3.0 DESCRIPTION OF ADVERSE EFFECTS ON PACIFIC SALMON ESSENTIAL FISH HABITAT AND ACTIONS TO ENCOURAGE THE CONSERVATION AND ENHANCEMENT OF ESSENTIAL FISH HABITAT

3.1 FISHING ACTIVITIES AFFECTING SALMON ESSENTIAL FISH HABITAT

The Magnuson-Stevens Act requires the Council to minimize adverse effects on EFH from fishing activities to the extent practicable. According to the interim final rule to implement EFH provisions of the Magnuson-Stevens Act, adverse effects of fishing may include physical, chemical or biological alterations of the substrate, and loss of or injury to benthic organisms, prey species and their habitat, and other components of the ecosystem.

The marine activities considered in this section which the Council can directly influence are the effects of fishing gear, prey removal by other fisheries, and the effect of salmon fishing on the reduction of nutrient enrichment in salmon spawning streams. This section also considers similar activities under control of the states and tribes, as well as disturbance of redds or fish in shallow water environments from fishing activities (e.g., vessel operation).

Other activities that may be directly or indirectly associated with fishing but are not regulated by state, federal or tribal fishery management entities are considered in the section on nonfishing activities. These activities include environmental impacts from fish processing, hatchery operation, vessel operation and maintenance, and marina construction and dredging. The direct harvest and injury impacts of fishing activities on salmon abundance are addressed primarily in Chapters 2 and 3 of the Pacific Coast Salmon Plan.

Actions the Council will take to reduce fishing effects on habitat, and actions that the Council recommends others take to protect habitat, are not the only efforts being undertaken, nor the only efforts necessary, to help restore sustainable fisheries. For example, to restore salmon abundance, many fish hatchery operations have been improved to minimize negative effects on wild salmon populations, and extensive restrictions on salmon fishing have been imposed. In the past decade, the Council has significantly reduced fishing limits and seasons coastwide to assure that sufficient numbers of adult salmon from various stocks reach their spawning grounds. Specifically, to protect salmon listed under the ESA, the Council has limited recreational salmon fishing on healthy California salmon stocks to reduce the chance of catching endangered Sacramento River winter chinook. Similarly, the Council limited all commercial ocean fisheries on healthy salmon runs in 1997 to reduce the incidental take of threatened Snake River fall chinook. (It should be noted that Council-managed salmon fisheries do not affect Snake River spring-summer chinook or sockeye salmon and have only minor effects on pink salmon stocks.)

Despite fishing curtailments or closures and improved hatchery practices, coho and chinook populations have continued to decline in Oregon, Washington, and California (Nehlsen 1997). Four of 15 stocks of Puget Sound pink salmon are classified as not healthy, with two populations considered depressed and two in critical condition (WDF 1993). In earlier studies of salmon declines, habitat problems were a factor contributing to about 91% of these declines (Nehlsen *et al.* 1991).

3.1.1 Fishing Activities under the Control of the Council -- Potential Effects on EFH and Measures to Minimize Adverse Affects

Gear Effects

There are no studies that indicate direct gear effects on salmon EFH from Council-managed fisheries. A report prepared for NMFS by Auster and Langton (1998) provides a review and analysis of the studies done on fishing gear and habitat effects (primarily trawl and dredging studies from nonWest Coast sites). Additionally, the 1998 draft EFH report of the North Pacific Fishery Management Council (NPFMC 1998) provides a review of some of the current research of the Alaska Fisheries Science Center on the effects of trawling on the seafloor, and on benthic organisms and their habitat. Fishing effects on habitat include the reduction of fish habitat complexity by directly removing or damaging epifauna leading to mortality, smoothing sedimentary bedforms and reducing bottom roughness, removing taxa which produce structure (i.e., taxa which produce burrows and pits) or decreasing eelgrass or seagrass density.

Because salmon are not known to be directly dependent on soft ocean bottom habitats, fishing gear that has the potential for disturbing these habitats is not likely to directly affect EFH for salmon. If fishing gear were operated in areas of eelgrass beds, and if it removed or caused a decrease in this habitat, this would be of concern. Studies done in the Pacific Northwest have documented the importance of the nearshore environment and eel grass beds to salmonids (Simenstad 1983; Simenstad and Fresh 1995).

Since chinook salmon may be associated with near bottom topography at depths of 30 to 70 meters (see Section 2.1) and because juvenile and adult chinook are associated with structure such as channels, ledges, pinnacles, reefs, vertical walls and artificial structure in marine environments (NPFMC 1998), fishing gear which disrupts these habitats has a potential to affect salmon EFH. However, there is no research information available that documents direct effects on salmon or their prey.

Anecdotal information from fishermen notes concern over the potential effect that both longline and rock-hopper trawl gear have on rocky habitat that supports juvenile rockfish that are prey for juvenile salmon. In studies reviewed by Auster and Langton (1998) and by the NPFMC, trawl gear was found to be able to move or drag boulders, damage and kill organisms, reduce habitat complexity, and resuspend sediments. In studies reviewed by the NPFMC, longline gear was found to snag rocks and corals, break corals and dislodge invertebrates. There is also anecdotal information that lost gillnets can continue to intercept salmon and their prey (both in marine and freshwater environments), until the net tangles up on itself or becomes fouled by marine growth. State and federal regulations preclude the use of gillnets in ocean waters north of 38 degrees North Latitude, and gillnet usage in nearshore waters south of that line is very limited. Moreover, mesh size restrictions tend to preclude the capture of prey species.

Gear Types Used In Salmon EFH - Types of fishing gear used in Council area fisheries are listed below. The list includes fisheries managed by the Council as well as the states and tribes. The potential effects of any gear will depend on the specifics of each fishery and each gear type (e.g., some trawl gear is fished on or near the bottom and some in mid-water, nets vary by configuration and in response to mesh size restrictions, fisheries are controlled by various time and area restrictions, etc.).

Fishery	Gear
Anchovy, sardine, mackerel	purse seine, lampara net
Clam	shovel, hydraulic dredge, clam gun
Crab	pot/trap
Groundfish	bottom/mid-water trawl, longline, hook & line, pot/trap, set gillnet, spear
Hagfish	pot/trap
Halibut (Pacific)	longline, hook & line, troll
Herring	purse seine, gillnet, pound net, hook & line, weir
Lobster	pot/trap
Salmon	troll, gillnet, purse seine, hook & line, dip net, weir
Sea urchin, abalone	hand rake, abalone iron
Sea cucumber	hand rake, trawl
Scallop	abalone iron, dredge

Shrimp, prawn	pot/trap, trawl
Smelt	dip net, gillnet
Squid	seine
Sturgeon	hook and line, gillnet
Swordfish, thresher shark	drift gillnet
Tuna (Albacore)	troll, hook and line
Tuna (Yellowfin, skipjack tuna)	purse seine, hook and line
White croaker, white sea bass, Cal. halibut *et al.*	set gillnet, hook and line

Measures - Research is needed to study gear effects on EFH of salmon and their prey, especially disturbance of eelgrass beds and rocky habitat.

Harvest of Prey Species

Commercial or recreational fisheries exist or have existed for herring, sardine, anchovy, squid, smelt, groundfish and crab. These species, either as adults or juveniles (e.g., juvenile rockfish, crab larvae) serve as important prey for salmon, and their take in fisheries may affect salmon. Additionally, it is known that pinnipeds eat herring, anchovy, mackerel, whiting and other schooling fish. Significant fisheries on these prey species could increase pinniped predation on salmon (W. Pearcy, Oregon State University, College of Oceanic and Atmospheric Science, Corvallis, Oregon, 1998, pers. comm.). It is also known that whiting and mackerel prey on juvenile salmon, so that harvests of these species may reduce predation on salmon populations.

Measures - The Council manages fisheries for groundfish and anchovy and is expanding the anchovy plan to include sardine, squid, Pacific mackerel and jack mackerel (coastal pelagic species). The groundfish and coastal pelagic species plans will include provisions to prevent overfishing and protect essential fish habitat for all of the species in these management units, including those that are prey for salmon and other predators. In addition, the harvest formulas proposed for anchovy and sardine set aside a portion of the biomass as forage reserves for predator species. The states manage other fisheries for prey species, e.g., herring. The herring fisheries occur in bays and estuaries and are tightly regulated by the states to prevent overfishing. Herring and squid are harvested primarily as spawning adults, after which many or most die.

Removal of Salmon Carcasses (Effects on Stream Nutrient Levels)

Salmon carcasses as well as their eggs, embryos, alevins, and fry provide vital nutrients to stream and lake ecosystems. Carcasses have been shown to enhance salmon growth and survival. Salmon fishing activities, as well as removal of returning fish to support hatchery operations, remove a portion of the fish whose carcasses could otherwise perform that habitat function.

One study in the Willapa Bay basin estimated that more than several thousand metric tons of salmon tissue have been lost each year as a nutrient source to streams because of reductions in salmon returns. Present amounts of salmon carcasses and their nutrients in that basin were thought to be generally less than 10% of historical levels (NRC 1996).

Carcasses have been shown to be an important habitat component, enhancing smolt growth and survival by contributing significant amounts of nitrogen and phosphorus compounds to streams. (Spence *et al.* 1996). These are the nutrients that most often limit production in oligotrophic (nutrient poor) systems.

During their first year or so, salmon may obtain nourishment from "spawners" by directly feeding on carcasses (as well as eggs) as well as by eating insects or other organisms that have fed on decomposing salmon. Additionally, aquatic and riparian plants uptake nutrients from salmon carcasses. These plants are in turn consumed by invertebrates which are the prey for juvenile salmon (Bilby *et al.* 1997). Studies in western Washington have shown that as much as 40% of the nitrogen and carbon in juvenile salmonids derive from salmon carcasses, and that the amount of marine-derived nitrogen increased, up to a point, with increased density of spawning fish. Waters that contained salmon carcasses were also found to have higher densities of juveniles, and those fish grew much faster over the winter than young salmon in waters without salmon carcasses. Following spawning, fingerling coho salmon exhibited a doubling of the rate of growth in streams sections that had been enriched with salmon carcasses (Bilby *et al.* 1997).

Although placing carcasses in streams may be helpful, it is not as effective as allowing natural escapement because (1) natural spawners provide eggs as well as carcass tissue, (2) natural escapement provides carcasses over about one or two months rather than in a one-shot approach usually associated with carcass placement, and (3) carcasses are also present in the spring, which provides juveniles with food right before they begin their downstream migration (Bilby *et al.* 1997). This multi-month benefit is particularly evident in systems that are managed for natural production and have maintained a broad run timing such as Cedar River sockeye salmon and Snohomish River coho salmon (K. Bauersfeld, Washington Department of Fish and Wildlife, Olympia, 1998, pers. comm.). Additionally, naturally spawning salmon perform the additional function of cleaning redd site gravel, which reduces the amount of fine sediment in the gravel.

Measures - Theoretically, managing for maximum sustainable yield spawner escapements, the underlying basis for Council conservation objectives, should address meeting stream system nutrient recharge needs over the long-term. Section 3.2 of the fishery management plan addresses how the Council will prevent overfishing and rebuild overfished stocks. Many stocks are currently locked in a state of chronic low abundance as a result of various overall negative environmental conditions and/or specific freshwater habitat degradation, or have been largely replaced by mitigation from hatchery production programs. These stocks are at levels far below their historic maximum sustainable yields and, even with no fishing impacts, are not likely to return in sufficient numbers to provide stream nutrient recharge from carcasses at historic levels. More study is needed on the present importance of carcasses to specific ecosystems and whether or not Council conservation goals sufficiently account for nutrient needs. These studies should provide insight into regional differences in the hydrological dynamics affecting natural salmon production, identify limiting factors to production for various stream systems, and account for background levels of nutrient enrichment from other sources, including man-caused pollution.

3.1.2. Fishing Activities Not under the Control of the Council -- Potential Effects on Essential Fish Habitat and Measures to Minimize Adverse Affects

Gear Effects on Essential Fish Habitat

See previous section entitled Gear Effects on Essential Fish habitat.

Harvest of Prey Species

See previous section entitled Harvest of Prey Species.

Removal of Salmon Carcasses (Affects on Stream Nutrient Levels)

See previous section entitled Removal of Salmon Carcasses (Affects on Stream Nutrient Levels).

Redd or Juvenile Fish Disturbance

Trampling of redds during fishing and recreational activities has a potential to cause high mortality of salmonids. Most information on redd disturbance is anecdotal. However, one study of angler wading caused high mortality (43%-96%) of alevins (very young salmon that remain in the gravel) with only one or two passes per day. The extent or cumulative effects of this type of disturbance are not known (Roberts and White 1992).

Studies in Alaska and New Zealand (Horton 1994, Sutherland and Ogle 1975) have found that in shallow water where boat use is high, and especially where channels are constricted, developing salmon eggs and alevins in the gravel can suffer high mortalities as a result of pressure changes caused by boat operations, which can result in removal of gravel or mechanical shock generated in the area under the mid-line of the boat. Studies done on the effects of jet sleds (power boats with jet units), drift boat, or kayak operation on the behavior and survival of free swimming juvenile salmon on the Rogue River have shown minimal effects, though behavioral responses are observed when vessels pass directly overhead (especially nonmotorized kayaks or driftboats) (Satterwaithe 1995). Studies along the Columbia River indicated that the wake (uprush of the bow wave) of large ships (but not smaller vessels, e.g., tugs) caused significant numbers of chinook juveniles to be killed from being washed-up and stranded on sand bars and mud flats. Stranding was not observed on the Skagit River from jet sled use (K. Bauersfeld, WDFW, 1998, pers. comm.), nor on the Rogue River from private motorboat and commercial tour boat use (Satterwaithe 1995).

Measures - Measures to minimize the effects of anglers/vessels on salmon EFH include angler/vessel restrictions and/or closures in key spawning areas during the time frame when spawning is occurring and while eggs and alevins may be present in the stream substrate, and promoting angler awareness of redd trampling. The states close important spawning reaches during spawning periods to protect spawning fish and their eggs.

Effects of Fishing Vessel Operation on Habitat

Although effects to eelgrass meadows on the West Coast do not normally result from physical disturbance and cuts made by fishing boat propellers (Phillips 1984), monitoring of effects in shallow water areas with eelgrass and significant vessel activities is needed. Sediment stirred up by constant vessel operation can decrease water clarity and reduce eelgrass survival. Additionally, in both estuarine and stream environments, the wake from boats and ships may cause increased bank erosion, increasing turbidity and sedimentation effects. Also, for navigational safety or to open up stream areas to vessel use, logs are often cleared from estuaries and channels. Effects of activities of non-fishing vessels are discussed in Section 3.2 of this appendix.

Measures - Measures to minimize the effects of fishing vessels on salmon EFH include speed limits and channel markings to avoid damage to EFH areas susceptible to bank scour and eelgrass damage and shallow water areas susceptible to redd disturbance and alevin mortality.