AMENDMENT 5
to the Fishery Management Plan
for the Salmon Fisheries in the EEZ off the Coast of Alaska

Instruction 1
In Appendix A, add Section A - 4, entitled "Provisions of Amendment 5," and insert the following paragraph:

> Amendment 5 "Description and Identification of Essential Fish Habitat." On [insert date of approval of amendment], NMFS approved Amendment 5 to the FMP which implemented the Essential Fish Habitat (EFH) provisions contained in the Magnuson-Stevens Fishery Conservation and Management Act and 50 CFR 600.815. Amendment 5 describes and identifies EFH fish habitat for anadromous fish. It also describes and identifies fishing and non-fishing threats to salmon EFH, research needs, habitat areas of particular concern, and EFH conservation and enhancement recommendations.

Instruction 2
Change the title of Appendix E, Section III, to "Life History and Habitat Requirements of Pacific Salmon." At the end of Section III. A, insert the tables titled, "Known Life History Traits," "Habitat Associations," and "Reproductive Traits," found on pages 13 - 15 of the "Essential Fish Habitat Assessment Report for the Salmon Fisheries off the Coast of Alaska" dated March 31, 1998.

Replace Appendix E, Section III. B (Sockeye Salmon), with the text and tables from pages 43 through 53 of the "Essential Fish Habitat Assessment Report for the Salmon Fisheries off the Coast of Alaska" dated March 31, 1998.

Replace Appendix E, Section III. C (Chinook Salmon), with the text and tables from pages 55 through 66 of the "Essential Fish Habitat Assessment Report for the Salmon Fisheries off the Coast of Alaska" dated March 31, 1998.

Replace Appendix E, Section III. D (Coho Salmon), with the text and tables from pages 69 through 78 of the "Essential Fish Habitat Assessment Report for the Salmon Fisheries off the Coast of Alaska" dated March 31, 1998.

Replace Appendix E, Section III. E (Pink Salmon), with the text and tables from pages 17 through 28 of the "Essential Fish Habitat Assessment Report for the Salmon Fisheries in the EEZ off the Coast of Alaska" dated March 31,1998.

Replace Appendix E, Section III. F (Chum Salmon), with the text and tables from pages 31 through 41 of the "Essential Fish Habitat Assessment Report for the Salmon Fisheries in the EEZ off the Coast of Alaska" dated March 31, 1998.
Instruction 3

Delete the information in Appendix E, Section IV. Add a new Section IV to Appendix E titled "EFH Determination."

Add Section IV.A titled "Background Information." Under this heading, insert the sections titled "Alaska Salmon," "Information Sources," "References," "Table 1 -- *Criteria for determining the upstream limit of salmon in a stream system,"* and "Summary of Technical Team Recommendations" from section 6.5 of the Environmental Assessment for Amendment 55 to the Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area; Amendment 55 to the Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area; Amendment 8 to the Fishery Management Plan for Bering Sea/Aleutian Islands King and Tanner Crabs; Amendment 5 to the Fishery Management Plan for the Scallop Fishery Off Alaska; Fishery Management Plan for the Salmon Fisheries in the EEZ Off the Coast of Alaska," dated [insert date EA is signed by Assistant Administrator for Fisheries [**hereinafter "EFH EA"**]. Do not add the following tables, which were inserted in Section III A: "Habitat Associations,""Reproductive Traits," and "Known Life History Traits."

Add Section IV.B, titled "EFH Definitions" and under this heading insert the following EFH definitions from section 6.5 of the EFH EA:

EFH Definition for Chinook Salmon
EFH Definition for Coho Salmon
EFH Definition for Pink Salmon
EFH Definition for Chum Salmon
EFH Definition for Sockeye Salmon

Add Section IV.C, titled "EFH Maps" and insert the seven state and regional maps titled "General Distribution of Eggs and Larvae, Freshwater Juvenile and Adult Chinook, Chum, Coho, Pink, and Sockeye Salmon" from section 6.5 of the EFH EA.

Instruction 4

In Appendix E, Section 5, "Habitat Concerns and Conservation Measures," keep Section A, Introduction; delete Sections B - I.

Add Appendix E, Section 5.B, titled "Fishing activities that may adversely affect EFH" and insert the following:

Directed fisheries on salmon in Alaska include marine commercial and recreational hook-and-line fisheries; marine commercial gill-net and seine fisheries; and estuarine and riverine gill-net (both set-net and drift), recreational, personal use, and subsistence fisheries. Two types of impacts can occur: (1) direct effects of the fishing gear on habitat; and (2) by-catch or entanglement of non-target species. In the marine fisheries, direct impact of the gear on marine habitats is limited, but some localized effects can occur, such as trolling weights damaging coral or purse seines damaging kelp beds or benthic structure. By-catch and entanglement of non-target species can occur in the marine fisheries; for example, demersal rockfish are caught as by-catch in hook-and-line fisheries, and seabirds and marine mammals are entangled in nets. Changes in channel morphology can occur from fishing activities; stream banks may be damaged from boat wakes. Removing woody debris to provide access and trampling stream banks can also damage salmon habitat. Where use levels are high, this type of impact may require restoration or management initiatives. An example is the Kenai River, where restoration work was needed to repair damage from recreational fishing for chinook salmon and other salmonids.

Add Appendix E, Section 5.D, titled "Non-fishing related activities that may adversely affect EFH" and insert the following:

NON-FISHING THREATS

Habitat loss and alteration can adversely affect salmon populations in Alaska. Losses of salmon habitat can result from effects of resource development (e.g., logging, mining, hydroelectric development, oil development) and other activities (e.g., urbanization). These development activities can reduce the amount and quality of salmon harvests through physical changes in habitat structure or chemical contamination.

Effects on salmon habitat can result from both large and small development projects. A major project impact could coincide with a large concentration of living marine resources in a manner that would affect fishery stocks and their supporting habitat. The process of habitat degradation, however, generally begins with small-scale projects that result in only minor losses or temporary disruptions to habitat. As the number and occurrence of these and other projects increase, their cumulative and synergistic effects may become apparent over large areas. Effects of such changes in habitat may be masked by natural phenomena and not detected for various reasons, or may become evident only gradually. Salmon at different life stages also differ in habitat requirements and tolerance to effects of habitat alteration. Thus, effects of habitat alteration on salmon stocks are often difficult to separate from the effects of other factors, such as harvests, predation, and natural environmental fluctuations.

The following sections discuss the major sources of habitat alteration that potentially threaten salmon populations and associated fisheries and related industries.

<u>Oil Development</u>

The Alaska offshore area comprises 74% of the total area of the U.S. continental shelf and is a major area of oil development. Areas where oil and gas leases have occurred or are scheduled include the Navarin Basin (1989), St. George Basin (1990), North Aleutian Basin (1990), Gulf of Alaska/Cook Inlet (1984), and the Shumagin Basin (1992). Oil is currently being produced from rigs in the Beaufort Sea and Cook Inlet.

Oil- and gas-related activities can cause pollution and use conflicts. Alterations of existing habitat may occur because of the construction of offshore drilling rigs and platforms, loading platforms and other shoreside facilities, tanker terminals, pipelines, and tankering of oil. Large oil spills are the most serious potential source of oil and gas pollution in the eastern Bering Sea, Cook Inlet, Navarin Basin, and Prince William Sound.

The 1989 *Exxon Valdez* oil spill in Prince William Sound, the largest oil spill ever in U.S. waters, contaminated 2,000 km of coastal habitat (Spies et al. 1996). It spilled 42 million liters of crude oil which had immediate acute effects and longer-term impacts on fish and wildlife. Beached oil penetrated deeply into cobbled beaches and still persists in some areas beneath the surface layer of rocks and under mussel beds. Contamination of intertidal spawning areas for pink salmon caused increased embryo mortality and possible long-term developmental and genetic damage (Bue et al. in press). Wild pink salmon spawn in intertidal stream deltas, and therefore are susceptible to marine oil spills. The embryo is a critical stage of salmon development and is vulnerable to pollution because of its long incubation in intertidal gravel and its large lipid-rich yolk, which will accumulate petroleum hydrocarbons from low-level, intermittent exposures (Heintz et al., unpub.).

Residual oil from a spill can remain toxic for long periods because the most toxic components are the most persistent. Petroleum is a complex mixture of alkanes and aromatic hydrocarbons, of which the alkyl-substituted and multi-ring polynuclear aromatic hydrocarbons (PAH) are the most toxic and persistent. These large PAH predominate in weathered oil. Because of low solubility in water, the large PAH probably contribute little to acute toxicity of oil-water solutions. Lipophilic PAH, however, may cause physiological injury if they accumulate in tissues after lengthy exposure (Heintz et al., unpub.).

Chronic small oil spills are also a potential problem because residual oil can build up in sediments and affect living marine resources. Low levels of PAH from such chronic pollution can be accumulated in salmon tissues and cause lethal and sublethal effects, particularly at the embryo stage. Demonstrated effects from low-level chronic exposure include increased embryo mortality, reduced marine growth, and increased straying in returning adults.

Many factors determine the degree of damage from an oil spill. The most important variables are the type of oil, size and duration of the spill, geographic location, season, and oceanographic conditions. Habitats most sensitive to oil pollution are typically located in coastal areas with low physical energy (e.g., estuaries, tidal marshes). Exposed rocky shores and ocean surface waters are high-energy environments where physical processes more rapidly remove spilled oil.

After a large spill, aromatic hydrocarbons would generally be at toxic levels to some organisms within this slick. Beneath and surrounding the surface slick, there would be some oil-contaminated waters. Vertical mixing and current dispersal acts to reduce the oil concentrations with depth and distance. If the oil spill trajectory moves toward land, habitats and species could be affected by the loading of oil into contained areas of the nearshore environment. In the shallower waters, an oil spill could be mixed by wave action throughout the water column and contaminate subtidal sediment. Suspended sediment can also act to carry oil to the seabed. In the *Exxon Valdez* oil spill, 13% of spilled oil was deposited in subtidal sediments where it was available to deposit-feeding organisms (Spies et al. 1996).

Oil mixed into bottom sediments persists for years and becomes a long term source of low level pollution. Cold temperature slows the evaporation biodegradation processes, so toxic hydrocarbons persist longer. Oil can also be trapped by ice. Toxic aromatic fractions mixed to depth under the surface slick could cause mortalities and sublethal effects on salmon.

Tainting of salmon and fishing gear flesh is a potential problem in areas subject to either chronic or acute oil pollution. The *Exxon Valdez* oil spill, for example, caused the closure of fisheries for black cod, shrimp, herring, and salmon. Although sockeye salmon were not directly affected by the spill, the fishery in upper Cook Inlet was closed to forestall fouling of gear and public perception of tainting. The sockeye fishery closure caused over-escapement to some freshwater spawning and rearing lakes and subsequent poor production of fry and smolts.

Other sources of potential habitat degradation from oil and gas activities include the disposal of drilling muds and cuttings into the water and seabed and of drilling fluids and produced waters into the water column. These materials often contain heavy metals, hydrocarbons, and other chemicals. Dredged materials from pipeline laying are also a potential source of pollution and habitat degradation.

Timber Harvest

Timber harvest and related activities (e.g., road construction and use of forest chemicals) can cause multiple effects on salmon habitat. These activities can increase bedload and suspended sediments, alter streamflow, introduce excessive nutrients, decrease large woody debris, increase streambank erosion, alter temperature, and have toxic effects on biota.

Forest road construction can destabilize slopes and increase erosion and sedimentation. This erosion occurs in two forms, as mass soil movement (i.e., landslides) and as surface erosion. Both types can introduce debris and sediment into adjacent streams for many years after initial construction. Erosion is most severe where poor construction practices are allowed, inadequate attention is paid to proper road drainage, and where construction occurs in inclement weather. After construction, unpaved logging roads can be a chronic source of sediment to streams.

Stream crossings by forest roads may block fish migration. Culverts are often installed as an economical alternative to bridges, although bridges are usually less disruptive to the stream environment. Culverts are a serious threat to salmon unless specifically designed, installed, and maintained to accommodate fish passage.

Removal of streamside vegetation during timber harvest activities increases solar radiation to the stream and results in warmer water during summer, especially in small streams. The magnitude of temperature change depends on the amount of timber harvested adjacent to the stream (Meehan et al, 1969; Brown and Krygier, 1970) and time for regrowth of riparian areas. In Southeast Alaska, Meehan et al., (1969) found that maximum temperature in logged streams exceeded those of unlogged control streams by up to 5ºC, but the temperature did not reach lethal levels. The increased water temperature, however, frequently exceeded the optimum for pink and chum salmon documented by Reiser and Bjornn (1979).

High summer air temperature has been associated with adult salmon mortality. The Alaska Department of Fish and Game compiled a list of 43 streams that had mortality of pink and chum salmon in 1977 associated with high water temperature and low flow. The largest clearcut in Alaska is located in the Staney Creek watershed. In 1979, 15,000 pink salmon died there before spawning, a result of warm water and low oxygen. In northern areas, the removal of riparian vegetation may cause lower stream temperature during winter, increasing the formation of frazil and anchor ice.

By removing vegetation, timber harvest temporarily reduces transpiration losses from the watershed, thereby elevating water content of soil and increasing run-off during base-flow periods. The elevated water content can reduce soil strength and destabilize slopes, causing increased sediment and debris inputs to streams (Swanston 1974). Sediment deposition in streams can reduce benthic community production (Culp and Davies, 1983) and can cause mortality of incubating salmon eggs and alevins. Cederholm et al. (1981) and Hartman et al. (1987) showed that cumulative sedimentation from logging activities can significantly reduce the egg-to-fry survival of coho and chum salmon. Where egg-to-fry survival is impaired by habitat deterioration escapement goals may have to be increased to offset the effect of decreased spawning success.

Converting large portions of old-growth forests to rapidly growing second-growth forests can permanently reduce summer stream flows and thus permanently reduce salmonid production (Myren and Ellis, 1984). The studies of streams in second-growth forests have demonstrated that the input of large, potentially stable debris (logs and stumps) into salmon habitat from second-growth is reduced relative to inputs from old growth stands (Bisson et al. 1987). Further, the initial high productivity of prey organisms in streams running through open canopy (clearcuts) is short-lived and eventually the quantity of food organisms declines as the canopy closes (Sedell and Swanson, 1984).

The commercial removal of logs from the channels of the Unuk and Chickamin rivers has resulted in the loss of debris that provides habitat for juvenile chinook and other salmon. Discharge of these glacial rivers varies considerably, so that salvage loggers can mistakenly consider the high-flow habitat and the large woody debris to be out of the river channel.

Mining

At present, marine mining has been limited to extraction of gravel and gold in the Bering Sea and the Aleutian Peninsula. Gravel is needed for almost all construction projects throughout the area and is relatively unavailable from upland sources. Consequently, gravel is obtained by mining beaches along the Bristol Bay coast (e.g., Goodnews Bay, Kangirlvar Bay). Mining large quantities of beach gravel can significantly affect removal, transport, and deposition of sand and gravel along shore, both at the mining site and at other more distant areas. During mining, water turbidity increases and resuspension of organic materials may displace less motile organisms (i.e., eggs and recently hatches fishes) from the area. Spawning and rearing habitat may also be damaged or destroyed by these actions, particularly intertidal spawning grounds.

Neither the future extent or biological consequences of this mining activity are known. The demand for gravel is likely to increase, however, as the economy and associated development expand.

Dredging for gold has been attempted at various sites along the Aleutians and a major project presently mines gold with a dredge offshore of Nome. Such activity has the potential to cause physical damage to benthic habitat and biota. State and Federal agencies have recently initiated offshore mineral leasing programs. Portions of the Bering Sea are believed to have mineral potential. Interest will increase in offshore mining as onshore reserves dwindle and economic incentives increase.

Gravel and sand are removed from lower reaches of the Kuskokwim River and throughout the Yukon River drainage. Such operations can disrupt migration of anadromous fish and increase mortality of incubating eggs, fry, and smolts. If bottom contours are not reestablished after gravel removal, extraction pits can trap juveniles and fry as flows drop. The NMFS National Policy for gravel extraction should be consulted for further information and recommendations.

Placer mining for gold and associated suction dredging continues to be a problem in interior Alaska streams and Canadian portions of the Yukon River. In some cases, water is completely diverted from the streambed while gravel is processed. Dredging discharge increases turbidity and sediment--this is considered by some to be the most prevalent form of pollution in Alaska waters (Lloyd et al. 1987) and has contributed to the absence of grayling in some streams (LaPerriere et al. 1985).

Large-scale ore extraction and milling operations associated with gold mining are a growing concern, with several projects proposed on transboundary rivers flowing into Southeast Alaska. Heavy metals and milling reagents associated with such development may be a serious threat to salmonid habitat. Runoff from tailings stored in upland areas can enter streams and estuaries. The potential exists for tailings to contaminate groundwater, an important component of chum salmon spawning habitat.

Although open pit mining is limited in Alaska, the road building, water supply, and tailing disposal aspects of these operations may potentially impact salmon streams and estuarine habitat.

Ocean Discharge and Dumping

At present, there are two areas in Alaska where the ocean discharge of non-organic materials is known to occur on a large scale. Both of these areas are disposal sites for dredged material near the city of Nome and have been in use for approximately 50 years. Recently, these areas were given final designation as ocean dredged material disposal sites by the U.S. Environmental Protection Agency (EPA). Thus, use of these sites presents no habitat concerns. Similar proposals for marine dredging have been proposed for Southcentral and Southeast Alaska.

Return of materials dredged from the ocean to the water column is considered a discharge activity. Depending upon the chemical constituency of the local bottom sediments and any alterations of dredged materials prior to discharge, living marine resource in the area may be exposed to elevated levels of heavy metals. For example, natural deposits of mercury are know to occur in marine bottom sediments. The levels of this heavy metal in Norton Sound (Nelson et al. 1975) exceed the 3.7 ug/l set by the EPA Marine Quality Standards as the maximum allowable concentration. Wood (1974) demonstrated that mercury available to the aquatic environment in any form can result in steady-state concentrations of methyl, dimethyl, and metallic mercury through microbial catalysis and chemical equilibrium. Large-scale gold dredging projects in eastern Norton Sound will result in the discharge and resuspension of sediments that could introduce mercury to the water column.

Accumulation of heavy metals in fish occurs naturally, but also may be an indication of habitat deterioration. The Federal Drug Administration safety limit for mercury is 1.0 ppm of methyl mercury.

Derelict Fishing Gear and General Litter

Persistent plastic debris is introduced into the marine environment from offshore vessels and commercial fisheries, as well as from general shore activities. Debris includes synthetic netting, pots, longline gear, packing bands, and rope. Estimates of debris have been based on observations of debris at sea and on beaches, and occasional reports of accidental or deliberate discards of fishing gear. Studies by Merrell (1984) and others have shown that much of the observed entanglement debris consists of fragments of trawl web. Some trawl web gets discarded overboard following net repair, but most probably gets lost during normal fishing operations (e.g., fishing over rough bottoms, foul weather). Deliberate discharge at sea of all plastics are now prohibited by MARPOL Annex V.

Debris discarded at sea can entangle or be ingested by marine mammals, fish, shellfish, sea birds, and sea turtles. The persistent nature of plastics can pose a hazard to marine life for years. Other lost or discarded gear, such as crab pots continue to fish indefinitely. Neither the extent of debris-related mortality nor population effects on various species are known.

Dams and Impoundments

Dams usually have detrimental effects on salmon and their habitat. The transformation of a river from its natural free-flowing state to an impoundment fundamentally alters that environment and may cause declines of salmon runs.

Dams are a significant barrier to upstream and downstream migrations of salmon, and have probably caused the greatest loss of salmon habitat due to human activities in the lower 48 states. Dependence on technology to provide passage around dams has seldom been successful. Fishway design and flow are important to attract and guide adult salmon into passage facilities. Poorly designed fishways can inhibit upstream movement of adults, causing migration delays, increased pre-spawning mortality, and reduced reproductive success in fish that eventually reach their spawning grounds (U.S. Bureau of Reclamation 1985; Hallock et al. 1982). Dams also present obstacles to downstream passage of juveniles, and passage through turbines or over spillways can result in migration delays, increase predation, and direct mortality.

Major adverse effects on salmon stocks and habitat caused by dams have been avoided or mitigated in Alaska, as managers have learned from mistakes made in the lower 48 states. A more complete discussion of effects of dams on salmon can be found in the Habitat Appendix of the Eighth Amendment to the Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California Commencing in 1978 (PFMC 1987).

Urbanization, Pollution, and Coastal Development

Urbanization and associated coastal development can effect adjacent and downstream ecosystems through modification of the hydrology, chemistry, and biology of streams, lakes, bays, estuaries, and the associated wetlands Those aquatic features provide many essential ecological functions including flood and erosion control, diverse biological productivity, and as buffers to physicochemical changes in associated waterbodies. Prior to the 1960s, most untreated organic and industrial wastes were dumped directly into streams, lakes or estuaries. Environmental damage from such uncontrolled waste discharge was evident from fish kills, oxygen depletion, massive blooms of nuisance algae, and public health problems. Pacific salmon were most evidently affected by pollution from raw sewage, pulp mill effluents, and acid and metal wastes. Strict regulation of point source discharges of municipal and industrial waste continue to improve that situation. Some toxins from previous unregulated discharges, however, remain trapped in bottom sediments and can be disturbed by current activities. Nonpoint source pollution from urbanization and transportation infrastructure remains a threat to anadromous fish.

Excavation or deposition of material during development of urban areas and transportation infrastructure can directly impact anadromous fish habitat. Construction and maintenance of transportation corridors (e.g., roads, harbors, navigation channels), sewers, and other public infrastructure that parallels or intersects waterbodies are common types of development where such impacts occur. Construction of shoreline buildings or other structures can have similar impacts on habitat. Poor project design and construction can create barriers to migration, degrade water quality, limit fish food production, and degrade spawning and rearing habitat. Construction in other areas of the watershed may affect fish habitat through runoff diversion or acceleration. Sedimentation and suspended solids due to construction, maintenance (e.g., winter street sanding), and uncontrolled erosion can have direct respiratory and abrasive effects on salmon, degrade spawning gravels, and fill critical pool habitat.

Maintenance of channels for navigation and port facilities is another class of dredge and fill development requiring removal and relocation of accumulated river, harbor, and coastal sediments. Such sediments may be contaminated with pollutants that accumulated from earlier uncontrolled discharges or from more recent spills and chronic discharge to the waterway. Disturbing such pollutants by dredging may make them more biologically available and thus detrimental to anadromous fish habitat. Dredging also increases turbidity and suspended solids, with effects depending on type of substrate dredged, currents or tides, preventative measures, and areal and temporal extent of the dredging operation. Sedimentation from dredging and filling can degrade habitat and kill or injure salmonids by clogging and coating gill filaments and by causing abrasive injuries. Although these effects may be temporary, long-term habitat degradation can result when dredging disrupts benthic communities or causes loss of shallow water habitat.

Disposal of waste materials into waterways can seriously degrade anadromous fish habitat. Sewage, fertilizers, and de-icing chemicals (e.g., glycols, urea) are examples of common urban pollutants that decompose with high biological or chemical oxygen demand. Zones of low dissolved oxygen from their decomposition can retard growth of salmon eggs, larvae, and juveniles and may delay or block smolt and adult migration. Sewage and fertilizers also introduce nutrients into urban drainages that drive algal and bacterial blooms which may smother incubating salmon or produce toxins as they grow and die. Thermal effluents from industrial sites and removal of riparian vegetation from streambanks allowing solar warming of water can degrade salmon habitat. Heavy metals, petroleum hydrocarbons, chlorinated hydrocarbons, and other chemical wastes can be toxic to salmonids and their food, and they can inhibit salmon movement and habitat use in streams. Mining, ore processing, smelting, and refining operations often produce heavy metals as waste products that may effect the movement of salmon, causing migration delays. Petrochemicals and chlorinated compounds, such as those in herbicides and pesticides, are toxic or have long-term effects on survival, stamina, and reproduction in salmonids. Peripheral effects of pollution may include forcing rearing fish into areas of high predation or less than optimal salinity for growth.

In urban areas, wetlands are easily degraded or lost by dredging, filling, diking, or draining to provide harbors and building sites. When wetlands are filled, their function of buffering physicochemical changes in adjacent and downstream waterbodies is often lost. Development activities can, therefore, have severe impacts on anadromous fish, as well as other wetland-dependant species. Wetlands stabilize hydrology, improve water quality, and increase biological diversity in anadromous fish habitat. Wetlands store and control runoff, thereby decreasing flood peaks and erosion and providing greater base flows in downstream areas. With highly variable runoff, anadromous fish habitat may be eroded during floods and left dry during periods of low runoff. Salmon may be prevented from migrating due to velocity barriers or low water. Spawning areas may be scoured during high water or dry up or freeze during low water. Rearing salmon may be flushed into poor habitat during freshets or trapped in drying areas at low flows. Wetlands can improve water quality as nutrients and pollutants are removed through biological and chemical processes.

In some coastal areas, shallow nearshore waters necessitate construction of long structures projected seaward to provide access from the uplands to deep-draft ocean-going vessels. These causeways could alter both along-shore physical processes and migration and movement of marine organisms in the area. Without special considerations, these facilities could affect tidal flushing, water quality and temperature, and access for fish.

Mariculture

Mariculture can have adverse effects on habitat because of over-enrichment of water and benthic habitat by uneaten food, feces, or other organic materials (Faris 1987). Accumulations on the bottom can create anaerobic conditions near mariculture sites and degrade foraging areas for juvenile salmon (Phillips et al. 1985). Other threats include introductions of exotic species or domestic strains which might prey upon, compete with, or interbreed with wild stocks, and the spread of disease form culture facilities. Habitat can also be affected from the development of ancillary facilities, such as access roads, floating processing plants, or caretaker residences.

REFERENCES

ADFG (Alaska Department of Fish and Game). 1983. Susitna hydro aquatic studies Phase II report: synopsis of the 1982 aquatic studies and analysis of fish and habitat relationships. Alaska Department of Fish and Game, Susitna Hydro Aquatic Studies, Anchorage.

Alerdice, D.F., W.P. Wickett, and J.R. Brett. 1958. Some effects of temporary exposure to low dissolved oxygen levels on Pacific salmon eggs. Journal of the Fisheries Research Board of Canada 15:229-250.

Bell, M.C. 1986. "Fisheries handbook of engineering requirements and biological criteria. Useful factors in life history of most common species." Unpublished Report. Fisheries-Engineering Research Program, U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Berg, R.J., 1977. An updated assessment of biological resources and their commercial importance in the St. George Basis of the eastern Bering Sea. OCSEAP Research Unit #437, NMFS, Juneau, AK.

Bisson, P.A., and R.E. Bilby. 1982. Avoidance of suspended sediment by juvenile coho salmon. North American Journal of Fisheries Management 2:371-374.

Bisson, P.A., and R.E. Bilby, M.D. Bryant, C.A. Dolloff, G.B. Grette, R.A. House, M.L. Murphy, K.V. Koski, and J.R. Sedell. 1987. Large woody debris in forested streams in the Pacific Northwest: past, present, and future. IN: Streamside Management: Forestry and Fishery Interactions. Edited by Ernest O. Salo and Terrance W. Cundy. College of Forest Resources, University of Washington, Seattle, Washington. University of Washington, Inst. Forest Resources. Contr. No. 57.

Brett, J.R., M. Hollands, and D.F. Alderdice. 1958. The effect of temperature on the cruising speed of young sockeye and coho salmon. Fisheries Research Board of Canada 15(4):587-6605.

Brown, G.W. and J.T. Krygier. 1970. Effects of clearcutting on stream temperature. Water Resour. Res. 6(4):1133-1139.

Bue, B. G., S. Sharr, and J. E. Seeb. In press. Evidence of damage to pink salmon populations inhabiting Prince William Sound, Alaska, two generations after the *Exxon Valdez* oil spill. Trans. Am. Fish. Soc.

Bustard, D.R. and D.W. Narver. 1975. Aspects of the winter ecology of juvenile coho salmon

(Oncorhynchus kisutch) and steelhead trout (Salmo gairdneri). Fisheries Research Board of Canada, Journal, 32:681-687.

Cederholm, C.J. and L.M. Reid. 1987. Impact of Forest Management on Coho Salmon (Oncorhynchus kisutch) Populations of the Clearwater Rivers, Washington: A Project Summary. IN: Streamside Management: Forestry and Fishery Interactions. Edited by Ernest O. Salo and Terrance W. Cundy. College of Forest Resources, University of Washington, Seattle, WA. University of Washington, Institute of Forest Resources. Contribution No. 57.

Cederholm, C.J. and L.M. Reid and E.O. Salo. 1981. Cumulative effects of logging road sediment of salmonid populations in the Clearwater River, Jefferson County, Washington. Pages 38-74 in Proc. from the conference: Salmon - Spawning Gravel: a renewable resource in the Pacific Northwest. Rep. No. 39. Water Research Center, Pullman, WA.

Chamberlin, T.W. 1982. Timber Harvest. No. 3 in: Influence of forest and rangeland management on anadromous fish habitat in western North America. General Technical Report PNW-136. U.S. Department of Agriculture. Forest Service. Pacific Northwest Forest and Range Experiment Station, Portland, OR.

Cordone, A.J. and D.W. Kelley. 1961. The influence of inorganic sediment on the aquatic life of streams. Calif. Fish and Game 47(2):189-228.

Culp, J.M. and R.W. Davies. 1983. An assessment of the effects of streambank clear cutting on macroinvertebrate communities in a managed watershed. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1208.

Damkaer, D.M. and D.B. Dey. 1985. Effects of water-borne pollutants on salmon passage at John Day Dam, Columbia Rivers (1982-1984). Report for U.S. Army Corps of Engineers by the National Marine Fisheries Service, Seattle, Washington.

Deis, J. 1984. Bering Sea summary report, outer continental shelf oil and gas activities in the Bering Sea and their onshore impacts. U.S. Dept. of the Interior, Minerals Management Service, OCS Infor. Rept. MMS 84-0076, prepared by Rogers, Golden and Halpern, Inc., Reston, Virginia, 75p.

Faris, Tamra L. 1987. USDC, NOAA, National Marine Fisheries Service. Environmental Effects of Finfish Cage Culture. Proceedings Fourth Alaska Aquaculture Conference, November 19-21, 1987, Sitka, AK.

Gibbons, D.R. and E.O. Salo. 1973. An annotated bibliography of the effects of logging on fish of the western United States and Canada. USDA For. Serv. Gen. Tech. Rep. PNW-10, 145 pp. Pacific Northwest Forest and Range Experiment Station.

Hallock, R.J., D.A. Vogel, and R.R. Reisenbichler. 1982. The effect of Red Bluff Diversion Dam on the migration of adult chinook salmon, Oncorhynchus tshawytscha, as indicated by radio tagged fish. Calif. Dept. of Fish and Game, Anad. Fish. Br. Admin. Rept. No. 82-8. 17 pp.

Hartman, G., J.C. Scrivener, L.B. Holtby, and L. Powell. 1987. Some effects of different streamside treatments on physical conditions and fish population processes in Carnation Creek, a Coastal rain forest stream in British Columbia. IN: Streamside Management: Forestry and Fishery Interactions. Edited by E. O. Salo and T. W. Cundy. University of Washington, Institute of Forest Resources. Contribution No. 57.

Heifetz, J., M.L. Murphy, K.V. Koski. 1986. Effects of logging on winter habitat of juvenile salmonids in Alaskan streams. North American Journal of Fisheries Management. 6:52-58.

Heintz, R. A., J. W. Short, and S. D. Rice. Unpublished manuscript. Sensitivity of fish embryos to weathered crude oil: Part II. Incubating downstream from weathered *Exxon Valdez* oil caused increased mortality of pink salmon (*Oncorhynchus gorbuscha*) embryos. Submitted to Environmental Science & Technology.

Hillman, T.W., J.W. Griffith and W.S. Platts. Summer and winter habitat selection by juvenile chinook salmon in a highly sedimented Idaho stream. Trans. Amer. Fish. Soc. 116:185-195.

Kester, D.R., B. H. Ketchum, I.W. Duedall, and P.K. Park. 1983. Dredged material disposal in the ocean. Wastes in the Ocean Series, Volume 2. Wiley-Interscience. New York.

Kissner, P.D. 1983. A study of chinook salmon in southeast Alaska. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1981-82, volume 23, Study AFS 41-10, Juneau.

Laevastu, T. and R. Marasco. 1985. Evaluation of the effects of oil development on the commercial fisheries in the eastern Bering Sea. NWAFC Processed Report 85-19.

LaPerriere, J.D., S.M. Wagener, and D.M. Bjerklie. 1985. Gold mining effects on heavy metals in streams, Circle Quadrangle, Alaska. Water Resources Bulletin 21:245-252.

Levy, D.A., and T.G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Fraser River Estuary. Can. J. Fish. Aquat. Sci. 39:270-276.

Lloyd, D.S., J. P. Koenings, J.D. LaPerriere. 1987. Effects of turbidity in fresh waters of Alaska. North American Journal of Fisheries Management 7:18-33.

Meehan, W.R., W.A. Farr, D.M. Bishop, and J.H. Patric. 1969. Some effects of clearcutting on salmon habitat of two southeast Alaska streams. Inst. Northern Fore., Pacific Northwest & Range Exp. Sta. USDA Forest Serv. Res. Pap. PNW-82.

McNeil, W.J., 1980. Vulnerability of pink salmon populations to natural and fishing mortality. Pages 147-151 in W.J. McNeil and D.C. Himsworth, eds.

Merrell, T. R., Jr. 1984. A decade of change in nets and plastic letter from fisheries off Alaska. Marine Pollution Bulletin 15:378-384.

Morris, B. F. 1981. An assessment of the living marine resources of the central Bering Sea and potential resource use conflicts between commercial fisheries and petroleum development in the Navarin Basin, Proposed Sale 83. USDOC, NOAA, NMFS, Alaska.

Morris, B. F., 1987. Living Marine Resources of the Shumagin Region. A Resource Report fro the Shumagin Oil and Gas Lease Sale 86. USDOC, NOAA, NMFS, Alaska.

Mortensen, D.G., B.P. Snyder and E.O. Salo. 1976. An analysis of the literature on the effects of dredging on juvenile salmonids. Spec. Rep. to U.S. Dept. Navy, Fish. Res. Inst., Univ. of Washington, Seattle, WA. FRI-UW-7605.

Murphy, M.L. 1985. Die-Offs of Pre-Spawn adult pink salmon and chum salmon in southeastern Alaska. North American Journal of Fisheries Management 5:302-308.

Murphy, M.L., K.V. Koski, J. Heifetz, S.W. Johnson, D. Kirchhofer, and J.F. Thedinga. 1985. Role of large organic debris as winter habitat for juvenile salmonids in Alaska streams. Proc. Western Assoc. Fish and Wildl. Agencies, Vol. 64. Victoria, B.C.

Myers, K.W. 1980. an investigation of the utilization of four study areas in Yaquina Bay, Oregon, by hatchery and wild salmonids. M.S. Thesis, Oregon State University, Corvallis.

Myren, R.T. and R.J. Ellis. 1984. Evaportranspiration in forest succession and long-term effects upon fishery resources: a consideration for management of our old-growth forests. Pages 183-186 IN: M.R. Meehan, T.R. Merrill, Jr. and T.A. Hanley, eds. Fish and wildlife relationships in old growth forests. American Institute of Fishery Research Biologists.

National Marine Fisheries Service. 1979. Living marine resources, commercial fisheries and potential impacts of oil and gas development in the St. George Basin, eastern Bering Sea. NWAFC, Juneau, Alaska.

National Marine Fisheries Service. 1980. Living Marine resources and commercial fisheries relative to potential oil and gas development in the norther Aleutian shelf area. NWAFC, Juneau, Alaska.

Nelson, C.H., D.E. Pierce, K.W. Leong, and F.F. H. Wang, 1975. Mercury distribution in ancient and modern sediment of northeastern Bering Sea. Marine Geology 18:91-104.

Newbold, J.D., D.C. Erman, and K.B. Rody. 1980. Effects of logging on macro invertebrates in streams with and without buffer strips. Can. J. Fish. Aquat. Sci. 37:1076-1085. North Pacific Fishery Management Council. 1988. DRAFT Habitat Policy. 8/15/88 Memo to: Persons interested in Habitat Policy as it relates to North Pacific fisheries.

Outer Continental Shelf Environmental Assessment Program, Hameedi, M.J. (ed.), 1982. Proceedings of a synthesis meeting: the St. George Basin environment and possible consequences of planned offshore oil and gas development, Anchorage, Alaska, 28-30 April, 1981. U.S. Dept. of Commerce, NOAA Office of Marine Pollution Assessment, and U.S. Department of Interior, Bureau of Land Management, Juneau, Alaska.

Outer Continental Shelf Environmental Assessment Program, Jarvela, L. E. (ed.). 1984. The Navarin Basis environment and possible consequences of planned offshore oil and gas development, a synthesis report. USDOC, NOAA Office of Marine Pollution Assessment, and U.S. Department of Interior, Bureau of Land Management, Juneau, Alaska.

Outer Continental Shelf Environmental Assessment Program, Thorsteinson, L.K. (ed.), 1984. Proceedings of a synthesis meeting: The north Aleutian shelf environment and possible consequences of offshore oil and gas development, Anchorage, Alaska, 9-11 March, 1982. USDOC, NOAA, Office of Marine Pollution Assessment and U.S. Dept. of the Interior, Bureau of Land Management, Juneau, Alaska, 159p.

P.F.M.C. 1987. DRAFT Eight amendment to the fishery management plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon, ad California commencing in 1987. Pacific Fishery Management Council.

Parker, R.P. 1965. Estimation of sea mortality rates for the 1961 brood-year pink salmon of the Bella Coola Area, British Columbia. J. Fish Res. Bd. Canada, 11(6):1523-15.

Pella, J.J. and Richard T. Myren. 1974. Caveats concerning evaluation of effects of logging on salmon production in Southeastern Alaska from biological information. Northwest Science 48:132-144.

Phillips, M.J., M.C.M. Beveridge and J.F. Muir. 1985. Waste output and environmental effects

of rainbow trout cage culture. International Council for the Exploration of the Sea, C.M. F: 21/Mariculture Committee/Theme Session W.
Reiser, D.W. and T.J. Bjornn. 1979. Habitat requirements of anadromous salmonids in Influence of forest and rangeland management on anadromous fish habitat in the western United States and Canada. W.R. Meehan, ed. General Technical Report, PNW-96. U.S. Department of Agriculture. Forest Service. Pacific Northwest Forest Range Experiment Station.
Rice, S.D., D.A. Moles, J.F. Karinen, S. Korn, M.G. Carls, C.C. Brodersen, J.A. Gharrett, and M.M. Babcock, 1984. Effects of petroleum hydrocarbons on Alaskan aquatic organisms: a comprehensive review of all oil-effects research on Alaskan fish and invertebrates conducted by the Auke Bay Laboratory, 1970-1981. NOAA Tech. Me., NMFS F/NWC-67, Seattle, Washington, 128p.
Ross, B.D. 1982. Effects of suspended volcanic sediment on coho (O. kisutch) and fall chinook (O. tshawytscha) salmon smolts in artificial streams. M.S. Thesis. University of Washington, Seattle. 128p.
Scott, J.B., C. R. Steward, and Q.J. Stober. 1986. Effects of urban development on fish population dynamics in Kelsey Creek, Washington. Trans. Amer. Fish. Soc. 115:555-567.
Sedell, J.R. and F.J. Swanson. 1984. Ecological characteristics of streams in old-growth forests of the Pacific Northwest, Pages 9-16 IN: M.R. Meehan, T.R. Merrill, Jr. and Ta. Hanley, eds. Fish and wildlife relationships in old-growth forests. American Institute of Fishery Research Biologists.
Shaul, L.E., P.L. Gray, and J.F. Koerner. 1984. Migratory patterns and timing of Stikine River coho salmon (Oncorhynchus kisutch) based on code-wire tagging studies, 1978-1982. Alaska Department of Fish and Game, Informational Leaflet 232, Juneau.
Sheridan, W.L. 1982. Pink salmon escapements in some logged and unlogged streams in Southeast Alaska. USDA:FS. Unpubl, rep. 32 pp.
Sheridan, W.L. and W.J. McNeil. 1968. Some effects of logging on two salmon streams in Alaska. J. for Feb. 1968. pp. 128-133.
Short, J.W. and F.P. Thrower. 1986. Tributyltin caused mortality of chinook salmon, Oncorhynchus tshawytscha, on transfer to a TBT-treated marine net pen. In: Proceedings of the Oceans ‘86 Conference, Organotin Symposium. Vol. 4. IEEE Service Center, Piscataway, New Jersey. LOC #86-81984.
Shumway, D.L., C.E. Warren, and P. Doudoroff. 1964. Influence of oxygen concentration and water movement on the growth of steelhead trout and coho salmon embryos. Trans. Am. Fish. Soc. 93:342-356.
Silver, S.J., C.E. Warren, and P. Doudoroff. 1963. Dissolved oxygen requirements of steelhead trout and chinook salmon embryos at different water velocities. Trans. Amer. Fish. Soc. 92:327-343.
Spies, R. B., S. D. Rice, D. A. Wolfe, and B. A. Wright. 1996. The effects of the Exxon Valdez oil spill on the Alaskan coastal environment. American Fisheries Society Symposium 18:1-16.
Swanston, D.N. 1974. The forest ecosystem of southeast Alaska. Soil mass movement. General Technical Report PNW-17. U.S. Department of Agriculture. Forest Service.

Pacific Northwest Forest and Range experiment Station. Portland, Oregon.
Sylvester, J.R. 1971. Some effects of thermal stress on the predator-prey interaction of two salmonids. University of Washington. Ph.D. thesis.
Thorsteinson, F.V., and L.K. Thorsteinson, 1982. Finfish resources. In Proceedings of a synthesis meeting: the St. George Basin environment and possible consequences of planned offshore oil and gas development, OCSEAP, USDOC and USDI, Juneau, Alaska, 111-139.
USDA. 1995. Report to Congress: Anadromous Fish Habitat Assessment. USDA Forest Service, Pacific Northwest Research Station and the Alaska Region. R10-MB-279.
Viteri, A. and A. Kruse. 1988. Ward Cove water quality analysis. Alaska Department of Environmental Conservation, Southeast Alaska Office, Juneau, Alaska. February, 1988.
Wood, J.M. 1974. Biological cycles for toxic elements in the environment. In Science, No. 4129, Vol. 183, 1049-1052.

Instruction 5

Add Appendix E, Section 5.G titled "Cumulative Effects on EFH from Fishing and Non-Fishing Activities" and insert the following paragraphs:

The NPFMC and the Secretary of Commerce have taken appropriate actions when threats to fish habitat have been identified. These include cumulative effects from fishing activities and non-fishing activities. Cumulative effects have been examined in the Stock Assessment and Fishery Evaluation (SAFE) reports, which are produced annually for the crab, scallop, and groundfish fisheries. In addition, the an Ecosystem Considerations section to the SAFE reports is prepared, which identifies specific ecosystem concerns that are considered by fishery managers in maintaining sustainable marine ecosystems.

For salmon, the Alaska Board of Fisheries establishes a series of management plans for the major commercial fisheries throughout the state. Within these management plans are guidelines which set escapement goals and allocation by species by management area. In establishing these management measures, the Alaska Board of Fisheries considers the cumulative impacts of the fishery and ecosystem.

Cumulative effects from non-fishing activities relate to the amount of habitat loss from human interaction and alteration or natural disturbances. Non-fishing activities are widespread and can have localized impacts to habitats such as accretion of sediments from at-sea disposal areas, oil and gas exploration, sea floor mining, ice scouring and significant storm events. In addition to EFH consultation guidelines mandated by the MSA, NMFS reviews these types of effects during the review process required by Section

404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act for certain activities that are regulated by Federal, state, tribal or local authority. The jurisdiction of these activities is in "waters of the United States" and includes both riverine and marine habitats. To assist in understanding these widespread impacts, the development of a habitat and effect baseline database would accelerate the review process and outline areas of increased disturbance. Inter-agency coordination would prove beneficial to all.

Instruction 6

Add Appendix E, Section 5.E, titled "Habitat Conservation and Enhancement Recommendations for Non-fishing Threats to EFH" and insert section 9.1.3 of the EFH EA.

Instruction 7

Add Appendix E, Section 5.C, titled "Habitat Conservation and Enhancement Recommendations for Fishing Threats to EFH" and insert sections 1.4.1, 1.4.4 (only the paragraph titled "Salmon," and accompanying figure), and 1.5 of the EFH EA.

Instruction 8

Add Appendix E, Section 5.F, titled "Prey Species as a Component of EFH" and insert the following paragraph:

Loss of prey is an adverse effect on EFH because one criterion for identifying EFH is that it be necessary for feeding. Therefore, actions that reduce the availability of a major prey species, either through direct harm or capture, or through adverse impacts to prey species' habitat that are known to cause a reduction in the population of the prey species, may be considered adverse effects on a managed species and its EFH. Adverse effects on prey species and their habitats may result from fishing and non-fishing activities. For more information on prey species, see Appendix E, Section III.

Instruction 9

Add Appendix E, Section 5.H, titled "Habitat Areas of Particular Concern" and insert the text from sections 11.4.1, 11.4.2, and 11.4.3 of the EFH EA.

Instruction 10

Add Appendix E, Section 5.I, titled "Essential Fish Habitat Research and Information Needs" and insert the sections 10.1 and 10.5 of the EFH EA. At the end of this section, add the following:

Additional Research Needs Include:

1. Surveys and studies of nearshore pelagic and benthic areas are needed to determine their use by a variety of species, including Atka mackerel, Pacific cod, pollock, rockfish. sablefish, octopus and flatfishes, juveniles and larvae of all species, and forage species considered in NPFMC FMPs.

2. In salmon freshwater habitat, knowledge and management tools are needed for use in conserving or restoring habitat areas of particular concern.

3. Information on habitat distribution, in conjunction with fish distribution, is needed to determine species' habitat requirements and utilization. Information on the extent and distribution of complex habitat types susceptible to bottom fishing will greatly improve the ability to evaluate the potential of a fishery to physically alter bottom habitat and to evaluate proposed measures to minimize impacts on EFH. To attain this information, increased use of remote bottom typing technology is necessary, as well as increased application of currently available technology such as multi-beam sonar, which can provide detailed topographic maps of the continental shelf and slope.

4. Research necessary to raise the level of information known on a species life stage from Level 0 or 1 to Level 2 or higher. To increase EFH tier levels and obtain valid measures of habitat utilization, systematic surveys must be conducted throughout the full-depth habitat range of each species.

Instruction 11

Add Appendix E, Section 5.J, titled "Review and Revision of EFH Components of FMPs" and insert the following:

To incorporate the regulatory guidelines requirement for review and revision of EFH FMP components, the NPFMC will conduct a complete review of all the EFH components of each FMP once every 5 years and will amend those EFH components to include new information.

In between each five-year comprehensive review, the NPFMC will utilize its annual FMP amendment cycle to solicit proposals on HAPCs and/or conservation and enhancement measures to minimize the potential adverse effects from fishing. Those proposals that the NPFMC endorses should be developed independent of the five-year comprehensive EFH review cycle.

An annual review of all existing and new EFH information will be conducted.

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