helicopters are equipped with dipping sonar (lowered into the water). Helicopters and fixed wing aircraft may also deploy both active and passive sonobuoys and towed sonar arrays to search for and track submarines.

Submarines also use sonars to detect and locate other subs and surface ships. A submarine's mission revolves around stealth, and therefore submarines use their active sonar very infrequently since the pinging of active sonar gives away their location. Submarines are also equipped with several types of auxiliary sonar systems for mine avoidance, for top and bottom soundings to determine the submarine's position in the water column, and for acoustic communications. ASW training targets simulating submarines may also emit sonic signals through acoustic projectors.

Sonars employed in MIW training are typically high-frequency (greater than 10 kHz). They are used to detect, locate, and characterize mines that are moored, laid on the bottom, or buried. MIW sonars can be deployed from multiple platforms including towed systems or surface ships.

Torpedoes use high-frequency, low-power, active sonar. Their guidance systems can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, exploiting the emitted sound energy by the target, or actively, ensonifying the target and using the received echoes for tracking and targeting.

Military sonars for establishing depth and most commercial depth sounders and fish finders operate at high frequencies, typically between 24 and 200 kHz.

Low-Frequency Sonar

Low-frequency sound travels efficiently in the deep ocean and is used by whales for long-distance communication (Richardson et al. 1995, NRC 2003, 2005). Concern about the potential for low-frequency sonar (<1 kHz) to interfere with cetacean behavior and communication has prompted extensive debate and research (DoN 2001b, 2007, NRC 2000, 2003).

Some studies have shown that low-frequency noise will alter the behavior of fish. For example, research on low-frequency devices used to deter fish away from turbine inlets of hydroelectric power plants showed stronger avoidance responses from sounds in the infrasound range (5-10 Hz) than from 50 and 150 Hz sounds (Knudsen et al. 1992, 1994). In test pools, wild salmon exhibit an apparent avoidance response by swimming to a deeper section of the pool when exposed to low-frequency sound (Knudsen et al. 1997).

Turnpenny et al. (1994) reviewed the risks to marine life, including fish, of high intensity, low-frequency sonar. Their review focused on the effects of pure tones (sine waves) at frequencies between 50-1000 Hz. Johnson (2001) evaluated the potential for environmental impacts of employing the SURTASS LFA sonar system. While concentrating on the potential effects on whales, the analysis did consider the potential effects on fish, including bony fish and sharks. It appears that the swimbladders of most fish are too small to resonate at low frequencies and that only large pelagic species such as tunas have swimbladders big enough to resonate in the low-frequency range. However, investigations by Sand and Hawkins (1973) and Sand and Karlsen (1986) revealed resonance frequencies of cod swim bladders from 2 kHz down to 100 Hz.

Popper et al. (2005, 2007) investigated the impact of Navy SURTASS LFA sonar on hearing and on non-auditory tissues of several fish species. In this study, three species of fish in Plexiglas cages suspended in a freshwater lake were exposed to high intensity LFA sonar pulses for periods of time considerably longer than likely LFA exposure. Results showed no mortality and no damage to body tissues either at the gross or histological level. Some individuals exhibited temporary hearing loss but recovered within several days of exposure. The study suggests that SURTASS LFA sonar does not kill or damage fish even in a worst case scenario.

Although some behavioral modification might occur (i.e., startle, avoidance, etc.), adverse effects from low-frequency sonar on fish, including sensitive life stages (juvenile fish, larvae and eggs) are not expected. If they occur, behavioral responses would be brief, reversible, and not biologically significant. The use of Navy low-frequency sonar would not compromise the productivity of fish or adversely affect their habitat.

Mid-Frequency Sonar

ASW training activities use mid-frequency (1-10 kHz) sound sources. Most fish only detect sound within the 1-3 kHz range (Popper 2003, Hastings and Popper 2005). Thus, it is expected that most fish species would be able to detect the ASW mid-frequency sonar at the lower end of its frequency range.

Some investigations have been conducted on the effect on fish of acoustic devices designed to deter marine mammals from gillnets (Gearin et al. 2000, Culik et al. 2001). These devices generally have a mid-frequency range, similar to the sonar devices that would be used in ASW exercises. Adult sockeye salmon exhibited an initial startle response to the placement of inactive acoustic alarms designed to deter harbor porpoise. The fish resumed their normal swimming pattern within 10 to 15 seconds. After 30 seconds, the fish approached the inactive alarm to within 30 cm (1 ft). The same experiment was conducted with the alarm active. The fish exhibited the same initial startle response from the insertion of the alarm into the tank; however, within 30 seconds, the fish were swimming within 30 cm (1 ft) of the active alarm. After five minutes of observation, the fish did not show any reaction or behavior change except for the initial startle response. This demonstrated that the alarms were either inaudible to the fish, or the fish were not disturbed by the mid-frequency sound.

Jørgensen et al. (2005) carried out experiments examining the effects of mid-frequency (1 to 6.5 kHz) sound on survival, development, and behavior of fish larvae and juveniles. Experiments were conducted on the larvae and juveniles of Atlantic herring, Atlantic cod, saithe (*Pollachius virens),* and spotted wolffish (*Anarhichas minor)*. Swimbladder resonance experiments were attempted on juvenile Atlantic herring, saithe, and Atlantic cod. Sound exposure simulated Naval sonar signals. These experiments did not cause any significant direct mortality among the exposed fish larvae or juveniles, except in two (of a total of 42) experiments on juvenile herring where significant mortality (20 to 30 percent) was observed. Among fish kept in tanks one to four weeks after sound exposure, no significant differences in mortality or growth related parameters (length, weight and condition) between exposed groups and control groups were observed. Some incidents of behavioral reactions were observed during or after the sound exposure - 'panic' swimming or confused and irregular swimming behavior. Histological studies of organs, tissues, or neuromasts from selected Atlantic herring experiments did not reveal obvious differences between control and exposed groups.

The work of Jørgensen et al. (2005) was used in a study by Kvadsheim and Sevaldsen (2005) to examine the possible 'worst case' scenario of sonar use over a spawning ground. They conjectured that normal sonar operations would affect less than 0.06 percent of the total stock of a juvenile fish of a species, which would constitute less than 1 percent of natural daily mortality. However, these authors did find that the use of continuous-wave transmissions within the frequency band corresponding to swim bladder resonance will escalate this impact by an order of magnitude. The authors therefore suggested that modest restrictions on the use of continuous-wave transmissions at specific frequencies in areas and at time periods when there are high densities of Atlantic herring present would be appropriate.

The results of several studies have indicated that acoustic communication and orientation of fish, in particular of hearing specialists, may be limited by noise regimes in their environment (Wysocki and Ladich 2004). Most marine fish are hearing generalists, though a few have been shown to detect sounds in the mid-frequency and ultrasonic range. While these species can detect mid-frequency sounds, their best hearing sensitivities are not in the mid-frequency range. If a sound is at the edge of a fish's hearing range, the sound must be louder in order for it to be detected than if in the more sensitive range.

Experiments on fish classified as hearing specialists (but not those classified as hearing generalists) have shown that exposure to loud sound can result in temporary hearing loss, but it is not evident that this may lead to long-term behavioral disruptions in fish that are biologically significant (Amoser and Ladich 2003, Smith et al. 2004a,b). There is no information available that suggests that exposure to non-impulsive acoustic sources results in fish mortality.

In summary, some marine fish may be able to detect mid-frequency sounds, most marine fish are hearing generalists and have their best hearing sensitivity below mid-frequency sonar. If they occur, behavioral responses would be brief, reversible, and not biologically significant. Sustained auditory damage is not expected. Sensitive life stages (juvenile fish, larvae and eggs) very close to the sonar source may experience injury or mortality, but area-wide effects would likely be minor. The use of Navy mid-frequency sonar would not compromise the productivity of fish or adversely affect their habitat.

High-Frequency Sonar

Although most fish cannot hear sound frequencies over 10 kHz, some shad and herring species can detect sounds in the ultrasonic range, i.e., over 20 kHz. (Mann 2001, Higgs et al. 2004). Ross et al. (1996) reviewed the use of high-frequency sound to deter alewives from entering power station inlets. The alewife, a member of the shad family (Alosinae) which can hear sounds at ultrasonic frequencies (Mann et al. 2001), uses high-frequency hearing to detect and avoid predation by cetaceans. Wilson and Dill (2002) demonstrated that exposure to broadband sonar-type sounds with high frequencies cause behavioral modification in Pacific herring.

Since high-frequency sound attenuates quickly in water, high levels of sound from mine hunting sonars would be restricted to within a few meters of the source. Even for fish able to hear sound at high frequencies, only short-term exposure would occur, thus high-frequency military sonars are not expected to have significant effects on resident fish populations.

Because a torpedo emits sonar pulses intermittently and is traveling through the water at a high speed, individual fish would be exposed to sonar from a torpedo for a brief period. At most, an individual animal would hear one or two pings from a torpedo and would be unlikely to hear pings from multiple torpedoes over an exercise period. Most fish hear best in the low- to mid-frequency range and, therefore are unlikely to be disturbed by torpedo pings.

The effects of high-frequency sonar on fish behavior for species that can hear high-frequency sonar, would be transitory and of little biological consequence. Most species would probably not hear these sounds and would therefore experience no disturbance.

Conclusion – Sonar Use

While the impact of anthropogenic noise on marine mammals has been extensively studied, the effects of noise on fish are largely unknown (Popper 2003, Hastings and Popper 2005, Popper 2008). There is a dearth of empirical information on the effects of exposure to sound, let alone sonar, for the vast majority of fish. The few studies on sonar effects have focused on behavior of individuals of a few species and it is unlikely their responses are representative of the wide diversity of other marine fish species (Jorgensen et al. 2005). The literature on vulnerability to injury from exposure to loud sounds is similarly limited, relevant to particular species, and, because of the great diversity of fish, not easily extrapolated. More well-controlled studies are needed on the hearing thresholds for fish species and on temporary and permanent hearing loss associated with exposure to sounds. The effects of sound may not only be species specific, but also depend on the mass of the fish (especially where any injuries are being considered) and life history phase (eggs and larvae may be more or less vulnerable to exposure than adult fish). The use of sounds during spawning by some fish, and their potential vulnerability to masking by anthropogenic sound sources, also requires further investigation. No studies have established effects of cumulative exposure of fish to any type of sound or have determined whether subtle and long-term effects on behavior or physiology could have an impact upon survival of fish populations. The use of sounds during spawning by some fish and their potential vulnerability to masking by anthropogenic sound sources requires closer investigation.

With these caveats and qualifications in mind, the limited information currently available suggests that populations of fish are unlikely to be affected by the projected rates and areas of use of military sonar. Thus, sonar use in NWTRC training is not anticipated to result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, sonar use in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from sonar use movements in non-territorial waters would be minimal in accordance with EO 11214.

Non-Explosive Ordnance Use

Current Navy training activities in the NWTRC study area include firing a variety of weapons and employ a variety of non-explosive training rounds, including bombs, missiles, naval gun shells, cannon shells, and small caliber ammunition. These materials are used in the OPAREA located in the open ocean beyond 12 nm. Direct ordnance strikes from firing weapons are potential stressors to fish.

Inert bombs, intact missiles or some targets fall into the waters of the OPAREA during the following exercises:

- Missile Firing
- Bombing Exercise
- Sinking Exercise
- Gunnery Exercise

Non-explosive bombs and intact missiles and targets could impact the water with great force and produce a large impulse and loud noise. Physical disruption of the water column by the shock wave and bubble pulse is a localized, temporary effect, and would be limited to within tens of meters of the impact area and would persist for a matter of minutes. Physical and chemical properties would be temporarily affected (*e.g.*, increased oxygen concentrations due to turbulent mixing with the atmosphere), but there would be no lasting adverse effect on the water column habitat from this physical disruption.

Large objects hitting the water produce noises with source levels on the order of 240 to 271 dB re 1 μPa and pulse durations of 0.1 to 2 milliseconds, depending on the size of the object (McLennan 1997). Impulses of this magnitude could potentially injure fish. Because the rise times of these shock waves are very short, the impulses causing injury and mortality derived for explosive sources were used to estimate effects of shock pulses created by missile and target effects.

While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of non-explosive ordnance use, under the No Action Alternative ordnance use would not result in significant impacts to fish populations based on the low density of ordnance use (2.5

pieces/square nautical mile). Fish injury and mortality from ordnance use are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. Disturbances to water column and benthic habitats from ordnance use would be short-term and localized. Non-explosive ordnance use under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, non-explosive ordnance use in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from non-explosive ordnance use movements in non-territorial waters would be minimal in accordance with EO 11214.

Weapons Firing Disturbance

When a gun is fired from a surface ship, a blast wave propagates away from the gun muzzle. When the blast wave meets the water, most of the energy is reflected back into the air, but some energy is transmitted into the water. A series of pressure measurements were taken during the firing of a 5-inch gun aboard the USS Cole in June 2000 (Dahlgren 2000). The average peak pressure measured was about 200 dB re 1 μPa at the point of the air and water interface. Down-range peak pressure level, estimated for spherical spreading of the sound in water**,** would be 160 dB re 1 μPa at 100 m (328 ft) and 185 dB re 1 μPa at ~5.5 m (18 ft). The resulting ensonified areas (semi-circles with radius 100 and 5.5 m) would be 0.015 km^2 and ~50 m^2 (respectively).

Because fish apparently only react to impulsive sounds greater than 160 dB, only those in the immediate vicinity (0.015 km^2 area) would be affected and effects would be limited to short-term, transitory alarm or startle responses. Weapons firing under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, weapons firing disturbance in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from weapons firing disturbance movements in non-territorial waters would be minimal in accordance with EO 11214.

Expended Materials

The Navy uses a variety of expended materials during training exercises conducted in the NWTRC Study Area. The types and quantities of expended materials used and information regarding fate and transport of these materials within the marine environment are discussed in Sections 3.1, 3.3, and 3.4. The analyses presented in these sections predict that the majority of the expended materials would rapidly sink to the sea floor, become encrusted by natural processes, and incorporated into the sea floor, with no significant accumulations in any particular area and no significant negative effects to water quality or marine benthic communities.

Ordnance Related Materials

Ordnance related materials include various sizes of non-explosive training rounds and shrapnel from explosive rounds. These solid metal materials would quickly move through the water column and settle to the sea floor where they could be available for ingestion by foraging fish.

The probability of fish ingesting expended ordnance would depend on factors such as the location of the spent materials, size of the materials, and the level of benthic foraging that occurs in the impact area, which is a function of benthic habitat quality, prey availability, and species-specific foraging strategies. It is possible that persistent expended ordnance could be colonized by benthic organisms (such as clams and oysters) and mistaken for prey, or that expended ordnance could be accidentally ingested while foraging for natural prey items.

Under the No Action Alternative, the total number of expended ordnance in the Study Area would be just under 85,700 pieces per year. Assuming all ordnance would be expended throughout the OPAREA in an even distribution, the concentration of expended rounds would be 0.7 per nm^2 (2.4 per km^2).

Under the No Action Alternative, ingestion of expended ordnance may affect fish, but this affect would be minimal. Ordnance related expended materials under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, ordnance related materials in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from ordnance related materials in non-territorial waters would be minimal in accordance with EO 11214.

Target Related Materials

A variety of at-sea targets would potentially be used in the OPAREA, ranging from high-tech remotely operated airborne and surface targets (such as airborne drones) to low-tech floating at-sea targets (such as inflatable targets) and airborne towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training. The expendable targets used in the study area are the Expendable Mobile ASW Training Target (EMATT) and the MK-58 Marine Marker. These units are 2 and 3 ft in length, respectively, and sink to the bottom intact; these targets present no ingestion hazard to fish.

EMATTs are not recovered; they scuttle themselves and sink to the sea floor to be left in place. The EMATTs are unlikely to result in any physical impacts to the sea floor. They would sink into a soft bottom or would lie on a hard bottom, where they may provide a substrate for benthic colonization or eventually be covered by shifting sediments. Metal components are corroded by seawater at slow rates. Natural encrustation of exposed surfaces would eventually occur as invertebrates grow on the surfaces of the sunken objects. As the exterior becomes progressively more encrusted, the rates at which the metals will dissolve into the surrounding water will also decrease. Rates of deterioration would vary, depending on material and conditions in the immediate marine and benthic environment. Factors such as oxygen content, salinity, temperature and pH all contribute to the manner and speed at which metals will dissolve. Over a period of years, the EMATTs would degrade, corrode, and become encrusted or incorporated into the sediments, thus precluding adverse effects to fish. Under the No Action Alternative, 121 EMATTs would be used annually.

EMATTs use lithium sulfur dioxide batteries. An important component of the thermal battery is a hermetically-sealed casing of welded stainless steel 0.03 to 0.1-inches thick that is resistant to the battery electrolytes. As previously described in Section 3.3.2, in the evaluation of the potential effects associated with seawater batteries, it is expected that in the marine environment, lithium potentially released from these batteries would be essentially nontoxic in seawater. Because of these factors, lithium batteries would not adversely affect fish.

MK-58 marine markers produce chemical flames and regions of surface smoke and are used in various training exercises to mark a surface position to simulate divers, ships, and points of contact on the surface of the ocean. The smoke dissipates in the air having little effect on the marine environment. The marker burns similar to a flare, producing a flame until all burn components have been used. While the light generated from the marker is bright enough to be seen up to three miles away in ideal conditions, the resulting light would either be reflected off the water's surface or would enter the water and attenuate in brightness over depth. Approximately 208 marine markers would be used in the Study Area under the No Action Alternative. Given the size of the Study Area and the low number of markers used, it would be very unlikely that fish would be affected by use of marine markers.

Target and marine marker use under the No Action Alternative may affect fish, but the effects would be considered minimal because of the low number of markers used. Target related materials under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, target related materials in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from target related materials in non-territorial waters would be minimal in accordance with EO 11214.

Threatened and Endangered Species, and Critical Habitat

Threatened and Endangered Species. As discussed in Section 3.7.1.4, species of ESA-designated salmonids with known or potential occurrence in the NWTRC include: chinook, coho, and chum salmon; and steelhead and bull trout. Chinook, coho, and chum salmon; and steelhead trout are under the jurisdiction of NMFS. Bull trout are under the jurisdiction of USFWS. Both Northern and Southern DPS green sturgeon occupy coastal estuaries and coastal marine waters in the NWTRC. Green sturgeon are under the jurisdiction of NMFS.

On November 7, 2008, USWFS issued a Biological Opinion (USFWS 2008) for Navy EOD Operations, Puget Sound. The Biological Opinion applies to Navy's ongoing EOD training conducted from the date of the Biological Opinion through December 31, 2009. The Navy has determined that EOD training through December 31, 2009 will include six underwater detonations (each limited to 2.5 lb charge) and two surface or floating mine detonations (each limited to 2.5 lb charge), and will only occur at Crescent Harbor. The Biological Opinion determined that these EOD training activities would result in the following:

- incidental take in the form of harm (through death or physical injury from the direct effects of the pressure wave resulting from detonation of the explosive during the EOD training) to a total of five juvenile, sub-adult or adult bull trout in the Crescent Harbor action area.

The USFWS Biological Opinion concluded that this level of anticipated take is not likely to jeopardize the continued existence of the bull trout. USFWS also stated that "…no reasonable and prudent measure(s) are necessary and appropriate to minimize impacts of incidental take of bull trout. Measures that are designed to minimize impacts to bull trout have been incorporated by the Navy…" The terms and conditions included in USFWS' Biological Opinion require Navy to monitor the impacts of the incidental take.

Since ESA-listed fish in the NWTRC are in either USFWS or NMFS jurisdiction, both agencies were included in the consultation process for the Navy EOD Operations in Puget Sound. NMFS issued a separate Biological Opinion in June 2008 (NMFS 2008). The NMFS Biological Opinion states "the National Marine Fisheries Service concludes that the proposed action is not likely to jeopardize the continued existence of the Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Hood Canal summer-run chum salmon (*O. keta*), Puget Sound steelhead (*O. mykiss*), or southern resident killer whales (*Orcinus orca*); and not likely to adversely modify critical habitat for Puget Sound Chinook salmon, Hood Canal summer-run chum salmon or southern resident killer whales."

The findings of these Biological Opinions have been used in the analysis for this EIS/OEIS. Utilizing criteria and analysis methodology as presented previously for non-listed species, vessel movements, aircraft overflight, underwater detonations, explosive ordnance use, sonar, non-explosive ordnance use, weapons firing, and expended materials may affect individual ESA-listed fish in the NWTRC, However, these activities would not have community or population level effects.

As part of the EIS/OEIS process, the Navy has prepared a BE for the NWTRC for use, as appropriate, in consultation with NMFS and USFWS. The BE provides detailed descriptions and analysis of the potential impacts to all threatened or endangered species and critical habitats protected under the ESA.

Critical Habitat. The potential effects of the Proposed Action on the habitat of ESA-designated species within the NWTRC are analyzed in the BE two ways: First, using a matrix of pathways approach developed by NMFS (1996) and USFWS (1998), second, using an approach that relies upon habitat primary constituent elements (PCEs).

The matrix of pathway approach is an analysis that develops a matrix of pathways (water quality and physical and biological habitat elements) and indicators (various elements of the pathway categories) for fish habitat present in the NWTRC and then characterizes the baseline environmental conditions. The potential effects of the No Action Alternative on habitat present in the action area are characterized by their potential to restore, maintain, or degrade existing environmental baseline conditions for each habitat indicator within the matrix of pathways. The matrix of pathways analysis indicates implementation of the No Action Alternative would maintain baseline environmental conditions, as presented in Table 3.7-8.

Table 3.7-8: Summary of No Action Alternative Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Pathway	Indicator	Effects of No Action Alternative
Water Quality	Turbidity, Dissolved Oxygen, Water Contamination/Nutrients, Sediment Contamination	Implementation of the No Action Alternative would maintain baseline water quality conditions.
Physical Habitat Features	Substrate/Armoring, Depth/Slope, Tideland Conditions, Marsh Prevalence, Refugia, Physical Barriers, Current Patterns, Salt/Fresh Water Mixing Patterns and Locations	Implementation of the No Action Alternative would maintain existing environmental baseline conditions for fish habitat.
Biological Habitat Features	Fish Prey Availability, Forage Fish Community, Aquatic Vegetation, Exotic Species	Implementation of the No Action Alternative would maintain existing environmental baseline conditions for fish prey availability, forage fish community, aquatic vegetation and exotic species. Underwater detonations and ordnance use would result in potential injury or mortality to individual fish, prey, and forage fish.

The second method of analysis, the PCE method, determines whether Navy activities are likely to substantially change one or more of the biological, physical, or chemical elements essential for the conservation of the fish species and habitat. PCEs are defined for each species in the Federal Register at the time the species is ESA-listed. The BE provides detailed descriptions of the PCEs for each fish species analyzed; Table 3.7-9 provides a summary of the results of the PCE analysis.

Table 3.7-9: Summary of No Action Alternative Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Chinook Salmon California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Chinook Salmon Puget Sound ESU, Washington Chinook Salmon Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Table 3.7-9: Summary of No Action Alternative Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area (cont'd)

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Steelhead Trout Northern California ESU Steelhead Trout Central California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Steelhead Trout Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Chum Salmon Hood Canal ESU Washington Chum Salmon Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Oregon Coast ESU, Oregon	FR 73(28):7832; (2/11/08)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Northern California-Southern Oregon Coasts ESU, California and Oregon	FR 64(86): 24050, 24053, 24059; (5/5/99)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater and riparian components of critical habitat areas and will not adversely affect the designated PCEs.
Bull Trout Coastal Puget Sound, Washington (CHU 28) Bull Trout Olympic Peninsula River Basins Washington (CHU 27)	FR 70(185):56266; (9/26/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will occur in the critical habitat area, but the level of activity would be too small to substantially affect the PCEs; DOD lands where the most intensive Navy training and other activities will occur are excluded from critical habitat designation, thereby further reducing total effects on the PCEs.
Green Sturgeon Southern DPS	FR 73(174):52084; (9/8/08)	No destruction or adverse modification of designated critical habitat	Navy training activities and operations will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Based on the matrix of pathways analysis, implementation of the No Action Alternative would maintain baseline water quality, physical habitat features, and biological habitat features. As previously stated, the June 2008 NMFS Biological Opinion for Navy EOD Operations concluded that EOD activities are not likely to adversely modify critical habitat of Puget Sound Chinook salmon or Hood Canal summer-run chum salmon (NMFS 2008). The USFWS also considered habitat in their analysis of EOD activities impacts on bull trout. Based on the agency findings and the PCE analysis presented above, the Navy finds the NWTRC activities associated with implementation of the No Action Alternative would result in no destruction or adverse modification of designated critical habitat.

Essential Fish Habitat

This section discusses the potential impacts by the No Action Alternative to EFH and managed species. Despite nearshore and offshore designations of the Study Area, species within all FMPs may utilize both nearshore and offshore areas during their lives, as eggs and larvae for most species are planktonic and can occur in nearshore and offshore waters, while adults may be present in nearshore and/or offshore waters. Therefore, all project activities under the No Action Alternative can potentially affect a lifestage of a managed species.

Adverse effects mean any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810(a)).

The proposed activities in the NWTRC have the potential to result in the following impacts:

- Physical disruption of habitat;
- Physical destruction or adverse modification of benthic habitats;
- Alteration of water or sediment quality from debris or discharge; and
- Cumulative impacts.

Impacts and activities associated with those impacts are discussed below, and a more comprehensive analysis is available in the associated EFH Assessment. Permanent, adverse impacts to EFH components are not anticipated since activities are conducted to avoid sensitive habitats and potential impacts; however, there are temporary unavoidable impacts associated with several activities that may result in localized adverse impacts.

Effects to EFH could potentially result from either acoustic impacts, or from explosive forces and material introduced into the water column and sediments from explosive source sonobuoy activities. Therefore, no effects to EFH due to active sonar are anticipated.

Impacts to EFH from explosions would be possible, but have a low potential for occurrence. Habitat disturbance from explosions is reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. Disturbances to water column and benthic habitats from explosions would be short-term and localized. The Navy conducts a limited number of training activities over a large area (112,400 nm^2 [approximately 430,000 km^2]).

Explosive source sonobuoys could affect water quality by the release of explosive byproducts, and could affect bottom habitats releasing chemicals (primarily from batteries) into the sediment. The sonobuoy explosive package consists primarily of HLX (*i.e.,* explosive cord) and small amounts of plastic-bonded molding powder. Explosions create gaseous byproducts, many of which travel to the surface and escape into the atmosphere. A small amount of the gas, however, dissolves into the water column. Although several byproducts are produced, the products with greatest potential to result in toxicity are hydrogen fluoride compounds. However, only a minute amount of these substances are expected to be introduced, and they would be rapidly diluted by water movement. It is therefore considered unlikely that the explosive reactions associated with sonobuoys will result in contamination to EFH.

Sonobuoys use various types of batteries to power different components. Typical batteries employed include seawater, lithium, and thermal batteries. Soluble battery constituents of potential concern that may be released into the water column or sediments include lead, silver, and copper. Several other constituents such as chloride, bromide, and lithium may be released as well. Several investigations into the potential effects of battery constituents on seawater and sediment conditions found acceptable levels of such substances (ESG 2005, Kszos 2003, Borener and Maughan, 1998, U.S. Coast Guard, 1994, NAVFAC, 1993). Little accumulation of battery constituents occurred in sediments, and mixing and diffusion resulted in low concentrations in the water column. Therefore, there are no significant impacts to EFH anticipated from sonobuoy batteries.

Lithium sulfur dioxide batteries provide power for propulsion of EMATTs. The final battery byproducts include lithium ions, hydroxide (which combines with hydronium to form water), and sulfate. All of these substances are considered benign in the marine environment. In addition, the chemical reactions of the batteries will be highly localized and short-lived, and ocean currents will diffuse concentrations of the chemicals leached by the batteries. Due to the rapid dilution of chemical releases, accumulation of chemicals in sediments is not likely. Therefore, there are no significant impacts to EFH anticipated from or EMATTs.

Vessel movements, aircraft overflights, underwater detonations and explosive ordnance use, sonar activities, non-explosive ordnance use, weapons firing disturbance, expended materials, and target related materials under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA.

3.7.2.4 Alternative 1

Under Alternative 1, the general level of some activities in the NWTRC Study Area would increase relative to the baseline No Action Alternative; however, underwater detonation exercises would decrease, as described in Chapter 2.

Vessel Movements

As described for the No Action Alternative, the number of Navy vessels operating during training exercises varies, but generally includes up to two vessels, with an average of one vessel. Under Alternative 1, steaming hours would increase four percent from current conditions. During a year of activities, 7,228 steaming hours would occur in the NWTRC. Vessel movements would be widely dispersed throughout the OPAREA, with approximately 0.06 hours of steaming per square nautical mile.

The small increase in steaming hours would not measurably increase potential effects to fish. Disturbance impacts to fish from vessel movements under Alternative 1 would be the same as those described for the No Action Alternative.

Vessel movements under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, vessel movements in territorial waters under the Alternative 1 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from vessel movements in non-territorial waters would be minimal in accordance with EO 11214.

Aircraft Overflights

Under Alternative 1, approximately 8,077 overflights would occur above the NWTRC annually. This would represent an 18 percent increase from current conditions. Of these, 93 would be helicopter flights, conducted primarily over land. The majority of the remaining non-helicopter overflights would occur over marine environments of the NWTRC, at elevations in excess of 3,000 ft above sea level, and over 3 nm from shore.

This increase in overflights would produce an annual distribution of 0.01 overflights per square nautical mile over the NWTRC. This modest increase in potential exposure to visual and noise disturbance would not measurably increase effects to fish. Thus, the impacts of overflights under Alternative 1 would be the same as those for the No Action Alternative.

Aircraft overflights under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under MSFCMA. In accordance with NEPA, aircraft overflights in territorial waters under Alternative 1 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from aircraft overflights in non-territorial waters would be minimal in accordance with EO 11214.

Underwater Detonations and Explosive Ordnance

As shown in Table 2-9, underwater explosions that occur in the offshore areas of the NWTRC are associated with explosive ordnance use. Under Alternative 1, approximately 144 bombs, 35 missiles, and 9,422 sonobuoys (includes 136 explosive sonobuoys) would be used in the OPAREA training area each year. This would produce a very low density of offshore explosions per year in the Study Area of less than 0.003 explosions per nm^2. Explosive ordnance use would increase under Alternative 1, compared to the No Action Alternative, as described in Chapter 2. Fish exposed to underwater explosions would suffer temporary effects, sub-lethal or lethal injuries, or direct mortality, in proportion to the proximity to the explosion and size of the detonation.

Under Alternative 1, the number of underwater detonations and net explosive weight of underwater detonations would decrease by more than 90 percent. Under Alternative 1, two detonations (2.5-lb net explosive weight each) would occur per year at the Crescent Harbor Underwater EOD Range; one detonation (2.5-lb net explosive weight) would occur at the Floral Point Underwater EOD Range; and one detonation (2.5-lb net explosive weight) would occur at the Indian Island Underwater EOD Range. Detonations would occur either at water surface, or underwater at depth. As such, fewer and smaller detonations would reduce the potential to affect fish in the Study Area, compared to the No Action Alternative.

As described for the No Action Alternative, impacts to fish from explosions would be possible, but have a low potential for occurrence. Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of underwater detonations and high explosive ordnance use, explosions under the Alternative 1 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from explosions would be short-term and localized.

Sonar

Under Alternative 1, sonar would have the potential to affect fish in the Study Area. Most fish species would be able to detect mid-frequency sonar at the lower end of its range. Short-term behavioral responses such as startle and avoidance may occur, but are not likely to adversely affect indigenous fish communities. Auditory damage from sonar signals is not expected and there is no indication that non-impulsive acoustic sources would result in fish mortality. Sonar use under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, sonar use in territorial waters under the Alternative 1 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from sonar use in non-territorial waters would be minimal in accordance with EO 11214.

Non-Explosive Ordnance Use

Under Alternative 1, non-explosive ordnance use would increase over the No Action Alternative by approximately 12 percent. The Navy conducts a limited number of training activities over a large area, therefore the rate of ordnance use would result in a spent ordnance density of approximately 0.78 pieces/nm^2 in the OPAREA. This modest increase in potential exposure would not measurably increase effects to fish. Thus, the impacts of ordnance strikes on fish would be the same as those for the No Action Alternative.

Impacts to fish from non-explosive ordnance use would be possible, but have a low potential for occurrence. Habitat disturbance and fish injury and mortality from ordnance use are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of non-explosive ordnance use, implementation of Alternative 1 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from explosions would be short-term and localized. Non-explosive ordnance use under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, non-explosive ordnance use in territorial waters under the Alternative 1 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from non-explosive ordnance use in non-territorial waters would be minimal in accordance with EO 11214.

Weapons Firing Disturbance

Under Alternative 1, weapons firing activities would continue, but because fish apparently only react to impulsive sounds greater than 160 dB, only those in the immediate vicinity (0.015 km^2 area) would be affected and effects would be limited to short-term, transitory alarm or startle responses. The impacts to fish would be the same as those described for the No Action Alternative.

Under the Alternative 1, weapons firing may affect fish, but this affect would be minimal. Weapons firing under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, these activities would have minimal impact on fish in territorial waters. Furthermore, harm to fish from weapons firing would not be likely in non-territorial waters in accordance with EO 12114.

Expended Materials

Under Alternative 1, expended ordnance in the Study Area would increase approximately eleven percent over the No Action Alternative. Assuming all ordnance would be expended throughout the OPAREA in an even distribution, the concentration of expended rounds would be approximately 0.86 per nm^2 (0.25 per km^2). Under Alternative 1, the use of targets would increase by approximately four percent. The impacts to fish would be the same as those described for the No Action Alternative.

Under Alternative 1, ingestion of expended materials is possible, but has a low potential for occurrence, as described for the No Action Alternative. Expended materials under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, expended materials in territorial waters under the Alternative 1 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from expended materials in non-territorial waters would be minimal in accordance with EO 11214.

Threatened and Endangered Species and Critical Habitat

Threatened and Endangered Species. As discussed in Section 3.7.1.4, species of ESA-designated salmonids with known or potential occurrence in the NWTRC include: chinook, coho, and chum salmon; and steelhead and bull trout. Chinook, coho, and chum salmon; and steelhead trout are under the jurisdiction of NMFS. Bull trout are under the jurisdiction of USFWS. Both Northern and Southern DPS green sturgeon occupy coastal estuaries and coastal marine waters in the NWTRC. Green sturgeon are under the jurisdiction of NMFS.

Underwater detonations under Alternative 1 would be similar to those analyzed by NMFS and USFWS for Navy EOD Operations, Puget Sound. The June 2008 NMFS Biological Opinion states "the National Marine Fisheries Service concludes that the proposed action is not likely to jeopardize the continued existence of the Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Hood Canal summer-run chum salmon (*O. keta*), Puget Sound steelhead (*O. mykiss*), or southern resident killer whales (*Orcinus orca*); and not likely to adversely modify critical habitat for Puget Sound Chinook salmon, Hood Canal summer-run chum salmon or southern resident killer whales."

The November 2008 USFWS Biological Opinion determined that these EOD training activities would result in the incidental take in the form of harm (through death or physical injury from the direct effects of the pressure wave resulting from detonation of the explosive during the EOD training) to a total of five juvenile, sub-adult or adult bull trout in the Crescent Harbor action area. The USFWS Biological Opinion concluded that this level of anticipated take is not likely to jeopardize the continued existence of the bull trout. USFWS also stated that "…no reasonable and prudent measure(s) are necessary and appropriate to minimize impacts of incidental take of bull trout. Measures that are designed to minimize impacts to bull trout have been incorporated by the Navy…" The terms and conditions included in USFWS' Biological Opinion require Navy to monitor the impacts of the incidental take.

The findings of these Biological Opinions have been used in the analysis for this EIS/OEIS. Utilizing criteria and analysis methodology as presented previously for non-listed species, vessel movements, aircraft overflight, underwater detonations, explosive ordnance use, sonar, non-explosive ordnance use, weapons firing, and expended materials may affect individual ESA-listed fish in the NWTRC, However, these activities would not have community or population level effects.

As part of the EIS/OEIS process, Navy has prepared a BE for the NWTRC for use, as appropriate, in consultation with NMFS and USFWS. The BE provides detailed descriptions and analysis of the potential impacts to all threatened or endangered species and critical habitats protected under the ESA.

Critical Habitat. The potential effects of the Proposed Action on the habitat of ESA-designated species within the NWTRC are analyzed in the BE two ways: first, using a matrix of pathways approach developed by NMFS (1996) and USFWS (1998), and second, using an approach that relies upon habitat primary constituent elements (PCEs).

The matrix of pathways analysis indicates implementation of Alternative 1 could improve baseline environmental conditions, as Table 3.7-10 presents.

The second method of analysis, the PCE method, determines whether Navy activities are likely to substantially change one or more of the biological, physical, or chemical elements essential for the conservation of the fish species and habitat. PCEs are defined for each species in the Federal Register at the time the species is ESA-listed. The BE provides detailed descriptions of the PCEs for each fish species analyzed; Table 3.7-11 provides a summary of the results of the PCE analysis.

Table 3.7-10: Summary of Alternative 1 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Pathway	Indicator	Effects of Alternative 1
Water Quality	Turbidity, Dissolved Oxygen, Water Contamination/Nutrients, Sediment Contamination.	Implementation of Alternative 1 would maintain off shore baseline water quality conditions. Implementation of Alternative 1 has the potential to restore existing near shore environmental baseline conditions due to the >90% reduction in underwater detonation activities.
Physical Habitat Features	Substrate/Armoring, Depth/Slope, Tideland Conditions, Marsh Prevalence, Refugia, Physical Barriers, Current Patterns, Salt/Fresh Water Mixing Patterns and Locations.	Implementation Alternative 1 would maintain existing environmental baseline conditions for fish habitat.
Biological Habitat Features	Fish Prey Availability, Forage Fish Community, Aquatic Vegetation, Exotic Species.	Implementation of Alternative 1 would maintain existing environmental baseline conditions for prey availability, forage fish community, aquatic vegetation and exotic species. Underwater detonations and ordnance use would result in potential injury or mortality to individual fish, prey, and forage fish.

Table 3.7-11: Summary of Alternative 1 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Chinook Salmon California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Chinook Salmon Puget Sound ESU, Washington Chinook Salmon Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Steelhead Trout Northern California ESU Steelhead Trout Central California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Steelhead Trout Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Table 3.7-9: Summary of Alternative 1 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area (cont'd)

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Chum Salmon Hood Canal ESU Washington Chum Salmon Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Oregon Coast ESU, Oregon	FR 73(28):7832; (2/11/08)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Northern California-Southern Oregon Coasts ESU, California and Oregon	FR 64(86): 24050, 24053, 24059; (5/5/99)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater and riparian components of critical habitat areas and will not adversely affect the designated PCEs.
Bull Trout Coastal Puget Sound, Washington (CHU 28) Bull Trout Olympic Peninsula River Basins Washington (CHU 27)	FR 70(185):56266; (9/26/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will occur in the critical habitat area, but the level of activity would be too small to substantially affect the PCEs; DOD lands where the most intensive Navy training and other activities will occur are excluded from critical habitat designation, thereby further reducing total effects on the PCEs.
Green Sturgeon Southern DPS	FR 73(174):52084; (9/8/08)	No destruction or adverse modification of designated critical habitat	Navy training activities and operations will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Based on the matrix of pathways analysis, implementation of Alternative 1 would maintain (or potentially improve, since there would be fewer underwater detonations under Alternative 1 than current conditions) baseline water quality, and maintain physical and biological habitat features. Based on the PCE analysis, implementation of Alternative 1 would result in no destruction or adverse modification of designated critical habitat. Based analysis methods presented in Section 3.7.2.4, physical injury to fish could occur within the distances of a detonation site shown in Tables 3.7-5 and 3.7-6. Fish injury and mortality from explosions are reduced by Navy protective measures, as discussed in Section 3.7.1.6.

As previously stated, the June 2008 NMFS Biological Opinion for Navy EOD Operations concluded that EOD activities are not likely to adversely modify critical habitat of Puget Sound Chinook salmon or Hood Canal summer-run chum salmon (NMFS 2008). The USFWS also considered habitat in their analysis of EOD activities impacts on bull trout. Based on the agency findings and the PCE analysis presented above, the Navy finds the NWTRC activities associated with implementation of Alternative 1 would result in no destruction or adverse modification of designated critical habitat.

Essential Fish Habitat

Under Alternative 1, increased vessel movement and aircraft over-flights would cause brief, reversible disruptions in fish distribution. Additional expended materials are not expected to measurably increase exposure to toxic chemicals, through contact with or ingestion of debris, or from entanglement. The quantity of material expended over a large area, combined with the rapid dilution of dissolved constituents, the relatively non-toxic nature of the debris, and its eventual encrustation and incorporation into the sediments, would minimize adverse affects on resident marine communities.

Underwater detonations and weapons training could kill or injure marine life, affect hearing organs, modify behavior, and have indirect effects on prey species and other components of the food web. Under Alternative 1, annual underwater detonations would be decreased by >90%. Beyond the range of direct, lethal or sub-lethal impacts to individual fish, minor, short-term behavioral reactions would not be ecologically substantial. No lasting adverse effect of underwater detonations or weapons training on prey availability or on the food web is expected.

Most munitions used in the NWTRC would not have explosive warheads. The shock force from inert bombs and missiles hitting the sea surface would not substantially affect local species or habitats. Munitions use is not anticipated to have adverse regional consequences.

The EFH assessment concludes that vessel movements, aircraft overflights, underwater detonations and explosive ordnance use, sonar activities, non-explosive ordnance use, weapons firing disturbance, expended materials, and target related materials under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA.

3.7.2.5 Alternative 2, the Preferred Alternative

Under Alternative 2, the general level of activities in the NWTRC Study Area would increase relative to the baseline No Action Alternative.

Vessel Movements

As described for the other alternatives, the number of Navy vessels operating during training exercises varies and would average one vessel per exercise. During a year of activities, steaming hours would increase, relative to current conditions, by 10 percent to 7,628 hours. Vessel movements would be widely dispersed throughout the OPAREA, with approximately 0.06 hours of steaming per nm^2.

The small increase in steaming hours would not measurably increase potential effects to fish. Disturbance impacts to fish from vessel movements under Alternative 2 would be the same as those described for the No Action Alternative, and Alternative 1.

Vessel movements under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, vessel movements in territorial waters under Alternative 2 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from vessel movements in non-territorial waters would be minimal in accordance with EO 11214.

Aircraft Overflights

Under Alternative 2, 10,582 overflights would occur annually which would represent a 54 percent increase over current conditions. As described for the other alternatives, the majority of these overflights would occur over marine environments of the NWTRC, at elevations in excess of 3,000 ft above sea level, and beyond 12 nm.

Under Alternative 1, overflights would produce an annual distribution of 0.086 overflights per square nautical mile over the NWTRC. This modest increase in potential exposure to visual and noise disturbance would not measurably increase effects to fish populations over existing conditions. Thus, the impacts of overflights under Alternative 2 would be the same as those for the No Action Alternative and Alternative 1.

Aircraft overflights under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under MSFCMA. In accordance with NEPA, aircraft overflights in territorial waters under the Alternative 2 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from aircraft overflights in non-territorial waters would be minimal in accordance with EO 11214.

Underwater Detonations and Explosive Ordnance

Underwater explosions that occur in the offshore areas of the NWTRC are associated with explosive ordnance use. As shown in Table 2-9, under Alternative 2, approximately 144 bombs, 57 missiles, and 9,651 sonobuoys (includes 149 explosive sonobuoys) would be used in the OPAREA training area each year. This would produce a very low density of offshore explosions per year in the Study Area of less than 0.003 explosions per nm^2. Explosive ordnance use under Alternative 2 would increase over baseline conditions, as described in Chapter 2. Fish exposed to underwater explosions would suffer temporary effects, sub-lethal or lethal injuries, or direct mortality, in proportion to the proximity to the explosion and size of the detonation.

Underwater detonations under Alternative 2 would be the same as under Alternative 1; underwater detonations under Alternative 2 would be approximately 93 percent less than the No Action Alternative.

Impacts to fish from explosions would be possible, but have a low potential for occurrence. Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of underwater detonations and high explosive ordnance use, explosions under the Alternative 2 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from explosions would be short-term and localized. The Navy conducts a limited number of training activities over a large area (112,400 nm^2 [430,000 km^2]).

Sonar

Under Alternative 2, sonar would have the potential to affect fish in the Study Area. Most fish species would be able to detect mid-frequency sonar at the lower end of its range. Short-term behavioral responses such as startle and avoidance may occur, but are not likely to adversely affect indigenous fish communities. Auditory damage from sonar signals is not expected and there is no indication that non-impulsive acoustic sources result in fish mortality. Sonar use under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, sonar use in territorial waters under the Alternative 2 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from sonar use in non-territorial waters would be minimal in accordance with EO 11214.

Non-Explosive Ordnance Use

Under Alternative 2, non-explosive ordnance would increase (approximately 200%) above current baseline conditions. The Navy conducts training activities over a large area; as such, the rate of ordnance use would result in a spent ordnance density of approximately 0.44 pieces per nm^2 in the OPAREA. This increase in potential exposure would not measurably increase effects to fish. Thus, the impacts of non-explosive ordnance use on fish would be essentially the same as those for the No Action Alternative and Alternative 1.

Impacts to fish from non-explosive ordnance use would be possible, but have a low potential for occurrence. Habitat disturbance as well as fish injury and mortality are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of non-explosive ordnance use, implementation of Alternative 2 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from non-explosive ordnance use would be short-term and localized. Non-explosive ordnance use under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, non-explosive ordnance use in territorial waters under the Alternative 2 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from non-explosive ordnance use in non-territorial waters would be minimal in accordance with EO 11214.

Weapons Firing Disturbance

Under Alternative 2, weapons firing activities would continue, but because fish apparently only react to impulsive sounds greater than 160 dB, only those in the immediate vicinity (0.015 km^2 area) would be affected and effects would be limited to short-term, transitory alarm or startle responses. The impacts to fish would be the same as those described for the No Action Alternative.

Under the Alternative 2, weapons firing may affect fish, but this affect would be minimal. Weapons firing under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, these activities would have minimal impact on fish in territorial waters. Furthermore, harm to fish from weapons firing would not be likely in non-territorial waters in accordance with EO 12114.

Expended Materials

Under Alternative 2, the expended materials in the study area would increase over current baseline conditions by approximately 93 percent. The Navy conducts training activities over a large area; as such, the rate of ordnance use would result in an annual spent ordnance density of approximately 1.5 pieces per nm^2 in the OPAREA. This increase in potential exposure would not measurably increase effects to fish. Thus, the impacts of expended materials on fish would be similar to those for the No Action Alternative and Alternative 1. The use of targets would be the same as Alternative 1.

Under Alternative 2, ingestion of expended materials is possible, but has a low potential for occurrence, as described for the No Action Alternative. Expended materials under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, expended materials in territorial waters under the Alternative 2 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from expended materials in non-territorial waters would be minimal in accordance with EO 11214.

Threatened and Endangered Species and Species of Concern

Threatened and Endangered Species. As discussed in Section 3.7.1.4, species of ESA-designated salmonids with known or potential occurrence in the NWTRC include: chinook, coho, and chum salmon; and steelhead and bull trout. Chinook, coho, and chum salmon; and steelhead trout are under the jurisdiction of NMFS. Bull trout are under the jurisdiction of USFWS. Both Northern and Southern DPS green sturgeon occupy coastal estuaries and coastal marine waters in the NWTRC. Green sturgeon are under the jurisdiction of NMFS.

Underwater detonations under Alternative 2 would be similar to those analyzed by NMFS and USFWS for Navy EOD Operations, Puget Sound. The June 2008 NMFS Biological Opinion states "the National Marine Fisheries Service concludes that the proposed action is not likely to jeopardize the continued existence of the Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Hood Canal summer-run chum salmon (*O. keta*), Puget Sound steelhead (*O. mykiss*), or southern resident killer whales (*Orcinus orca*); and not likely to adversely modify critical habitat for Puget Sound Chinook salmon, Hood Canal summer-run chum salmon or southern resident killer whales."

The November 2008 USFWS Biological Opinion determined that these EOD training activities would result in the incidental take in the form of harm (through death or physical injury from the direct effects of the pressure wave resulting from detonation of the explosive during the EOD training) to a total of five juvenile, sub-adult or adult bull trout in the Crescent Harbor action area. The USFWS Biological Opinion concluded that this level of anticipated take is not likely to jeopardize the continued existence of the bull trout. USFWS also stated that "…no reasonable and prudent measure(s) are necessary and appropriate to minimize impacts of incidental take of bull trout. Measures that are designed to minimize impacts to bull trout have been incorporated by the Navy…" The terms and conditions included in USFWS' Biological Opinion require Navy to monitor the impacts of the incidental take.

The findings of these Biological Opinions have been used in the analysis for this EIS/OEIS. Utilizing criteria and analysis methodology as presented previously for non-listed species, vessel movements, aircraft overflight, underwater detonations, explosive ordnance use, sonar, non-explosive ordnance use, weapons firing, and expended materials may affect individual ESA-listed fish in the NWTRC. However, these activities would not have community or population level effects.

As part of the EIS/OEIS process, Navy has prepared a BE for the NWTRC for use, as appropriate, in consultation with NMFS and USFWS. The BE provides detailed descriptions and analysis of the potential impacts to all threatened or endangered species and critical habitats protected under the ESA.

Critical Habitat. The potential effects of the Proposed Action on the habitat of ESA-designated species within the NWTRC are analyzed in the BE two ways: first, using a matrix of pathways approach developed by NMFS (1996) and USFWS (1998), and second, using an approach that relies upon habitat primary constituent elements (PCEs).

Based on the matrix of pathways analysis, implementation of Alternative 2 would maintain (or potentially improve, since there would be fewer underwater detonations under Alternative 2 than current conditions) baseline water quality, and maintain physical and biological habitat features, as Table 3.7-12 presents. Based on the PCE analysis, implementation of Alternative 2 would result in no destruction or adverse modification of designated critical habitat (Table 3.7-13). Based analysis methods presented in Section 3.7.2.4, physical injury to fish could occur within the distances of a detonation site shown in Tables 3.7-5 and 3.7-6. Fish injury and mortality from explosions are reduced by Navy protective measures, as discussed in Section 3.7.1.6.

As previously stated, the June 2008 NMFS Biological Opinion for Navy EOD Operations concluded that EOD activities are not likely to adversely modify critical habitat of Puget Sound Chinook salmon or Hood Canal summer-run chum salmon (NMFS 2008). The USFWS also considered habitat in their analysis of EOD activities impacts on bull trout. Based on the agency findings and the PCE analysis presented above, the Navy finds the NWTRC activities associated with implementation of Alternative 2 would result in no destruction or adverse modification of designated critical habitat

Table 3.7-12: Summary of Alternative 2 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Pathway	Indicator	Effects of Alternative 2
Water Quality	Turbidity, Dissolved Oxygen, Water Contamination/Nutrients, Sediment Contamination	Implementation of Alternative 2 would maintain off shore baseline water quality conditions. Implementation of Alternative 2 has the potential to restore existing near shore environmental baseline conditions due to the >90% reduction in underwater detonation activities.
Physical Habitat Features	Substrate/Armoring, Depth/Slope, Tideland Conditions, Marsh Prevalence, Refugia, Physical Barriers, Current Patterns, Salt/Fresh Water Mixing Patterns and Locations	Implementation Alternative 2 would maintain existing environmental baseline conditions for fish habitat.
Biological Habitat Features	Fish Prey Availability, Forage Fish Community, Aquatic Vegetation, Exotic Species	Implementation of Alternative 2 would maintain existing environmental baseline conditions for prey availability, forage fish community, aquatic vegetation and exotic species. Underwater detonations and ordnance use would result in potential injury or mortality to individual fish, prey, and forage fish.

Table 3.7-13: Summary of Alternative 2 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Chinook Salmon California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Chinook Salmon Puget Sound ESU, Washington Chinook Salmon Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Steelhead Trout Northern California ESU Steelhead Trout Central California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Steelhead Trout Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Table 3.7-9: Summary of Alternative 1 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area (cont'd)

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Chum Salmon Hood Canal ESU Washington Chum Salmon Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Oregon Coast ESU, Oregon	FR 73(28):7832; (2/11/08)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Northern California-Southern Oregon Coasts ESU, California and Oregon	FR 64(86): 24050, 24053, 24059; (5/5/99)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater and riparian components of critical habitat areas and will not adversely affect the designated PCEs.
Bull Trout Coastal Puget Sound, Washington (CHU 28) Bull Trout Olympic Peninsula River Basins Washington (CHU 27)	FR 70(185):56266; (9/26/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will occur in the critical habitat area, but the level of activity would be too small to substantially affect the PCEs; DOD lands where the most intensive Navy training and other activities will occur are excluded from critical habitat designation, thereby further reducing total effects on the PCEs.
Green Sturgeon Southern DPS	FR 73(174):52084; (9/8/08)	No destruction or adverse modification of designated critical habitat	Navy training activities and operations will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.

<u>Essential Fish Habitat</u>

Under Alternative 2, increased vessel movement and aircraft over-flights would cause brief, reversible disruptions in fish distribution. Additional expended materials are not expected to measurably increase exposure to toxic chemicals, through contact with or ingestion of debris, or from entanglement. The quantity of material expended over a large area, combined with the rapid dilution of dissolved constituents, the relatively non-toxic nature of the debris, and its eventual encrustation and incorporation into the sediments, would minimize adverse affects on resident marine communities.

Underwater detonations and weapons training could kill or injure marine life, affect hearing organs, modify behavior, and have indirect effects on prey species and other components of the food web. Under Alternative 2, annual underwater detonations would be decreased by more than 90%. Beyond the range of direct, lethal or sub-lethal impacts to individual fish, minor, short-term behavioral reactions would not be ecologically substantial. No lasting adverse effect of underwater detonations or weapons training on prey availability or on the food web is expected.

Most munitions used in the NWTRC would not have explosive warheads. The shock force from inert bombs and missiles hitting the sea surface would not substantially affect local species or habitats. Munitions use is not anticipated to have adverse regional consequences.

The EFH assessment concludes that vessel movements, aircraft overflights, underwater detonations and explosive ordnance use, sonar activities, non-explosive ordnance use, weapons firing disturbance, expended materials, and target related materials under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA.

3.7.3 Mitigation Measures

As summarized in Section 3.7.4, the alternatives proposed in the EIS/OEIS would be expected to affect individual fish and have localized affects on their habitats, but would not affect communities or populations of species or their use of the NWTRC. The current protective measure described in Chapter 5 would continue to be implemented; and no further mitigation measures would be needed to protected fish in the NWTRC.

3.7.4 Summary of Effects by Alternative

Table 3.7-14 presents a summary of effects on fish and EFH for the No Action, Alternative 1, and Alternative 2.

Table 3.7-14: Summary of Effects – Fish and Essential Fish Habitat

Alternative	NEPA (Inland Waters and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Aircraft overflight, weapons firing disturbance, and expended materials associated with the No Action Alternative would result in minimal effects to fish and EFH. • Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, effects of sonar used in Navy exercises on fish and EFH are minimal. • Effects of non-explosive ordnance use on fish populations or EFH would be minimal. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Baseline environmental conditions of critical habitat would remain the same. The No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. • Underwater explosions may affect ESA-listed fish species.	• Aircraft overflight, weapons firing disturbance, and expended materials would result in minimal harm to fish or EFH. • Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, sonar used in Navy exercises would result in minimal harm to fish or EFH. • Non-explosive ordnance use would result in minimal harm to fish populations or EFH. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Baseline environmental conditions of critical habitat would remain the same. • No effect to threatened and endangered species or critical habitat.
Alternative 1	• Impacts similar to those described in the No Action Alternative. Environmental conditions of critical habitat would be improved compared to current baseline conditions, since underwater detonations would be reduced from current conditions by greater than 90 percent.	• Impacts similar to those described in the No Action Alternative.
Alternative 2 (Preferred Alternative)	• Impacts similar to those described in the No Action Alternative. Environmental conditions of critical habitat would be improved compared to current baseline conditions, since underwater detonations would be reduced from current conditions by greater than 90 percent.	• Impacts similar to those described in the No Action Alternative.