Amendments 7 and 8 to the Fishery Management Plan for the Salmon Fisheries in the EEZ off the Coast of Alaska

1. Amendment 7 supersedes Amendment 5.

2. In Section 6.0 *Management Measures*, add a subsection 6.3 to read as follows:

6.3 Essential Fish Habitat and Habitat Areas of Particular Concern

6.3.1 Description of Essential Fish Habitat

Section 303(a)(7) of the Magnuson-Stevens Act requires FMPs to describe and identify Essential Fish Habitat (EFH), minimize to the extent practicable adverse effects of fishing on EFH, and identify other actions to conserve and enhance EFH. This FMP describes salmon EFH in text, maps EFH distributions, and includes information on habitat and biological requirements for each life history stage of the species. Appendix E contains this required information for salmon, as well as identifying an EFH research approach.

6.3.2 Description of Habitat Areas of Particular Concern

The EFH regulations at 50 CFR 600.815(a)(8) provide the Councils with guidance to identify habitat areas of particular concern (HAPCs). HAPCs are meant to provide greater focus to conservation and management efforts and may require additional protection from adverse effects. FMPs should identify specific types or areas of habitat within EFH as HAPCs based on one or more of the following considerations:

1. the importance of the ecological function provided by the habitat;
2. the extent to which the habitat is sensitive to human-induced environmental degradation;
3. whether, and to what extent, development activities are, or will be, stressing the habitat type; or
4. the rarity of the habitat type.

In 2005, the Council identified the following areas as HAPCs within EFH:

- Alaska Seamount Habitat Protection Areas
- Bowers Ridge Habitat Conservation Zone
- GOA Coral

Maps of these HAPCs, as well as their coordinates, are contained in Appendix E.

6.3.3 Conservation and Enhancement Recommendations for EFH and HAPC

Appendix E identifies fishing and non-fishing threats to EFH. Conservation and enhancement recommendations for non-fishing threats to EFH and HAPCs are described therein.

In order to protect EFH from fishing threats, the Council established the following areas:

- Aleutian Islands Habitat Conservation Area
- Aleutian Islands Coral Habitat Protection Areas
- GOA Slope Habitat Conservation Areas

Maps of these areas, as well as their coordinates, are contained in Appendix E. In addition, the Council established restrictions for these areas as described below.

Aleutian Islands Habitat Conservation Area
The use of nonpelagic trawl gear, as described in 50 CFR part 679, is prohibited year-round in the Aleutian Islands Habitat Conservation Area, except for the designated areas open to nonpelagic trawl gear fishing.

Aleutian Islands Coral Habitat Protection Areas
The use of bottom contact gear, as described in 50 CFR part 679, and anchoring by federally permitted fishing vessels is prohibited in the Aleutian Islands Coral Habitat Protection Areas.

GOA Slope Habitat Conservation Areas
The use of nonpelagic trawl gear in the GOA Slope Habitat Conservation Areas by any federally permitted fishing vessel, as described in 50 CFR part 679, is prohibited.

In order to minimize adverse effects of fishing, the Council also established restrictions for HAPCs. These restrictions are described below.

Alaska Seamount Habitat Protection Areas
The use of bottom contact gear and anchoring by a federally permitted fishing vessel, as described in 50 CFR part 679, is prohibited in the Alaska Seamount Habitat Protection Area.

Bowers Ridge Habitat Conservation Zone
The use of mobile bottom contact gear, as described in 50 CFR part 679, is prohibited in the Bowers Ridge Habitat Conservation Zone.

GOA Coral Habitat Protection Areas within GOA Coral HAPC
The GOA Coral Habitat Protection Areas are five specific areas within the larger GOA Coral HAPC. Maps of these areas, as well as their coordinates, are in Appendix E. The use of bottom contact gear and anchoring, as described in 50 CFR part 679, is prohibited in these areas.

6.3.4 Review of EFH

To address regulatory guidelines for review and revision of EFH FMP components, the Council will conduct a complete review of all the EFH components of the FMP once every 5 years and will amend the FMP as appropriate to include new information.

Additionally, the Council may use the FMP amendment cycle every three years to solicit proposals for HAPCs and/or conservation and enhancement measures to minimize the potential adverse effects of fishing. Any proposal endorsed by the Council would be implemented by FMP amendment.

3. Revise Section 10.0 *References Cited* by adding the following references in alphabetical order:

NMFS. 2005. Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska. April 2005. NMFS P. O. Box 21668, Juneau, AK 99801.

NPFMC. 2005. Environmental Assessment/Regulatory Impact Review/Regulatory Flexibility Analysis for Amendments 65/65/12/7/8 to the BSAI Groundfish FMP (#65), GOA Groundfish FMP (#65), BSAI Crab FMP (#12), Scallop FMP (#7) and the Salmon FMP (# 8) and regulatory amendments to provide Habitat Areas of Particular Concern. March 2005. NPFMC 605 West 4th St. Ste. 306, Anchorage, AK 99501-2252. 248pp.

4. Replace Appendix E with the file **Appendix E EFH**.

G:\FMGROUP\Amendment 78-73 EFH-HAPC\CouncilFiles\salmon FMP text\salmon fmp amend text without appendix.wpd
dstram: 10/20/05
gharrington: 8/05

FMP for the Salmon Fisheries in the EEZ off the Coast of Alaska
Appendix E: Essential Fish Habitat and Habitat Areas of Particular Concern

Contents

1.0 Overview

Section 303(a)(7) of the Magnuson-Stevens Act requires that FMPs describe and identify Essential Fish Habitat (EFH), minimize to the extent practicable the adverse effects of fishing on EFH, and identify other actions to conserve and enhance EFH. FMPs must describe EFH in text, map EFH distributions, and provide information on habitat and biological requirements for each life history stage of the species. This appendix contains all of the required EFH provisions of the FMP, including the requirement in EFH regulations (50 Code of Federal Regulations [CFR] 600.815(a)(2)(i)) that each FMP must contain an evaluation of the potential adverse effects of all regulated fishing activities on EFH.

In 2005 NMFS and the Council completed the Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska (EFH EIS, NMFS 2005). The EFH EIS provided a thorough analysis of alternatives and environmental consequences for amending the Council's FMPs to include EFH information pursuant to Section 303(a)(7) of the Magnuson-Stevens Act and 50 CFR 600.815(a). Specifically, the EFH EIS examined three actions: (1) describing and identifying EFH for Council managed fisheries, (2) adopting an approach to identify HAPCs within EFH, and (3) minimizing to the extent practicable the adverse effects of fishing on EFH. The Council's preferred alternatives from the EFH EIS were implemented through Amendment 7 to the salmon FMP and corresponding amendments to the Council's other FMPs.

2.0 Life History Features and Habitat Requirements of FMP Species

This section describes habitat requirements and life histories of the salmon species managed by this FMP. Information contained in this appendix details life history information for federally managed salmon species. Each species or species group is described individually; however, summary tables that denote habitat associations (Table 2), reproductive traits (Table 3), and predator and prey associations (Table 4) are also provided. In each section, a species-specific table summarizes habitat requirements.

2.1 Habitat Types in the Bering Sea, Aleutian Islands, and Gulf of Alaska

Bering Sea

The Bering Sea is a semi-enclosed, high-latitude sea. Of its total area of 2.3 million sq. km, 44 percent is continental shelf, 13 percent is continental slope, and 43 percent is deep-water basin. Its broad continental shelf is one of the most biologically productive areas of the world. The eastern Bering Sea (EBS) contains approximately 300 species of fish, 150 species of crustaceans and mollusks, 50 species of seabirds, and 26 species of marine mammals (Livingston and Tjelmeland 2000). However, commercial fish species diversity is lower in the EBS than in the GOA.

A special feature of the EBS is the pack ice that covers most of its eastern and northern continental shelf during winter and spring. The dominant circulation of the water begins with the passage of North Pacific water (the Alaska Stream) into the EBS through the major passes in the AI (Favorite et al. 1976). There is net water transport eastward along the north side of the Aleutian Islands (AI) and a turn northward at the continental shelf break and at the eastern perimeter of Bristol Bay. Eventually EBS water exits northward through the Bering Strait, or westward and south along the Russian coast, entering the western North Pacific via the Kamchatka Strait. Some resident water joins new North Pacific water entering Near Strait, which sustains a permanent cyclonic gyre around the deep basin in the central Bering Sea (BS).

The EBS sediments are a mixture of the major grades representing the full range of potential grain sizes of mud (subgrades clay and silt), sand, and gravel. The relative composition of such constituents determines the type of sediment at any one location (Smith and McConnaughey 1999). Sand and silt are the primary components over most of the seafloor, with sand predominating the sediment in waters with a depth less than 60 m. Overall, there is often a tendency of the fraction of finer-grade sediments to increase (and average grain size to decrease) with increasing depth and distance from shore. This grading is particularly noticeable on the southeastern BS continental shelf in Bristol Bay and immediately westward. The condition occurs because settling velocity of particles decreases with particle size (Stokes Law), as does the minimum energy necessary to resuspend or tumble them. Since the kinetic energy of sea waves reaching the bottom decreases with increasing depth, terrigenous grains entering coastal shallows drift with water movement until they are deposited, according to size, at the depth at which water speed can no longer transport them. However, there is considerable fine-scale deviation from the graded pattern, especially in shallower coastal waters and offshore of major rivers, due to local variations in the effects of waves, currents, and river input (Johnson 1983).

The distribution of benthic sediment types in the EBS shelf is related to depth (Figure 2). Considerable local variability is indicated in areas along the shore of Bristol Bay and the north coast of the Alaska Peninsula, as well as west and north of Bristol Bay, especially near the Pribilof Islands. Nonetheless, there is a general pattern whereby nearshore sediments in the east and southeast on the inner shelf (0 to 50 m depth) often are sandy gravel and gravelly sand. These give way to plain sand farther offshore and west. On the middle shelf (50 to 100 m), sand gives way to muddy sand and sandy mud, which continue over much of the outer shelf (100 to 200 m) to the start of the continental slope. Sediments on the central and northeastern shelf (including Norton Sound) have not been so extensively sampled, but Sharma (1979) reports that, while sand is dominant in places here, as it is in the southeast, there are concentrations of silt both in shallow nearshore waters and in deep areas near the shelf slope. In addition, there are areas of exposed relic gravel, possibly resulting from glacial deposits. These departures from a classic seaward decrease in grain size are attributed to the large input of fluvial silt from the Yukon River and to flushing and scouring of sediment through the Bering Strait by the net northerly current.

McConnaughey and Smith (2000) and Smith and McConnaughey (1999) describe the available sediment data for the EBS shelf. These data were used to describe four habitat types. The first, situated around the shallow eastern and southern perimeter and near the Priblof Islands, has primarily sand substrates with a little gravel. The second, across the central shelf out to the 100 m contour, has mixtures of sand and mud. A third, west of a line between St. Matthew and St. Lawrence islands, has primarily mud (silt) substrates, with some mixing with sand (Figure 2). Finally, the areas north and east of St. Lawrence Island, including Norton Sound, have a complex mixture of substrates.

Important water column properties over the EBS include temperature, salinity, and density. These properties remain constant with depth in the near-surface mixed-layer, which varies from approximately 10 to 30 m in summer to approximately 30 to 60 m in winter (Reed 1984). The inner shelf (less than 50 m) is, therefore, one layer and is well mixed most of the time. On the middle shelf (50 to 100 m), a two-layer temperature and salinity structure exists because of downward mixing of wind and upward mixing due to relatively strong tidal currents (Kinder and Schumacher 1981). On the outer shelf (100 to 200 m), a three-layer temperature and salinity structure exists due to downward mixing by wind, horizontal mixing with oceanic water, and upward mixing from the bottom friction due to relatively strong tidal currents. Oceanic water structure is present year-round beyond the 200-m isobath.

Three fronts, the outer shelf, mid-shelf, and inner shelf, follow along the 200-, 100-, and 50-m bathymetric contours, respectively; thus, four separate oceanographic domains appear as bands along the broad EBS shelf. The oceanographic domains are the deep water (more than 200 m), the outer shelf (200 to 100 m), the mid-shelf (100 to 50 m), and the inner shelf (less than 50 m).

The vertical physical system also regulates the biological processes that lead to separate cycles of nutrient regeneration. The source of nutrients for the outer shelf is the deep oceanic water; for the mid-shelf, it is the shelf-bottom water. Starting in winter, surface waters across the shelf are high in nutrients. Spring surface heating stabilizes the water column, then the spring bloom begins and consumes the nutrients. Steep seasonal thermoclines over the deep EBS (30 to 50 m), the outer shelf (20 to 50 m), and the mid-shelf (10 to 50 m) restrict vertical mixing of water between the upper and lower layers. Below these seasonal thermoclines, nutrient concentrations in the outer shelf water invariably are higher than those in the deep EBS water with the same salinity. Winter values for nitrate-N/phosphate-P are similar to the summer ratios, which suggests that, even in winter, the mixing of water between the mid-shelf and the outer shelf domains is substantially restricted (Hattori and Goering 1986).

Effects of a global warming climate should be greater in the EBS than in the GOA. Located further north than the GOA, the seasonal ice cover of the EBS lowers albedo effects. Atmospheric changes that drive the speculated changes in the ocean include increases in air temperature, storm intensity, storm frequency, southerly wind, humidity, and precipitation. The increased precipitation, plus snow and ice melt, leads to an increase in freshwater runoff. The only decrease is in sea level pressure, which is associated with the northward shift in the storm track. Although the location of the maximum in the mean wind stress curl will probably shift poleward, how the curl is likely to change is unknown. The net effect of the storms is what largely determines the curl, and there is likely to be compensation between changes in storm frequency and intensity.

Ocean circulation decreases are likely to occur in the major current systems: the Alaska Stream, Near Strait Inflow, Bering Slope Current, and Kamchatka Current. Competing effects make changes in the Unimak Pass inflow, the shelf coastal current, and the Bering Strait outflow unknown. Changes in hydrography should include increases in sea level, sea surface temperature, shelf bottom temperature, and basin stratification. Decreases should occur in mixing energy and shelf break nutrient supply, while competing effects make changes in shelf stratification and eddy activity unknown. Ice extent, thickness, and brine rejection are all expected to decrease.

Temperature anomalies in the EBS illustrate a relatively warm period in the late 1950s, followed by cooling (especially in the early 1970s), and then by a rapid temperature increase in the latter part of that decade. For more information on the physical environment of the EBS, refer to the Alaska Groundfish Fisheries Programmatic Supplemental EIS (NMFS 2004).

Aleutian Islands

The Aleutian Islands lie in an arc that forms a partial geographic barrier to the exchange of northern Pacific marine waters with EBS waters. The AI continental shelf is narrow compared with the EBS shelf, ranging in width on the north and south sides of the islands from about 4 km or less to 42 to 46 km; the shelf broadens in the eastern portion of the AI arc. The AI comprises approximately 150 islands and extends about 2,260 km in length.

Bowers Ridge in the AI is a submerged geographic structure forming a ridge arc off the west-central AI. Bowers Ridge is about 550 km long and 75 to 110 km wide. The summit of the ridge lies in water approximately 150 to 200 m deep in the southern portion deepening northward to about 800 to 1,000 m at its northern edge.

The AI region has complicated mixes of substrates, including a significant proportion of hard substrates (pebbles, cobbles, boulders, and rock), but data are not available to describe the spatial distribution of these substrates.

The patterns of water density, salinity, and temperature are very similar to the GOA. Along the edge of the shelf in the Alaska Stream, a low salinity (less than 32.0 ppt) tongue-like feature protrudes westward. On the south side of the central AI, nearshore surface salinities can reach as high as 33.3 ppt, as the higher salinity EBS surface water occasionally mixes southward through the AI. Proceeding southward, a minimum of approximately 32.2 ppt is usually present over the slope in the Alaska Stream; values then rise to above 32.6 ppt in the oceanic water offshore. Whereas surface salinity increases toward the west as the source of fresh water from the land decreases, salinity values near 1,500 m decrease very slightly. Temperature values at all depths decrease toward the west.

Climate change effects on the AI area are similar to the effects described for climate change in the EBS. For more information on the physical environment of the AI, refer to the Alaska Groundfish Fisheries Programmatic Supplemental EIS (NMFS 2004).

Gulf of Alaska

The GOA has approximately 160,000 km^2 of continental shelf, which is less than 25 percent of the EBS shelf (Figure 1). The GOA is a relatively open marine system with land masses to the east and the north. Commercial species are more diverse in the GOA than in the EBS, but less diverse than in the Washington-California region. The most diverse set of species in the GOA is the rockfish group; 30 species have been identified in this area.

The dominant circulation in the GOA (Musgrave et al. 1992) is characterized by the cyclonic flow of the Alaska gyre. The circulation consists of the eastward-flowing Subarctic Current system at approximately 50° N and the Alaska Coastal Current (Alaska Stream) system along the northern GOA. Large seasonal variations in the wind-stress curl in the GOA affect the meanders of the Alaska Stream and nearshore eddies. The variations in these nearshore flows and eddies affect much of the region's biological variability.
The GOA has a variety of seabed types such as gravely sand, silty mud, and muddy to sandy gravel, as well as areas of hardrock (Hampton et al. 1986) (Figure 1). Investigations of the northeast GOA shelf (less than 200 meters [m]) have been conducted between Cape Cleare (148° W) and Cape Fairweather (138° W) (Feder and Jewett 1987). The shelf in this portion of the GOA is relatively wide (up to 100 km). The dominant shelf sediment is clay silt that comes primarily from either the Copper River or the Bering and Malaspina glaciers. When the sediments enter the GOA, they are generally transported to the west. Sand predominates nearshore, especially near the Copper River and the Malaspina Glacier. Most of the western GOA shelf (west of Cape Igvak) consists of slopes characterized by marked dissection and steepness. The shelf consists of many banks and reefs with numerous coarse, clastic, or rocky bottoms, as well as patchy bottom sediments. In contrast, the shelf near Kodiak Island consists of flat relatively shallow banks cut by transverse troughs. The substrate in the area from Near Strait and close to Buldir Island, Amchitka, and Amukta Passes is mainly bedrock outcrops and coarsely fragmented sediment interspersed with sand bottoms.

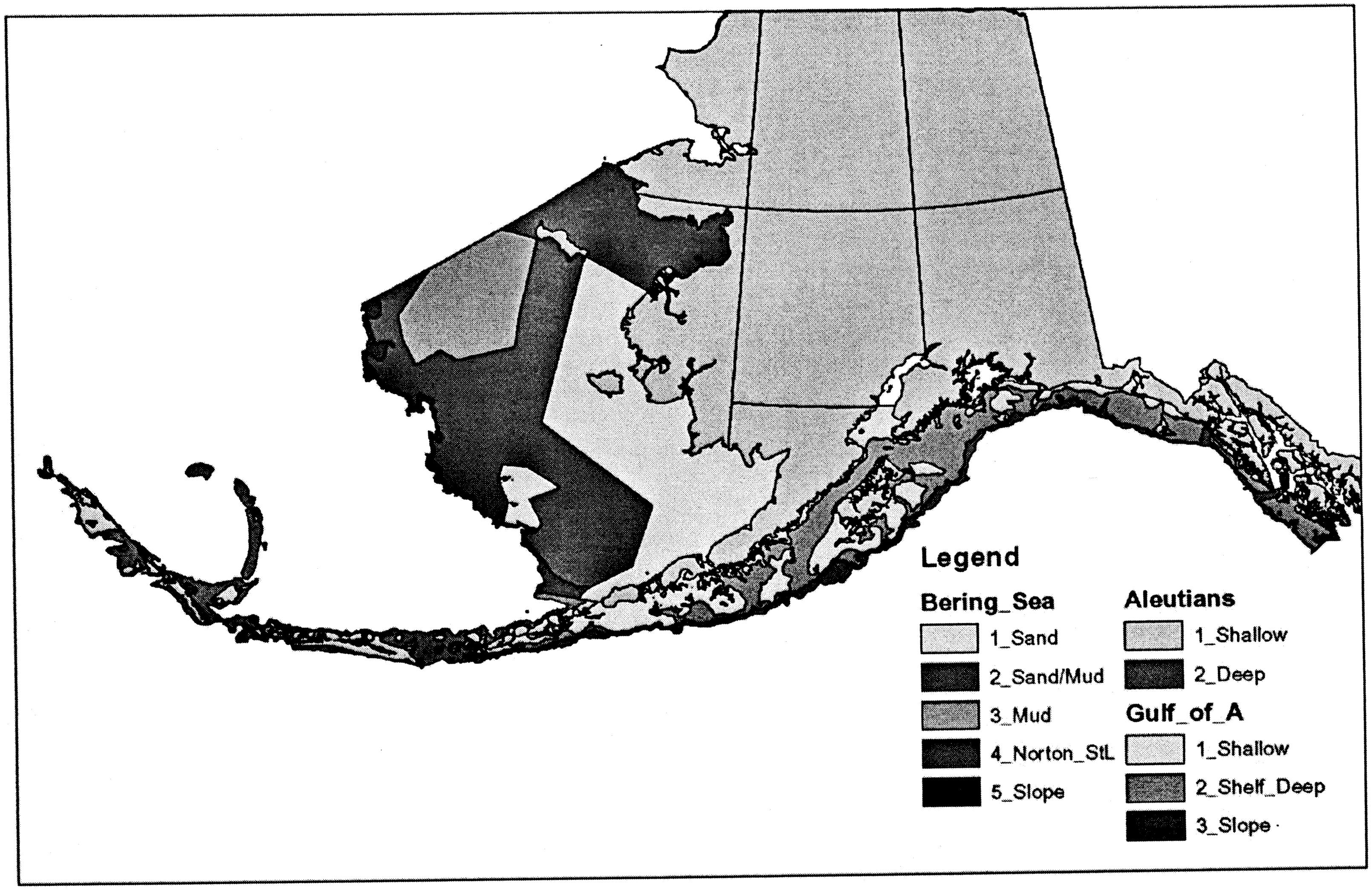
Temperature anomalies in the GOA illustrate a relatively warm period in the late 1950s, followed by cooling (especially in the early 1970s), and then by a rapid temperature increase in the latter part of that decade.

Subsurface temperature anomalies for the coastal GOA also show a change from the early 1970s into the 1980s, similar to that observed in the sea surface (U.S. GLOBEC 1996). In addition, high latitude temperature responses to El Niño southern oscillation events can be seen, especially at depth, in 1977, 1982, 1983, 1987, and the 1990s. Between these events, temperatures in the GOA return to cooler and more neutral temperatures. The 1997/98 El Niño southern oscillation event, one of the strongest recorded this century, has significantly changed the distribution of fish stocks off California, Oregon, Washington, and Alaska. The longer-term impacts of this event remain to be seen.

Piatt and Anderson (1996) provide evidence of possible changes in prey abundance due to decadal scale climate shifts. These authors examined relationships between significant declines in marine birds in the northern GOA during the past 20 years and found that significant declines in common murre populations occurred from the mid- to late-1970s to the early 1990s. Piatt and Anderson (1996) found marked changes in diet composition of five seabird species collected in the GOA from 1975 to 1978 and from 1988 to 1991. Their diet changed from capelin-dominated in the former period to one in which capelin was virtually absent in the latter period.

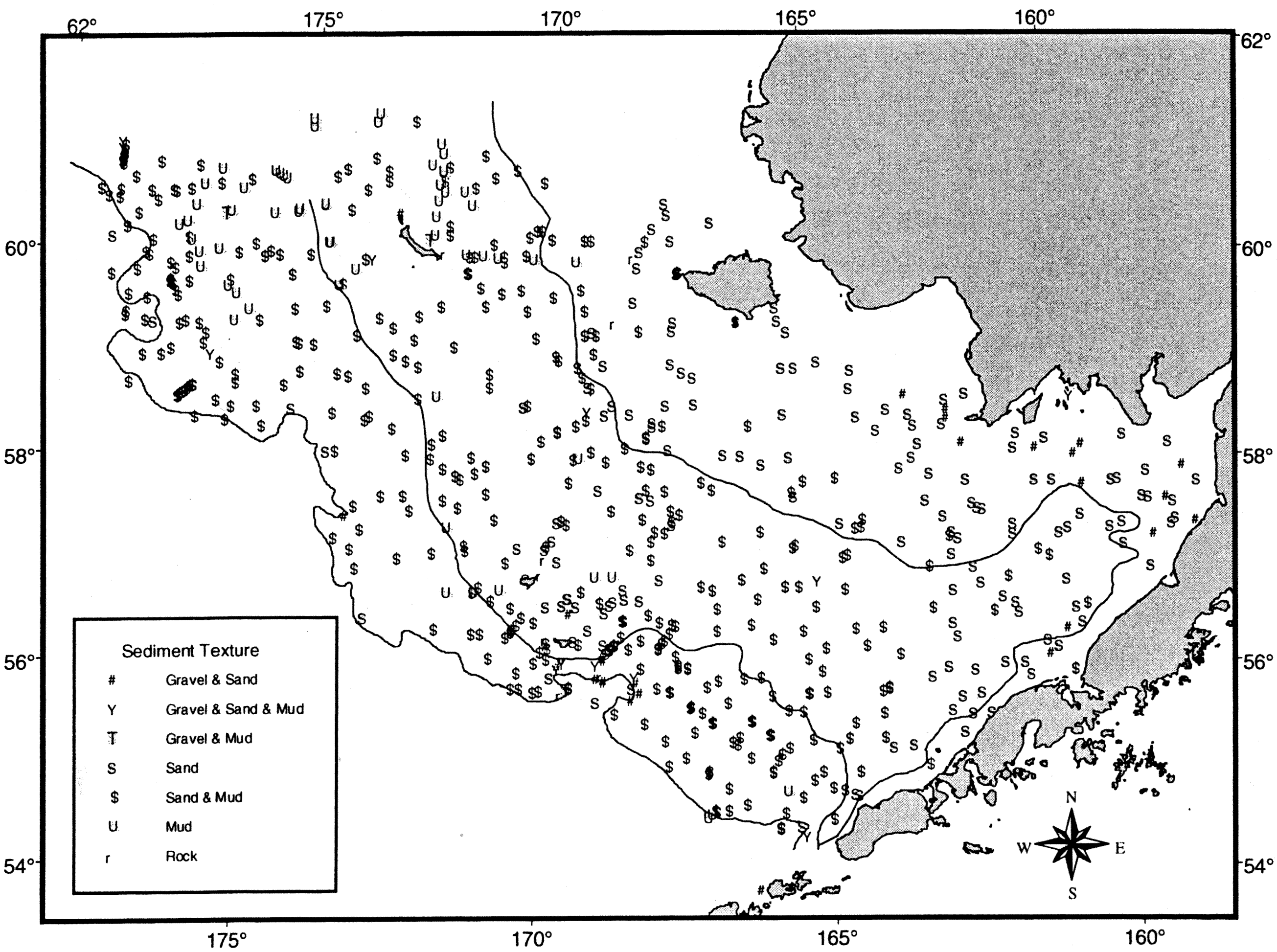
On a larger scale, evidence of biological responses to decadal-scale climate changes is also found in the coincidence of global fishery expansions or collapses of similar species complexes. For example, salmon stocks in the GOA and the California Current are out of phase. When salmon stocks do well in the GOA, they do poorly in the California Current and vice versa (Hare and Francis 1995, Mantua et al. 1997). For more information about the GOA physical environment, refer to the final programmatic groundfish SEIS (NMFS 2004).

Figure 1 Surficial sediment textural characteristics (Appendix B, NMFS 2005) for the continental shelf.



Source: Naidu, 1988

Figure 2 Distribution of Bering Sea Sediments



Source: Smith and McConnaughey 1999

2.2 Information Specific to Salmon

Freshwater habitat for the salmon fisheries in Alaska includes all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in the state. This represents a vast array of diverse aquatic habitats over an extremely large geographic area. Alaska contains over 3,000 rivers and has over 3 million lakes > 8 hectares. Over 14,000 water bodies containing anadromous salmonids identified in the state represent only part of the salmon EFH in Alaska because many likely habitats have not been surveyed. In addition to current and historically accessible waters used by Alaska salmon, other potential spawning and rearing habitats exist beyond the limits of upstream migration due to barrier falls or steep-gradient rapids. Salmon access to existing or potential habitats can change over time due to many factors, including glacial advance or recession, post-glacial rebound, and tectonic subsidence or uplifting of streams in earthquakes.

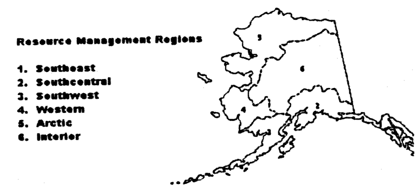


Figure 1. Regional boundaries of the Resource Management Regions established by the Joint Boards of Fisheries and Game.

A significant body of information exists on the life histories and general distribution of salmon in Alaska. The location of many freshwater water bodies used by salmon are contained in documents organized and maintained by the Alaska Department of Fish and Game (ADF&G). Alaska Statute 16.05.870 requires ADF&G to specify the various streams that are important for spawning, rearing, or migration of anadromous fishes. This is accomplished through the *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes* and the *Atlas to the Catalog of Waters Important for Spawning, Returning or Migration of Anadromous Fishes*. The Catalog lists water bodies documented to be used by anadromous fish. The Atlas shows locations of these waters and the species and life stages that use them. The Catalog and Atlas are divided into six volumes for the six resource management regions established in 1982 by the Joint Boards of Fisheries and Game; see figure at right.

The Catalog and Atlas, however, have significant limitations. The location information and maps are derived from U.S. Geological Survey quadrangles which may be out of date because of changes in channel and coastline configurations. In southeast Alaska, for example, new streams are colonized by salmon in Glacier Bay as glaciers rapidly recede. Polygons are sometimes used to specify areas with a number of salmon streams that could not be depicted legibly on the maps. Waters within these polygons are often productive for juvenile salmon.

Data for the Catalog come from personal, in-field surveys by aircraft, boat, and foot for purposes of managing fish habitat and fisheries, and the upper limit of salmon is not always observed. Upper points specified in the Catalog usually reflect the extent of surveys or known fish usage rather than actual limits of anadromous fish. Upper areas used by salmon are further limited due to the remoteness and vastness of the Alaska regions. Comparably, the Alaska region has identified salmon for freshwater reaches in an area that would span between the states of Washington and Ohio and between the northern and southern borders of the United States.

In addition, only a limited number of water bodies have actually been surveyed. Virtually all coastal waters in the State provide important habitat for anadromous fish, as do many unsurveyed small- and medium-sized tributaries to known anadromous fish-bearing water bodies in remote parts of the State. Small tributaries, flood channels, intermittent streams, and beaver ponds are often used for juvenile rearing. Because of their remote location, small size, or ephemeral nature, most of these systems have not been surveyed and are not included in the Catalog or Atlas.

Marine EFH for the salmon fisheries in Alaska includes all estuarine and marine areas utilized by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. EEZ. This habitat includes waters of the Continental Shelf, which extends to about 30 to 100 km offshore from Dixon Entrance to Kodiak Island, then becomes more narrow along the Pacific Ocean side of the Alaska Peninsula and AI chain. In BS areas of southwest and western Alaska and in Chukchi and Beaufort Seas areas of northwest and northern Alaska, the Continental Shelf becomes much wider. In oceanic waters beyond the Continental Shelf, the documented range of Alaska salmon extends from lat. 42° N north to the Arctic Ocean and to long. 160° E. In the deeper waters of the Continental Slope and ocean basin, salmon occupy the upper water column, generally from the surface to a depth of about 50 m. Chinook and chum salmon, however, use deeper layers, generally to about 300 m, but on occasion to 500 m. The range of EFH for salmon is the subset of this habitat that occurs within the 320 km EEZ boundary of the United States. Foreign waters (i.e., off British Columbia in the GOA and off Russia in the BS) and international waters are not included in salmon EFH because they are outside United States jurisdiction.

The following abbreviations are used in the habitat tables to specify location, position in the water column, bottom type, and other oceanographic features.

Abbreviations used in the EFH Reports.

Location: WC = water courses, rivers, streams, sloughs; LK = lakes, ponds (some are temporary); BCH = beach (intertidal); EST = estuarine, intermediate salinity, nearshore bays with inlet watercourses, eelgrass and kelp beds; ICS = inner continental shelf (1-50 m deep); MCS = middle continental shelf (1-100 m deep); OCS = outer continental shelf (1-200 m); BAY = nearshore bays (e.g., fjords); IP = island passes (areas of high current).

Water Column: P = pelagic (found off bottom, not necessarily associated with a particular bottom type); N = neustonic (found near surface).

Bottom Type: G = gravel; K = kelp; SAV = subaquatic vegetation (e.g., eelgrass).

Oceanographic/Riverine Features: UP = upwelling; G = gyres; F = fronts; CL = thermo- or pycnocline; E = edges.

General: U = Unknown; NA = not applicable

Table 2. Summary of Habitat Associations for Salmon

Salmon		Nearshore				Shelf			Slope						Stratum Reference						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin							
Species	Life Stage	Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully
Chinook	M	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
	LJ														x	x	x	x			
	EJ	x	x	x											x	x	x				
	L	x																			
	E	x																			
Chum	M	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
	LJ				x	x	x	x	x	x						x	x	x			
	EJ	x	x	x	x	x	x								x	x	x	x			
	L	x		x																	
	E	x		x																	
Coho	M	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	LJ		x	x		x	x									x	x				
	EJ	x	x	x		x									x						
	E/L	x																			
Pink	M	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	LJ		x		x		x	x	x						x	x	x				
	EJ		x	x	x	x	x	x	x						x	x	x				
	L	x																			
	E	x																			
Sockeye	M	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	LJ		x	x	x	x	x	x	x							x	x				
	EJ	x				x															
	L	x																			
	E	x				x															

Salmon		Location							Physical Oceanography					Substrate												
						Pelagic																				
Species	Life Stage	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock
Chinook	M	x	x	x	x	x			x	x	x	x	x													
	LJ	x	x	x	x	x			x	x	x	x	x													
	EJ	x	x	x	x									x		x						x			x	x
	L				x												x								x	
	E				x												x								x	
Chum	M	x	x	x	x	x	x		x	x	x	x	x	x			x					x			x	
	LJ	x	x	x	x	x	x		x	x	x	x	x													
	EJ	x	x	x		x			x	x		x		x	x	x	x					x		x	x	x
	L													x		x	x					x			x	x
	E													x		x	x					x			x	
Coho	M	x	x			x						x	x	x			x					x			x	
	LJ	x	x			x																				
	EJ	x		x											x	x	x					x			x	
	E/L													x			x									
Pink	M	x	x			x			x	x	x	x		x			x					x			x	
	LJ	x	x						x	x	x	x														
	EJ	x													x	x	x					x		x	x	
	L													x			x									
	E													x			x					x			x	
Sockeye	M	x	x			x											x					x			x	
	LJ	x	x			x																				
	EJ				x																					
	L																x					x			x	
	E																x					x			x	

Salmon		Structure										Community /					
Species	Life Stage	Bars	Sinks	Stumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca
Chinook	M	x		x	x	x	x		x	x	x						
	LJ	x		x	x	x	x		x	x	x						
	EJ																
	L																
	E																
Chum	M	x		x	x	x	x		x	x	x						
	LJ	x			x	x	x	x	x	x	x						
	EJ	x		x	x	x	x		x	x	x	x					
	L																
	E																
Coho	M	x		x	x	x	x		x	x	x						
	LJ																
	EJ	x		x	x	x	x		x	x	x						
	E/L																
Pink	M	x		x	x	x	x		x	x	x						
	LJ							x									
	EJ	x		x	x	x	x		x	x	x	x					
	L																
	E																
Sockeye	M																
	LJ							x									
	EJ																
	L																
	E																

Table 3. Summary of Reproductive Traits for Salmon

Salmon		Age at Maturity				Fertilization/Egg Development					Spawning Behavior						Spawning Season											
		Female		Male																								
Species	Life Stage	50%	100%	50%	100%	External	Internal	Oviparous	Ovoviviparous	Viviparous	Batch Spawner	Broadcast Spawner	Egg Case Deposition	Nest Builder	Egg/Young Guarder	Egg/Young Bearer	January	February	March	April	May	June	July	August	September	October	November	December
Chinook	M	4	7	4	7	X		X						X			X						X	X	X	X	X	X
	LJ																											
	EJ																											
	L																											
	E																											
Chum	M	4	7	4	7	X		X						X			X	X					X	X	X	X	X	X
	LJ																											
	EJ																											
	L																											
	E																											
Coho	M		4		4	X		X						X									X	X	X	X	X	X
	LJ																											
	EJ																											
	L																											
	E																											
Pink	M		2		2	X		X						X									X	X	X	X		
	LJ																											
	EJ																											
	L																											
	E																											
Sockeye	M	5	6	5	6	X		X						X									X	X	X	X	X	X
	LJ																											
	EJ																											
	L																											
	E																											

Reproductive Traits

Table 4. Summary of Predator and Prey Associations for Salmon

Predator to

Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Salmon	Cod	Pollock	Halibut
Chinook	M							x						x						x	x	x	x	x			x	x	x	
	LJ							x						x						x	x	x	x	x			x	x	x	
	EJ				x			x		x	x		x	x				x		x										
	L																													
	E																													
Chum	M			x	x			x		x	x			x						x	x	x	x	x	x			x	x	
	LJ			x	x			x		x	x			x				x		x	x	x	x	x	x			x	x	
	EJ			x	x			x		x	x		x					x		x	x	x	x		x			x	x	
	L			x	x																									
	E																													
Coho	M							x						x						x	x	x	x							
	LJ				x			x													x						x			
	EJ				x			x		x	x									x					x		x			
	L																													
	E																													
Pink	M				x			x		x	x									x	x	x	x	x						
	LJ				x			x		x	x									x	x	x	x							
	EJ				x			x		x	x									x	x	x	x							
	L				x																									
	E																													
Sockeye	M			x	x			x		x	x		x	x						x	x	x	x	x	x			x	x	
	LJ			x	x			x		x	x																			
	EJ			x	x																									
	L																													
	E																													

Prey of

Species	Life Stage	Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pac fic Cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Halibut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale
Chinook	M															x		x	x			x
	LJ															x			x			x
	EJ						x	x	x													
	L																					
	E																					
Chum	M															x	x	x	x			x
	LJ															x	x	x	x			x
	EJ						x	x	x													
	L																					
	E																					
Coho	M															x		x	x		x	x
	LJ																					
	EJ				x		x															
	L																					
	E																					
Pink	M															x	x	x	x	x		
	LJ															x	x	x	x	x		
	EJ						x	x	x	x												
	L																					
	E																					
Sockeye	M															x	x	x	x			x
	LJ						x	x	x													
	EJ																					
	L																					
	E																					

2.3 Habitat Description for Pink Salmon *(Oncorhynchus gorbuscha)*

Life History and General Distribution

The natural freshwater range of pink salmon includes the Pacific rim of Asia and North America north of about 40°N. Within this vast area, spawning pink salmon are widely distributed in coastal streams of both continents up to the Bering Strait. North, east, and west of the Bering Strait, spawning populations become more irregular and occasional. Centers of large spawning populations occur at roughly parallel positions along the two continents from about lat. 44°N to 65°N in Asia and about 48°N to 64°N in North America. In marine environments along both the Asian and North American coastlines pink salmon occupy ocean waters south of the limits of spawning streams.

Pink salmon are distinguished from other Pacific salmon by having a fixed 2-year life span, being the smallest of the Pacific salmon as adults (averaging 1.0 to 2.5 kg), the fact that the young migrate to sea soon after emerging from the gravel, and developing a marked hump in large maturing males. This last characteristic is responsible for the vernacular name humpback salmon used in some areas. Because of the fixed 2-year life cycle, pink salmon spawning in a particular river system in old and even years are reproductively isolated from each other and have developed into genetically different lines. In some river systems, like the Fraser River in British Columbia, only the odd-year line exists; returns in even years are negligible. In Bristol Bay, Alaska, the major runs occur in even years, whereas the coastal area between these two river systems is characterized by runs in both even and odd years. In different parts of the range populations are sometimes characterized by the phenomena of dominance where one brood line is much stronger than the other brood line. Upon emergence, pink salmon fry migrate quickly to sea and grow rapidly as they make extensive feeding migrations. After 18 months in the ocean the maturing fish return to their river of origin to spawn and die.

Pink salmon are considered to be have either the simplest or most specialized life cycle within the genus, depending on whether Pacific salmon originated from marine or freshwater ancestors. One view holds that *Oncorhynchus* evolved from an ancestral freshwater form of Pacific *Salmo* during the Pleistocene, probably in the vicinity of the present-day Sea of Japan. Under this scenario, pink salmon that rely least on the freshwater environment are the most specialized. Pink salmon have 52 chromosomes, fewer than other Pacific salmon, which also may suggest specialization. Another view considers Salmonidae as relatively primitive teleosts, of probable marine pelagic origin, and about five million years old. This alternative view to freshwater origin of Pacific salmon is supported, in part, by Pliocene fossils from California and Oregon. The marine origin view holds that during evolution salmonids tended towards greater dependence on fresh water and away from dependence on the sea. Under this scenario, pink salmon, with the least dependence on the freshwater environment, is considered the least advanced extant *Oncorhynchus* species.

Fisheries

Pink salmon are the most abundant Pacific salmon, contributing about 40 percent by weight and 60 percent in numbers of all salmon caught commercially in the North Pacific Ocean and adjacent waters. Coastal fisheries for pink salmon presently occur in Asian (Japan and Russia) and North America (Canada and the United States) with major fisheries in both Russia and the United States. Historically some pink salmon were caught in high seas fisheries by Japan and Russia. Most pink salmon in the United States are caught in Alaska where major fisheries occur in the southeast Alaska, Prince William Sound, and Kodiak regions. Lesser fisheries for pink salmon occur in Cook Inlet, Alaska Peninsula, and Bristol Bay regions. Alaska fisheries for pink salmon occur primarily within State of Alaska territorial seas (inside 3 miles).

Pink salmon catches have been at historic records in Alaska over the past decade with catches exceeding 100 million fish in several years. Most pink salmon in Alaska are caught by purse seines with smaller commercial catches made by set and drift gill net and troll fisheries. Recreational fisheries in Alaska usually harvest between 200 and 400 thousand pink salmon annually. Historically, pink salmon in Alaska have been harvested, on average, at between 60 and 75 percent of the total annual run.

Purse seine fisheries for pink salmon have some bycatch associated with them, primarily other salmon. The most important bycatch issue is in the southeast Alaska region where younger marine-age Chinook salmon, similar in size to adult pink salmon, are caught in pink salmon purse seine fisheries. The total harvest of Chinook salmon in this region is controlled by quotas under auspices of the Pacific Salmon Treaty. The Alaska Board of Fisheries allocates a portion of the quota for Chinook salmon as an allowable bycatch in purse seine fisheries targeted on pink salmon.

Measured marine survivals of pink salmon, from entry of fry into stream mouth estuaries to returning adults, have ranged from 0.2 to over 20 percent. Scientist, in general, believe that much of the natural mortality of pink salmon in the marine environment occurs within the first few months before advanced juveniles move offshore into more pelagic ocean waters. Pink salmon populations can be very resilient, rebounding from weak to strong run strength in regional stock groups within one or two generations.

Because pink salmon are primarily caught in purse seines, there are no known gear impacts to the marine habitats where these fisheries occur.

Relevant Trophic Information

Pink salmon eggs, alevins, and fry in freshwater streams provide an important nutrient input and food source for aquatic invertebrates, other fishes, birds and small mammals. In the marine environment, pink salmon fry and juveniles are food for a host of other fishes and coastal sea birds.

Subadult and adult pink salmon are known to be eaten by 15 different marine mammals, sharks, other fishes such as Pacific halibut and humpback whales. Because pink salmon are the most abundant salmon in the North Pacific, it is likely they comprise a significant portion of the salmonids eaten by marine mammals.

Millions of pink salmon adults returning to spawn in thousands of streams throughout Alaska provide significant nutrient input into the trophic level of these coastal watersheds. Adult pink salmon in streams are major food sources for gulls, eagles, and other birds, along with bear, otter, mink, and other mammals.

Approximate Upper Size Limit of Juvenile Fish (in cm): Roughly 25 cm

Habitat and Biological Associations

Eggs and Spawning: Pink salmon choose a fairly uniform spawning bed in small and large streams in both Asia and North America. Generally, these spawning beds are situated on riffles with clean gravel, or along the borders between pools and riffles in shallow water with moderate to fast currents. In large rivers, they may spawn in discrete sections of main channels or in tributary channels. Pink salmon avoid spawning in quiet deep water, in pools, in areas with a slow current, or over heavily silted or mud-covered streambeds. Places selected for egg deposition is determined by the optimal combination of two main interconnecting variables: depth of water and velocity of current.

On both the Asian and North American sides of the Pacific Ocean, pink salmon generally spawn at depths of 30 to 100 cm. Well populated spawning grounds of pink salmon are mainly at depths of 20 to 25 cm, less often reaching depths of 100 to 150 cm. In dry years, when spawning grounds are crowded, nests can be found at shallower depths of 10 to 15 cm. Current velocities in pink salmon spawning grounds varied from 30 to 100 cm/s, sometimes reaching 140 cm/s. Directly over the redds, about 5 to 7 cm from the surface, the velocity can range from 30 to 140 cm/s but usually averages from 60 to 80 cm/s.

In general, pink salmon select sites in gravel where the gradient increases and the currents are relatively fast. In these areas, surface stream water must have permeated sufficiently to provide intragravel flow for dissolved oxygen delivery to eggs and alevins. Chum salmon, by contrast, tended to select spawning sites in areas with upwelling spring water and a relatively constant water temperature, without much regard to surface stream water. Pink salmon spawning beds consist primarily of coarse gravel with a few large cobbles, a large mixture of sand, and a small amount of silt. High quality spawning grounds of pink salmon can best be summarized as clean, coarse gravel.

Larvae/Alevins: Fertilized eggs begin their 5- to 8-month period of embryonic development and growth in intragravel interstices. To survive successfully, the eggs, alevins, and pre-emergent fry must first be protected from freezing, desiccation, stream bed scouring or shifting, mechanical injury and predators. Water surrounding them must be non-toxic and of sufficient quality and quantity to provide basic requirements of suitable temperatures, adequate supply of oxygen, and removal of waste materials. Collectively, these requirements are, on average, only partially met even under the most favorable natural conditions. Overall freshwater survival of pink salmon from egg to advanced alevin and emerged fry, even in highly productive streams, commonly reaches only 10 to 20 percent and at times is as low as about 1 percent.

Rates of egg development, survival, size of hatched alevins and percentage of deformed fry are related to temperature and oxygen levels during incubation. Temporary low stream temperatures or dissolved oxygen concentrations, however, may be relatively unimportant at some developmental stages, but lethal at others. Generally, low oxygen levels are non-lethal early, but lethal late in development. Eggs subjected to low dissolved oxygen levels hatched prematurely at a rate dependent on the degree of hypoxia. Spinal deformities occurred in eggs incubated at 3.0° and 4.5°C before gastrulation. In one study, over 50 percent of developing pink salmon eggs died at dissolved oxygen levels of 3 to 4 mg/l, and among those that hatched many alevins were deformed.

Juveniles: Newly emerged pink salmon fry show a preference for saline water over fresh water, which may, in some situations, facilitate migration from the natal stream area. Schools of pink salmon fry may move quickly from the natal stream area or remain to feed along shorelines up to several weeks. The timing and pattern of seaward dispersal is influenced by many factors, including general size and location of the spawning stream, characteristics of adjacent shoreline and marine basin topography, extent of tidal fluctuations and associated current patterns, physiological and behavioral changes with growth, and, possibly, different genetic characteristics of individual stocks.

Early marine schools of pink salmon fry, often in tens or hundreds of thousands of fish, tend to follow shorelines and, during the first weeks at sea, spend much of their time in shallow water of only a few centimeters deep. It has been suggested that this onshore period involves a distinct ecological life history stage in both pink and chum salmon. In many areas throughout their ranges, pink salmon and chum salmon fry of similar age and size co-mingle in both large and small schools during early sea life. Juvenile pink salmon in the BS off the northeastern Kamchatka coast are found in one of three hydrological zones during their first three to four months of marine life: (1) the littoral zone, up to 150 m from shore; (2) open parts of inlets and bays from 150 m to 3.2 km from shore; and (3) the open parts of the large Karaginskiy Gulf, 3.2 to 96.5 km from shore. Distribution within these regions is seasonally related to the size of pinks, with an offshore movement of larger fish in August and September.

Pink salmon juveniles routinely obtain large quantities of food sufficient to sustain rapid growth from a broad range of habitats providing pelagic and epibenthic foods. Collectively, diet studies show that pink salmon are both opportunistic and generalized feeders and on occasion they specialize in specific prey items. Diel sampling of stomachs showed fewer and more digested food items at night than during the day indicating that juvenile pinks are primarily diurnal feeders.

Adults: Ocean growth of pink salmon is a matter of considerable interest because, although this species has the shortest life span among Pacific salmon, it also is among the fastest growing. Entering the estuary as fry at around 3 cm in length, maturing adults return to the same area 14 to 16 months later ranging in length from 45 to 55 cm.

The population biology of pink salmon revolves around the 2-year life cycle. A phenomenon of cycle dominance between odd- and even-year brood lines within specific regions is common. Dominance can be weak or strong, complete, or non-existent. It can also shift between brood lines. With complete dominance, the "off-year" line is absent while non-dominance is characterized by similar population strength between odd- and even-year runs. Although many causes for dominance and its various characteristics in pink salmon populations have been proposed, none satisfactorily explains the event. Genetically, pink salmon are more similar within odd- or even-year brood lines across broad geographic regions than across brood lines within the same stream. It has been suggested for some geographic areas that present odd- and even-year pink salmon populations arose from separate glacial refuges during late Pleistocene times.

Scientists have recognized six distinct ocean migration patterns for regional stock groups of pink salmon throughout the North Pacific. Only two of these stock groups, those originating in Washington state and British Columbia and those originating in southeast, central, and southwest Alaska, occur in marine waters where they might interact in some way with the salmon fisheries off the coast of southeast Alaska. Pink salmon from these two broad stock groups co-mingle in the GOA during their second summer at sea while migrating towards natal areas.

SPECIES: Pink salmon, *Onchorynchus gorbuscha*

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs and larvae	90 to 125 days	eggs predated by birds, fish, and mammals	late summer, fall, winter, and early spring	intragravel in stream beds WC, LK, BHC	15 to 50 cm in gravel depth	medium to coarse gravel CB, G	NA	Develop at 1-10°C, eggs hatch at about 100 d, larvae emerge from gravel about 125 d post hatch
Juveniles, freshwater	1 to 15 days; short streams = 1 day, longer rivers=15 day	fry are predated by birds, fish, and mammals	spring	rivers and streams WC, LK, BHC	generally migrating in upper portion of water column	varied	NA	downstream migration is mostly in darkness
Juveniles, estuarine	2 to 3 months	copepods, euphausiids, decapod larva, amphipods	summer	EST, initially nearshore, then offshore in bays and inlets, along kelp beds	generally occupying the upper portion of water column	varied: K, SAV	NA	Preference for increasing salinities, school with other salmon and Pacific sandfish
Juveniles, marine	3 to 6 months	copepods, euphausiids, decapod larva, amphipods	summer, fall, and early, pre anulus winter	coastal, ICS, MCS, OCS; moving further offshore with growth	generally migrating in upper portion of water column	varied: K, SAV	UP, F, CL, E	Coastal and shelf migrations move into oceanic waters in later stages

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Immature and maturing adults marine	6 to 10 months	fish, squid, euphausiids, amphipods, and copepods	spring, summer, and early fall	Oceanic to nearshore in final migration	P, N	NA	UP, F, CL, E: Regional stocks have specific oceanic migratory patterns	Rapid marine growth; onset of maturation timing varies among stocks; earlier north, later south
Adults, freshwater	2 years of age from egg to mature adult, final stage 1 to 2 months	Active feeding ceases, digestive organs atrophy	spawning (Aug-Oct)	WC, LK, BCH	Varied, holding in pools, spawning on shallow riffles	medium to coarse gravel CB, G	NA	sexual dimorphism in spawning males, called humpback salmon

2.4 Habitat Description for Chum Salmon (*Oncorhynchus keta)*

Life History and General Distribution

Chum salmon spawn in streams emptying into the North Pacific Ocean north of about 40°N in both Asia and North America. In Asia, chum salmon spawn in streams on the east side of the Korean peninsula in both South and North Korea northward, including Japan, China (tributaries to the Amur River), Russia and westward into the Arctic Ocean as far west as the Lena River. In North America, chum salmon spawn in streams entering the North Pacific Ocean as far south as northern California and northward in streams along the coasts of Oregon, Washington, British Columbia, and Alaska on into the BS, Arctic Ocean, and Beaufort Sea as far east as the Mackenzie River in Northwest Territory. Chum salmon spawn in Yukon Territory, Canada, in tributaries of the Yukon River. Only populations small in numbers spawn north and east of the Noatak River, which enters the ocean at Kotzebue, Alaska, and south of Tillamook Bay, Oregon.

In general, chum salmon spawn in the lower reaches of coastal streams less than 100 miles upstream from the ocean. Two notable exceptions are the Yukon River in North America and the Amur River in Russia and China where chum salmon migrate upstream more than 1,500 miles to spawning areas. In Prince William Sound, and to a lesser extent southeast Alaska, chum salmon will spawn in the intertidal portions of streams in areas where ground water upwells into the streams. Chum salmon throughout their range tend to build their redds in areas of streams where ground water (about 4 to 7°C) upwells.

In North America, chum salmon return from the ocean to spawn, for the most part, between June and January. In general, spawning starts earlier in the north and ends later in the southern part of their range. Of course, major exceptions in this pattern occur. The latest spawning in southeast Alaska occurs in the Chilkat River, near Haines, Alaska, from September through January. Most chum salmon spawning in Alaska is usually finished by early November. Most spawning in Washington/Oregon takes place from August through November; however, August spawners have been declining in recent years. Chum salmon return to the Quilcene National Fish Hatchery in December, and the Nisqually River near Olympia, Washington, has spawners during January and February and sometimes into March.

So called summer and fall races of chum salmon occur in Asia and North America. Summer and fall races both enter the Yukon River. The summer chum salmon start entering the river in May and the fall chum enter the river in June and July. The fall stocks tend to spawn farthest up river in September through November. Summer chum are more abundant than fall chum in the Yukon River; however, the fall chum are larger. In southern southeast Alaska and northern British Columbia summer chum enter mostly mainland rivers in mid-June and spawning may extend into late October and early November. Fall chum in southern southeast Alaska and northern British Columbia spawn mostly in streams on the Islands and spawning typically occurs during September and October. Unlike the Yukon River, summer chum salmon in southern Southeast Alaska and northern British Columbia are larger than the fall stocks for the same age, even though the summer stocks may spawn more than 3 months earlier.

Chum salmon return to spawn as 2- to 7-year-olds. Two-year-old chum are rare in North America and occur primarily in the southern part of their range, e.g., Oregon. Seven-year-old chum are also rare and occur mostly in the northern areas. In general, chum salmon get older from south to north. Three- and four-year-olds tend to dominate in the southern areas and 4-, 5-, and 6-year-olds tend to dominate in the more northern areas. For the most part older chum salmon are larger than younger fish but much overlap occurs between the age groups. The largest chum salmon in North America (and probably the world) occur in the Portland Canal area, which forms the border between Alaska and British Columbia.

Chum salmon fry, like pink salmon, do not overwinter in the streams but migrate (mostly at night) out of the streams directly to the sea shortly after emergence. The range of this outmigration occurs between February and June but most fry leave the streams during April and May. Chum salmon do tend to linger and forage in the intertidal areas at the head of bays. Estuaries are very important for chum salmon rearing during the spring and summer.

Juvenile chum salmon are present in the coastal waters mostly during July through October, and generally move to the north and west along the coasts of Oregon, Washington, British Columbia, and Alaska. Most juvenile chum salmon are thought to leave the coastal waters and move south into the North Pacific Ocean between Kodiak and False Pass during late fall. After chum salmon form an annulus on their scales (January to March) they are considered immature. They may remain immature for several years until they start maturing and begin their migration to their spawning streams.

Both Asian and North American chum salmon winter in the North Pacific but Asian chum salmon migrate much further east than North American chum salmon migrate to the west. North American chum salmon are seldom found west of 175°E; however, Asian salmon are found eastward to at least 140°W. However, Asian and North American stocks of chum salmon are intermingled on the high seas.

After the 1976 to 1977 Regime Shift in the North Pacific Ocean, most chum salmon stocks increased in abundance through the mid-1990s. The Regime Shift apparently created very favorable ocean conditions for all species of salmon from northern British Columbia to northern Alaska. However, as the abundance increased, age at maturity increased, and size at age decreased drastically. Chum salmon of the same age in the early 1990s weighed up to 46 percent less than they weighed in the early 1970s. During this same time, Asian chum salmon also matured older and their size at age declined. These changes in size and age at maturity as population numbers increased suggests that the North Pacific Ocean may have carrying capacity limits for chum salmon under certain conditions.

Fisheries

Chum salmon are captured primarily in purse seines and gill-nets in North America after traps were outlawed in Alaska in 1960. Some chum salmon are captured in troll fisheries, primarily in Canada.

Major fisheries occur for chum salmon from southern Washington to the Noatak River in northwestern Alaska. Significant declines of chum salmon in Oregon in the 1940s caused the state to abandon net fisheries and the stocks still have not recovered.

Most net fisheries for chum salmon occur in the coastal waters in Alaska, but some in-river gill-net fisheries occur in the larger rivers for both commercial and subsistence fisheries. Chum salmon are often captured incidently in fisheries targeting pink or sockeye salmon. Large incidental catches of chum salmon occur in southeast Alaska and Prince William Sound. When the Pacific Salmon Treaty between the United States and Canada was signed in 1984, chum salmon in the Portland Canal (on both sides of the border but particularly in Canada) were identified as a major conservation concern. The cause of this problem was blamed on incidental capture of chum salmon in fisheries targeting pink and sockeye salmon.

Chum salmon have also been captured incidentally in the trawl fisheries for pollock in the BS. Apparently, the chum are "scooped" at the surface when the trawl is being let out and brought in. In some years this can be a major problem, e.g., in 1994 when about 250,000 chum were estimated to be part of the bycatch.

Chum salmon fisheries utilize seines, gill-nets, and troll gear and there are no apparent impacts of the gear on marine or freshwater habitats.

Relevant Trophic Information

Chum salmon eggs, alevins, and juveniles in freshwater streams provide an important food source for many birds (e.g., gulls, crows, magpies, ouzels, kingfishers), small mammals, other fishes, and many invertebrates. Chum salmon carcasses provide nutrients for the freshwater watersheds and estuaries. Carcasses are also highly important for food for many birds (e.g., eagles, ravens, crows, gulls, magpies). The late chum salmon return to the Chilkat River system near Haines, Alaska, is the reason that large numbers of bald eagles congregate on the spawning grounds every year in September through December. Adult chum salmon and spawned carcasses provide a major food source for brown and black bears, wolverines, wolves, and many other small mammals. Many species of invertebrates utilize carcasses for food.

Approximate Upper Size Limit of Juvenile Fish (in cm): If the term juvenile chum salmon refers to the fry stage up to the time of the first annulus formation in the ocean, which occurs in January-March, the upper size limit is about 30 cm. Juvenile chum salmon in the outside waters of Southeast Alaska in mid to late August range in size up to about 25 cm.

Habitat and Biological Associations

Eggs/Spawning: Chum salmon spawn in gravel in streams, side-channel sloughs, and intertidal portions of streams when the tide is below the spawning area. In all of these areas upwelling ground water is often the common denominator. Many side-channel sloughs have very little current on the surface and can be very silty; however, the upwelling ground water keeps the silt in suspension in the intragravel water. The upwelling water also keeps these spawning areas with slow moving surface water from freezing in the winter. The depth that eggs are deposited in the streams varies according to the gravel size, current, and size of the female, but the range is about 8 to 50 cm. Eggs and sperm are deposited in the redd simultaneously and each female spawns with up to six males at the same time. Several redds are constructed by each female and different males may be involved in the spawning act in subsequent redds. Stream life of both sexes varies and is longer in the early stages of the run (about 14 days) and shorter near the end of the run (as few as 6 days) in coastal streams.

Larvae/Alevins: Fertilized eggs incubate in the streambed gravel for about 5 to 8 months. Eggs, alevins, and pre-emergent fry can be killed by desiccation, freezing, mechanical injuries due to streambed shifting, e.g., during floods, and predators. The intragravel water during incubation and rearing must be of suitable temperatures and be free of toxins with adequate oxygen and flow to remove waste products. Survival from deposited eggs to emergent fry is highly variable, ranging from about 1 to 20 percent. The health of the eggs and emerging fry is also dependent on gravel composition, spawning time, spawning density, and genetic characteristics. In general, chum salmon eggs have to be fertilized in water above 4°C and in salinity less than 2 parts per thousand. Dissolved oxygen levels during incubation need to be above 3 to 4 mg/l.

Juveniles: After emerging from the streambed (as early as February and as late as June) schooling chum salmon fry migrate downstream, mostly at night, to the estuaries where they tend to feed in the intertidal grass flats and along the shore. Chums can utilize these intertidal wetlands for several months before actively migrating out of bays and into channels on the way to the outside waters. Pink salmon on the other hand tend to move more directly to more open water areas. Chum salmon utilize a wide variety of food items, including mostly invertebrates (including insects), and gelatinous species. Offshore movement of larger juveniles occurs mostly in July to September.

Adults: Chum salmon reside in the ocean for about 1 to 6 years. Adults mature at ages 2 through 7 years; however, 2- and 7-year-old chum salmon are rare. Throughout their range 3-, 4-, and 5-year olds are common but 3- and 4-year-old salmon dominate the southern stocks and 4-, 5-, and 6-year-old chum salmon dominate the northern stocks. Slow or rapid growth in the ocean can modify age at maturity. Slower growth during the second year at sea causes some chum salmon to mature 1 or 2 years later. Chum salmon eat a variety of foods during their ocean life, e.g., amphipods, euphausiids, pteropods, copepods, fish, and squid larvae. Chum salmon also utilize gelatinous zooplankton for food more often than any of the other species of salmon. Chum salmon have a much larger stomach than the other species of salmon and this large capacity may allow them to utilize the nutrients from the gelatinous zooplankton more efficiently.

Asian and North American chum salmon are intermingled on the high seas as immature and during their last year at sea. Recently, immature and maturing chum salmon from Washington, British Columbia, and southeast Alaska have been identified in the BS in August. Chum salmon spawn mostly in November in Washington and southern British Columbia so these fish are capable of long distant migrations in their last year in the sea.

Special Habitat Concerns: Chum salmon are subject to the same habitat concerns as the other species of salmon, e.g., habitat destruction or silting due to logging and road building activities, blockages due to dams, and pollution. In addition, chum salmon have two habitat requirements that are essential in their life history that make them very vulnerable: (1) reliance on upwelling ground water for spawning and incubation, and (2) reliance on estuaries/tidal wetlands for juvenile rearing after migrating out of the streams. The hydrology of upwelling ground water into stream gravel is highly complex and poorly understood. Whatever activities change the amount and quality of groundwater that upwells would very likely affect chum salmon survival in a negative manner. Drilling activities and uplift of land masses due to earthquakes are two phenomena known to affect groundwater. Wetlands and estuaries near communities are very vulnerable to pollution and filling activities that would negatively affect essential chum salmon rearing areas.

Chum salmon will spawn in intertidal portions of streams, most notably in Prince William Sound. The intertidal portion of streams is very vulnerable to coastal pollution from oil spills et al. In Prince William Sound, chum salmon spawners are active in the intertidal zone of streams from late June through September. Eggs, alevins, and fry are in the intertidal gravel from late June through May. That leaves a very narrow "window" in June when the intertidal zone may be free of adults, eggs, alevins, or fry.

SPECIES: Chum Salmon, *Onchorhynchus keta*

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs and larvae	90 to 125 days	eggs predated by birds, fish, and mammals	early summer, fall, winter, and early spring	intragravel in stream beds WC, LK, BCH	7.5 to 50 cm in gravel depth	small to coarse gravel CB, G	NA	Develop at 1-10°C, eggs hatch at 52-173 d, larvae emerge from gravel 146-325 d
Juveniles (freshwater)	1 to 15 days; short streams = 1 day, longer rivers=30 days	fry are predated by birds, fish, and mammals	spring	rivers and streams WC, LK, BCH	generally migrating in upper portion of water column	varied	NA	downstream migration is mostly in darkness
Juveniles (estuarine)	2 to 3 months	copepods, euphausiids, decapod larva, amphipods, gelatinous zooplankton	summer	EST, initially nearshore, then offshore in bays and inlets, along kelp beds	generally occupying the upper portion of water column	varied: K, SAV	NA	Preference for increasing salinities, school with other salmon and Pacific sandfish
Juveniles, (marine)	3 to 6 months	copepods, euphausiids, decapod larva, amphipods, gelatinous zooplankton	summer, fall, and winter prior to annulus formation in Jan.-Mar.	coastal, ICS, MCS, OCS; moving further offshore with growth	generally migrating in upper portion of water column	varied: K, SAV	UP, F, CL, E	Coastal and shelf migrations move into oceanic waters in later stages

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other **Page 2 of 2**
Immature and maturing adults (marine)	6 to 10 months	fish, squid, euphausiids, amphipods, copepods, and gelatinous zooplankton	spring, summer, and early fall	Oceanic to nearshore in final migration	P, N	NA	UP, F, CL, E: Regional stocks have specific oceanic migratory patterns	Rapid marine growth; onset of maturation timing varies widely among stocks; generally earlier north, later south
Adults (freshwater)	2 to 7 years of age from egg to mature adult, final stage 1-2 months	Active feeding ceases, digestive organs atrophy	spawning (June-January)	WC, LK, BCH	Varied, holding in pools, spawning on shallow riffles, pools or side-channel sloughs	small to coarse gravel CB, G	NA	sexual dimorphism in spawners, males develop large teeth, called dog salmon

2.5 Habitat Description for Sockeye Salmon (*Oncorhynchus nerka*)

Life History and General Distribution

The natural freshwater range of sockeye salmon includes the Pacific rim of Asia and North America north of about 40°N. Within this area, the primary spawning grounds of sockeye salmon in North America extend from tributaries of the Columbia River to the Kuskokwim River in western Alaska, and on the Asian side, the spawning areas are found mainly on the Kamchatka Peninsula. Spawning populations become more irregular and occasional north of the Bering Strait, on the north coast of the Sea of Okhotsk, and in the Kuril Islands. Centers of the two largest spawning complexes in the North Pacific rim occur in the Bristol Bay watershed of southwestern Alaska and the Fraser River drainage of British Columbia. In marine environments along both the Asian and North American coastlines, sockeye salmon occupy ocean waters south of the limits of spawning systems.

Sockeye salmon exhibit a greater variety of life history patterns than other members of the genus *Oncorhynchus,* and characteristically make more use of lake rearing habitat in juvenile stages. Although sockeye salmon are primarily anadromous, there are distinct populations called kokanee, which mature, spawn, and die in fresh water without a period of sea life. Typically, but not universally, juvenile anadromous sockeye utilize lake rearing areas for 1 to 3 years after emergence from the gravel; however, some populations utilize stream areas for rearing and migrate to sea soon after emergence. Anadromous sockeye may spend from 1 to 4 years in the ocean before returning to fresh water to spawn and die in late summer and fall.

The adaptations of sockeye salmon to lake environments appear to require more precise homing to spawning areas, both as to time and location than is found in the other species of Pacific salmon. Although available spawning localities are more restricted because of the usual requirement of a lake rearing environment for the juveniles, the overall success of this adaptation is indicated by the fact that sockeye are much more abundant than Chinook (*O. tshawytscha*) and coho salmon (*O. kisutch*), which utilize stream rearing environments as juveniles. Juvenile sockeye salmon in fresh water do not need the territorial stream behavior displayed by juvenile Chinook and coho salmon, but do exhibit schooling tendencies more characteristic of pelagic feeding fishes.

Other distinctions of sockeye salmon include growth rate and size at maturity. Sockeye do not exhibit the rapid marine growth of coho or pink salmon (*O. gorbuscha*), which mature and return to fresh water after a single winter in the ocean, or of Chinook or chum salmon (*O. keta*), which attain a much larger average size at maturity. The flesh of sockeye is a darker red than that of the other salmon species, a color long considered to be a marketing attribute of the canned and, more recently, the fresh or fresh-frozen product.

Fisheries

Sockeye salmon are an important component, and often the most lucrative fishery for Pacific salmon. Coastal fisheries for sockeye salmon presently occur in North America (Canada and the United States) and Asia (Japan and Russia) with major fisheries in all areas except Japan. From 1920 through 1945, sockeye salmon were caught on the high seas by a Japanese mother ship fishery. This fishery started again in 1953 and a land based driftnet fishery moved sufficiently offshore to begin substantial catches of sockeye in 1958. Restrictions in fishing areas resulting from renegotiation of international fishery treaties ended the high seas fisheries in the mid 1980s. In recent years, about 22 percent of the numbers and 28 percent by weight of all salmon caught commercially in the North Pacific Ocean and adjacent waters were sockeye. Catches in North

America, primarily Alaska and British Columbia, have always been greater than Asian catches. North American catches averaged about 30 million through 1940, declined to 10 to 15 million in the early 1960s and surged to 40 million and more in the 1990s. The recent record high catches resulted primarily from an increase in run magnitudes of natural stocks in central and western Alaska. Historically, Asian catches of sockeye salmon have averaged fewer than 10 million fish. Most sockeye salmon in the United States are caught in Alaska where major fisheries occur in southeast, central, and westward areas. In Alaska, sockeye fisheries occur primarily within State territorial seas (inside 3 miles).

Sockeye salmon catches have been at historic records in Alaska over the past decade with catches exceeding 60 million fish in several years. Most sockeye salmon in Alaska are caught by set and drift gill net fisheries. Recreational fisheries in Alaska usually harvest between 200,000 and 400,000 sockeye salmon annually, mostly in river system of the Kenai Peninsula in central Alaska. Subsistence catches of sockeye salmon are not universally maintained, but the catches are important, particularly to native people in a number of localities. The Fraser River Indian tribes recorded annual subsistence catches for the years 1970 to 1982 of 240,000. The subsistence catch of sockeye salmon in the United States was 315,000 in 1993, and over 307,000 was caught in Alaskan waters.

Gill net fisheries for sockeye salmon have some bycatch associated with them, primarily other salmon. The most important bycatch issue is in the southeastern region where younger marine-age Chinook salmon, similar in size to sockeye, are caught in sockeye net fisheries. The total harvest of Chinook salmon in this region is controlled by quotas under auspices of the Pacific Salmon Treaty. The Alaska Board of Fisheries allocates a portion of the quota for Chinook salmon as an allowable bycatch in gill net fisheries.

Measured marine survivals of sockeye salmon, from entry of smolts into stream mouth estuaries to returning adults, have ranged from about 5 percent to over 50 percent. Scientists, in general, believe that much of the natural mortality of sockeye salmon juveniles in the marine environment occurs within the first few months, and is probably influenced by three factors of unknown relative importance: (1) size and age at seaward migration; (2) timing of entry into the marine environment; and (3) length of stay in the ocean. Variations in oceanographic conditions and in marine predator populations (fish, mammals, and birds) undoubtedly have affected the marine survival of sockeye populations in different ways around the North Pacific rim, but these effects are poorly understood.

Because sockeye salmon are primarily caught in gill nets, there are no known gear impacts to the habitats where these fisheries occur.

Relevant Trophic Information

Sockeye salmon eggs, alevins, and juveniles in freshwater streams and lake systems provide an important nutrient and food source for aquatic invertebrates, other fishes, birds, and small mammals. In the marine environment sockeye salmon juveniles are food for many other fishes and coastal sea birds. Adult sockeye salmon are known to be eaten by marine mammals and sharks.

Millions of sockeye salmon adults returning to spawn in thousands of streams throughout Alaska provide significant nutrient input into the trophic level of these coastal watersheds. Adult sockeye salmon in streams are major food sources for gulls, eagles, and other birds, along with bear, otter, mink, and other mammals.

Approximate Upper Size Limit of Juvenile Fish (in cm): Roughly 25 cm

Habitat and Biological Associations

Eggs/Spawning: Sockeye salmon generally spawn in late summer and autumn. Within this period, time of spawning for different stocks can vary greatly, apparently because of adaptations to the most favorable survival conditions for spawning, egg and alevin incubation, emergence, and subsequent juvenile feeding. Although timing of spawning varies little from year to year within a specific spawning area, there are great differences in timing among spawning areas. The timing of spawning appears to be dependent to some degree on the temperature regimen in the gravel where the eggs are incubated. This varies distinctly among spawning area types. In the Bristol Bay region of Alaska, spawning begins in late July in the smaller streams, in early to mid-August in the tributaries of some lakes, and in late August to mid-September in most lake beach areas. In Lake Kuril and its tributaries, spawning continues from the end of June until early February with the main spawning occurring from September to November.

Among the species of Pacific salmon, the sockeye salmon exhibits the greatest diversity in adaptation to a wide variety of spawning habitats. The selection of habitats and timing of spawning by a sockeye stock are linked to success of survival, not only during spawning and incubation of the eggs and alevins, but also in the chain of freshwater and marine environments to which the progeny are subsequently exposed. In most instances, but not all, the subsequent environment of the juveniles is a lake or lake chain, and the behavior of the juveniles after emergence depends on the location of the spawning area in relation to the lake rearing area to be utilized. Lake-beach spawning has been recorded in most sockeye lake systems, and is apparently important habitat. Sockeye are also known to spawn in areas that lack lake rearing habitat. These "river spawning" or "sea type" sockeye lay their eggs in river systems with no lake, and emergent fry apparently feed in the stream or low-salinity estuaries for several months before migrating to offshore ocean areas. The circumstances surrounding the initial establishment of a spawning colony and the subsequent adaptive behavior of the progeny can only be surmised. However, the continued use of a specific spawning environment by a sockeye stock depends on the precise homing ability of the species, in which straying to other potential spawning locations is minimal.

The composition of spawning substrate utilized by sockeye salmon varies widely. Some lake-beach spawning occurs to a depth of nearly 30 m in areas of strong upwelling groundwater. In some lakes, mass spawning takes place over large angular gravel too large to be moved by salmon in the normal digging process. The eggs settle in the crevices between the rocks. Generally, however, spawning along lake beaches and in streams takes place in gravel small enough to be readily dislodged by digging, and the digging process tends to remove the silt and clean the gravel where the eggs are deposited. Water depth does not seem to be a critical factor to sockeye in selecting a spawning site. In the small streams and spring ponds, it is common to observe pairs of salmon in the spawning process with their dorsal surfaces protruding from the water. In larger rivers, spawning depths are generally not great because riffle areas are preferred. Spawning on lake beaches can extend to considerable depths. It is clear that sockeye can detect upwelling groundwater areas along lake beaches and in spring ponds areas in which to spawn. Generally, the spawning beds are situated in areas with clean gravel, or along the borders between pools and riffles in shallow water with moderate to fast currents. In large rivers, they may spawn in discrete sections of main channels or in tributary channels.

Superimposition is minimized by the territorial defense of the redd by the female following egg deposition, which protects the redd for a few days. Female territory is partly a function of spawner density. Estimates of the capacity of streams to support spawning sockeye were based on density of one female/2 m^2. In spawning channels, maximum fry production was achieved at the spawner density of one female/m^2.

Larvae/Alevins: Fertilized eggs begin their 5- to 8-month period of embryonic development and growth in intragravel interstices. To survive successfully, the eggs, alevins and pre-emergent fry must first be protected from freezing, desiccation, stream bed scouring or shifting, mechanical injury and predators. Water surrounding them must be non-toxic and of sufficient quality and quantity to provide basic requirements of suitable temperatures, adequate supply of oxygen, and removal of waste materials. Collectively, these requirements are, on average, only partially met even under the most favorable natural conditions. Overall freshwater survival of sockeye salmon from egg to advanced alevin and emerged fry, even in highly productive streams, commonly reaches only 10 to 20 percent, and at times is as low as 1 percent.

Rates of egg development, survival, size of hatched alevins, and percentage of deformed fry are related to temperature and oxygen levels during incubation. Temporary low stream temperatures or dissolved oxygen concentrations, however, may be relatively unimportant at some developmental stages, but lethal at others. Generally, low oxygen levels are non-lethal early, but lethal late in development.

Juveniles: Fry emergence apparently begins in early to mid-April in most instances, peaks in early to mid-May, and ends in late May to early June. Newly emerged sockeye salmon fry show a marked negative rheotaxis and actively swim downstream to lakes. In some lake outlet spawning areas, the emerging fry swim laterally in an attempt to reach the river banks and avoid being swept downstream. The emergence behavior of fry in lakeshore spawning areas has not been reported. It has been suggested that the seasonal timing of sockeye fry emergence optimizes the timing of dispersal into their feeding habitat, particularly to take advantage of the seasonal peak abundance of zooplankton of appropriate size. It is postulated that fry emerging earlier or later than the optimum may suffer greater mortality, and thus that timing is a response to this selective pressure. The survival value in entering the lake early is to take advantage of feeding in the lake as long as possible during the summer, thus achieving larger size in preparation for spring smoltification. Annual timing of fry migration and its seasonal pattern is a function of the seasonal timing of the adult spawning period, ecological factors within the incubation habitat that affects development rate and alevin behavior, and transit time needed by the fry to reach their feeding habitat.

Upon entering nursery lakes, sockeye fry disperse quickly into their lake feeding areas. Movement of fry into the nursery areas may be direct and immediate, or sequential, the latter involving occupation of intermediate feeding areas for a period of time. The plasticity of response suggests definite racial adaptations to a variety of different environmental conditions. Intermediate feeding and growth can occur along outlet river banks before migration into the nursery lake. In-lake dispersions of fry is probably a mechanism whereby the lake zooplankton is effectively utilized as food for the juvenile fish.

Sockeye salmon juveniles typically spend one or more growing seasons in the limnetic zone of a nursery lake before smoltification. The transition in feeding behavior and diet from the time of emergence of the fry from stream or lakeshore to the time of smoltification takes many forms. In general, it is a shift from dependence on dipteran insects to pelagic zooplankton. The annual growth attained by juvenile sockeye and length of residence in fresh water varies greatly among populations in different lake systems, as well as between years within individual lakes. Factors affecting growth are highly complex and include (1) size and species composition of the food supply; (2) water temperature and thermal stratification of the lake; (3) photoperiod and length of growing season; (4) relative turbidity of the lake and available light intensity in the water column; (5) intra- and interspecific competition; (6) parasitism and disease; (7) feeding behavior of juvenile sockeye to minimize predation; and (8) migratory movements to seek favorable feeding environments. Growth influences durations of stay in fresh water before smoltification, and within many lake populations the larger members of a year class tend to migrate to sea earlier the spring or migrate a year earlier than smaller members. In the more southern systems, smoltification after 1 year is nearly universal. Size is not strictly the determinant for duration of stay in fresh water, because some populations with very poor freshwater growth in their first year migrate as yearlings, whereas other populations exhibiting good first-year growth migrate predominantly after a second year of growth. Emergent fry of "river spawning" or "sea type" sockeye, which spawn in systems lacking lake rearing habitat, feed in the stream or low-salinity estuaries for several months before migrating to offshore ocean areas.

Sockeye fry at the beginning of lake life are between 25 and 31 mm and weigh between 0.1 and 0.2 g. Yearling smolts vary greatly in size; average range 60 to 125 mm and 2.0 to 30.0 g. After a second year of growth in a lake, 2-year-old smolts often overlap the size range of yearlings, and have been reported at an average of 200 mm and 84.0 g at Hidden Lake in central Alaska. Sea type sockeye smolts are typically the same size as yearling smolts when they migrate to offshore ocean areas.

After smoltification and exodus from natal river systems in spring or early summer, juvenile sockeye enter the marine environment where they reside for 1 to 4 years, usually 2 or 3 years, before returning to spawn. Depending on the stock, they may reside in the estuarine or nearshore environment before moving into oceanic waters. They are typically distributed in offshore waters by autumn following outmigration. During the initial marine period, yearling sockeye forage actively on a variety of organisms, apparently preferring copepods and insects, but also eating amphipods, euphausiids, and fish larvae when available. Their growth rate is about 0.6 mm/d.

After entering the open sea during their first summer, juvenile sockeye salmon remain in a band relatively close to the coast. Off the outer coast of British Columbia and southeast Alaska, the juveniles are often recorded on the open sea in late June. By July, the fish are found moving northwestward into the GOA. Sampling in the North Pacific has shown that by October juvenile sockeye are still somewhat distributed primarily nearshore. Evidence indicates the northwestward movement up the eastern Pacific rim is followed by a southwestward movement along the Alaska Peninsula. An offshore movement into the GOA in late autumn or winter is conjectured for the location of age 1 sockeye in early spring.

Adults: Sockeye salmon from different regions differ in growth rate and age and size at maturity. Growth in length is greatest during the first year at sea, and increase in weight is greatest during the second year. Most sockeye spend 2 to 3 years feeding in the ocean before their final summer of return. There is substantial variation in size among populations within an age class. In Alaska, the average size of females that had spent 2 years in the ocean ranged from 45 to 54 cm, and of those that had spent 3 years the average ranged from 51 to 60 cm.

SPECIES: Sockeye Salmon, *Onchorynchus nerka*

Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs and larvae (alevins)	eggs: 90 to 100 days larvae: 100 to 125 days	NA	late summer, fall and winter	WC, LK	Intragravel	CB, G	NA	Develop at 1-10°C, eggs hatch about 100 d, alevins emerge from gravel about 125 d post hatch
Juveniles, Freshwater	1 to 3 years, fry emerge and move quickly to lakes, or, rarely, 3 to 4 months in estuaries	copepods, bosminids, Daphnia chironomids dipterans, stoneflies	for yearling and older smolt, early to late summer for sea type run	WC, LK EST	P, N	NA	NA	Preference pelagic feeding in lakes, usually not with other fishes, except when predators present
Juveniles, estuarine	1 to 4 months	copepods, amphipods,	spring, summer, fall	BCH, EST, to 30 m	P, N	NA	UP, CL	larger fish progressively farther from shore
Juveniles, marine	6 to 8 months	copepods, amphipods, small fishes, squid mysids, euphausiids	early summer to late winter	BCH, ICS, MCS, IP BAY	P, N	NA	UP, CL	movements from near-shore to offshore areas
Adult, immature and maturing, marine	1 to 4 years from smolt to mature adult	copepods, amphipods, insects, small fishes, squid	immature: year round 1 to 3 years	BCH, ICS, MCS, OCS, USP, LSP, BSN, BAY, IP	P, N	NA	UP	migration timing for different regional stock groups varies; earlier in the north, later in the south
Adults, freshwater	2 to 4 months	no active feeding in freshwater	Spawning migration (May-August)	WC, LK	depth in streams <10 cm, depth in lakes to 20 m	CB, G	NA	migration timing for different regional stock groups varies; earlier in the north, later in the south

2.6 Habitat Description for Chinook Salmon (*Oncorhynchus tshawytscha*)

Life History and General Distribution

Chinook salmon, also called king, spring, or tyee salmon, are the least abundant and largest of the Pacific salmon. They are distinguished from other species of Pacific salmon by their large size, the small black spots on both lobes of the caudal fin, black pigment at the base of the teeth, and a large number of pyloric caeca. The natural freshwater range of the species includes large portions of the Pacific rim of North America and Asia. In North America, Chinook salmon historically ranged from the Ventura River in California (lat. ~34°) to Kotzebue Sound in Alaska (~66° N); in addition, the species has been identified in North America in the Mackenzie River, which drains into the Arctic Ocean. In Asia, natural populations of Chinook salmon have been documented from Hokkaido Island, Japan (~42° N) to the Andyr River in Russia (~64° N). Within this range, the largest rivers tend to support the largest aggregate runs of Chinook salmon and have the largest individual spawning populations. Major rivers near the southern and northern extremes of the range support populations of Chinook salmon comparable to those near the middle of the range. For example, in North America, the Yukon River near the north edge of the range and the Sacramento-San Joaquin River system near the south edge of the range have historically supported Chinook salmon runs comparable to those of the Columbia River and the Fraser River, which are near the center of the species range along this Pacific coast.

In marine environments, Chinook salmon range widely throughout the North Pacific Ocean and the BS, from lat. 38°. The southern edge of the marine distribution expands and contracts seasonally and between years depending on ocean temperature patterns. While the marine distribution of Chinook salmon can be highly variable even within a population, there are general migration and ocean distribution patterns characteristic of populations in specific geographic areas. For example, Chinook salmon that spawn in rivers from the Rogue River in Oregon south to California disperse and rear in oceanic waters off the Oregon and California Coast, whereas those that spawn north of the Rogue River to southeast Alaska migrate north and westward along the Pacific coast. These migration patterns are of particular interest for the management of Chinook salmon in the EEZ off Alaska, as they result in the harvest of fish from Oregon, Washington, British Columbia, and Alaska within the management zone.

Pacific salmon have a generalized life history that includes the incubation and hatching of embryos and emergence and initial rearing of juveniles in freshwater; migration to oceanic habitats for extended periods of feeding and growth; and return to natal waters for completion of maturation, spawning, and death. Within this general life history strategy, Chinook salmon display diverse and complex life history patterns and tactics. Their spawning environments range from just above tidewater to over 3,200 km from the ocean, from coastal rainforest streams to arid mountain tributaries at elevations over 1,500 m. At least 16 age categories of mature Chinook salmon have been documented, involving three possible freshwater ages and total ages of 2 to 8 years, reflecting the high variability within and among populations in length of freshwater, estuarine, and oceanic residency. Chinook salmon also demonstrate variable ocean migration patterns and timing of spawning migrations.

This variation in life history strategy has been explained by separating Chinook salmon into two races: stream- and ocean-type fish. Stream-type fish have long freshwater residence as juveniles (1 to 2 years), migrate rapidly to oceanic habitats, enter freshwater as immature or "bright" fish, and spawn far upriver in late summer or early fall. Ocean-type fish have short, highly variable freshwater residency (from a few days to 1 year), extensive estuarine residency, enter fresh-water at a more advanced state of maturity, and spawn within a few weeks of freshwater entry in the lower portions of the watershed. Within these two types, there is also substantial variability due to a combination of phenotypic plasticity and genetic selection to local conditions. For example, adult run-timing is strongly influenced by in-river flow volumes and temperature levels.

Chinook salmon have distinctly different feeding habits and distribution and in ocean habitats than do other species of Pacific salmon. Chinook salmon are the most piscivorous of the Pacific salmon, and are also distributed deeper in the water column. While other species of salmon generally are surface oriented, utilizing primarily the upper 20 m, Chinook salmon tend to be at greater depths and are often associated with bottom topography. Because of their distribution in the water column, the majority of Chinook salmon harvested in commercial troll fisheries are caught at depths of 30 m or greater, and Chinook salmon is the most common salmon species taken as bycatch in mid-water and bottom trawl fisheries.

Declines in the abundance of Chinook salmon have been well documented throughout the southern portion of the range. Concern over coast-wide declines from southeast Alaska to the Pacific Northwest was a major factor leading to the signing of the Pacific Salmon Treaty between the United States and Canada in 1985. Wild Chinook salmon populations have been extirpated from large portions of their historic range in a number of watersheds in California, Oregon, Washington, Idaho, and southern British Columbia, and a number of evolutionarily significant units (ESUs) have been listed by National Marine Fisheries Service as at risk of extinction under the Endangered Species Act (ESA). Habitat degradation is the major cause for extinction of populations; most are related to dam construction. Urbanization, agricultural land use and water diversion, and logging are also factors contributing to habitat degradation and the decline of Chinook salmon. The development of large-scale hatchery programs, have, to some degree, mitigated the decline in abundance of Chinook in some areas. However, genetic and ecological interactions of hatchery and wild fish have also been identified as risk factors for wild populations, and the high harvest rates directed at hatchery fish may cause over-exploitation of co-mingled wild populations.

Fisheries

Because of their large size and excellent taste, Chinook salmon are highly prized by commercial, sport, and subsistence fishers. In Alaska, approximately 1 million Chinook salmon are harvested annually. While this is less than 1 percent of the annual salmon catch in the state, Chinook salmon typically are the focus of a disproportionately larger amount of management and regulatory effort because of the conservation concerns and intense allocation issues for this species.

In most of the state, there is no directed harvest of Chinook salmon in the EEZ. Most fishing effort takes place in the coastal or riverine waters of the state. The FMP for salmon in the Alaska EEZ prohibits commercial harvest in the EEZ, with a few exceptions. The most notable exception is the commercial troll harvest off of southeast Alaska. While much of this fishery is also in state waters, it has been traditionally managed since Alaska statehood (1959) with little recognition of the boundary separating state and federal waters. Chinook and coho salmon are the primary target species of this hook-and-line fishery.

The commercial troll fishery for Chinook salmon in southeast Alaska developed in the early 1900s. The fishery occurred all year with no overall catch limits. Peak harvests of Chinook were in the 1930s, when annual catch averaged over 600,000. Concurrent with the development of the Columbia River hydroelectric dams, catches declined to average 250,000 to 350,000 Chinook annually. Beginning in 1978, ADF&G and the Council set harvest limits for the fishery in the first FMP for salmon in Alaska. These limits were initially a harvest range of 286,000 to 320,000 Chinook salmon for the southeast Alaska troll fishery. The

FMP also banned commercial salmon fishing in the EEZ west of long. 175° E, banned fishing for salmon with nets throughout the EEZ (with a few specific exceptions), and imposed time closures on commercial trolling in the EEZ east of long. 175°.

These harvest ranges became part of a 15-year stock rebuilding program begun in 1981 for stocks that spawn in southeast Alaska and in transboundary rivers that originate in Canada and flow through southeast Alaska. In 1985, the Pacific Salmon Treaty between the United States and Canada included specific provisions for rebuilding Chinook salmon stocks coast-wide. The Chinook Annex to the treaty established specific total catch limits for Chinook in southeast Alaska and in certain fisheries in British Columbia in 1985 and 1986; subsequently, the catch limits were to be negotiated annually. The catch ceiling in southeast Alaska was originally established at 263,000 "treaty fish," with a provision for additional harvest of fish produced by new enhancement operations in the region. The catch ceiling included an allocation for incidental catch of Chinook salmon in net fisheries directed at other salmon species, as well as the commercial and recreational troll harvests. It resulted in a reduction of approximately 100,000 Chinook in the commercial troll fishery relative to its average catches over the prior two decades.

In 1990, the Council revised the salmon FMP to reduce redundant regulation of the salmon fisheries in the EEZ with ADF&G and the Pacific Salmon Commission (PSC). While recognizing that the salmon fisheries require Federal participation and oversight stipulated in the Magnuson Act, the Council deferred setting harvest levels to ADF&G and the PSC, and regulation of the sport and commercial fishery to ADF&G providing the harvest levels and allocations are consistent with Council goals and objectives stated in the FMP and the National Standards of the Magnuson-Stevens Act. To date, the Council has not exercised its option of specifying management measures in the EEZ that differ from state regulation.

Management and catch limits in the southeast Alaska Chinook salmon fishery have continued to be a contentious issue. While Chinook salmon spawning in southeast Alaska and the transboundary rivers have been generally stable or increasing in abundance since the establishment of the PSC management regime, abundance of many wild populations of Chinook salmon in British Columbia and the Pacific Northwest have not recovered or have continued to decline. Fixed harvest levels were formulated to result in decreasing exploitation rates of Chinook salmon in mixed-stock fisheries: as wild stocks rebuilt and enhancement activities increased, general abundance of Chinook salmon in the mixed-stock fisheries, in concert with catch ceilings, would result in a lower proportion harvested by these fisheries. In the first few years after the Treaty, this concept seemed reasonable, but poor survivals due to ocean conditions in the early 1990s resulted in declining abundances in the ocean fisheries, so that fixed harvest levels result in increasing exploitation. Due to this and other allocation and conservation concerns, there has been no agreement on catch ceilings within the PSC since 1993. In 1995, ADF&G proposed a management regime based on the estimated abundance of Chinook salmon. ADF&G implemented this abundance-based management approach in 1995, but tribal groups and the state management agencies in the Pacific Northwest sued successfully for the closure of the fishery in August of 1995. In 1996, the fishery reopened with a management ceiling agreed to by the United States Commissioners (which represent both Alaska and Pacific Northwest interests) to the PSC. In 1997, the United States Commissioners agreed to apply an abundance-based management approach using a modified version of the original ADF&G proposal. The agreement calls for setting preseason catch targets based on the forecasts made by the Chinook Technical Committee (CTC) of the PSC, then refining these preseason forecasts using catch per unit effort data from the summer troll fishery. This agreement has been implemented by ADF&G in 1997, but has not been agreed to by Canada in the PSC process.

Because fish from Chinook salmon ESUs that have been listed as threatened or endangered occur in the southeast Alaska troll fishery, NMFS reviews the fishery under Section 7 of the ESA and, in association with the Biological Opinion, issues an incidental take statement that covers the ESA listed fish that are inadvertently and unknowingly taken in the fishery. The biological assessment has found that the take of listed ESUs in the fishery has been incidental to other stocks and a small percentage of the total mortality, either on a single year or cohort basis. To date, NMFS has found that this fishery is not likely to jeopardize the continued existence or recovery of ESA-listed species.

Chinook salmon fisheries in Alaska have some bycatch associated with them. Generally, the numbers of other species taken during directed Chinook fishing is small and not considered a conservation issue. The most important bycatch issue in the commercial and recreational hook-and-line fisheries is the capture of undersized Chinook salmon that must be released. While the majority of these fish survive the hooking encounter, large numbers can be hooked and substantial mortality incurred. The Pacific Salmon Treaty requires accounting for the degree of such bycatch mortality, and the CTC uses this information in modeling the status and abundance of component stocks.

Directed fisheries of Chinook 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 gear to habitat and (2) bycatch or entanglement of non-target species. In the marine fisheries, direct impact of the gear to 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. Because these types of impacts also endanger the gear itself, they are typically self-limiting. Bycatch and entanglement of non-target species can occur in the marine fisheries, such as bycatch of demersal rockfish in hook-and-line fisheries, and entanglement of seabirds and marine mammals in net fisheries. In the estuarine and riverine fisheries, direct impact to riparian vegetation and channel morphology can occur from the shore-based fishing gears, such as set-nets and recreational fishing. Where use levels are high, this type of impact can be sufficient to require restoration management initiatives. An example is the Kenai River restoration work needed to repair damage from recreational fishing for Chinook salmon and other salmonids.

Relevant Trophic Information

Chinook salmon eggs, alevins, and juveniles in freshwater streams provide an important nutrient input and food source for aquatic invertebrates, other fishes, birds, and small mammals. The carcasses of Chinook adults can also be an important nutrient input in their natal watersheds, as well as providing food sources for terrestrial mammals such as bears, otters, and minks, and birds such as gulls, eagles, and ravens. Because of their relatively low abundance in coastal and oceanic waters, Chinook salmon in the marine environment are typically only an incidental food item in the diet of other fishes, marine mammals, and coastal sea birds.

Approximate Upper size limit of juvenile fish (in cm): 71 cm total length. This is the regulatory minimum harvest size used in the Alaska hook-and-line fisheries in order to minimize catches of immature fish. However, because Chinook salmon can mature at ages of 2 to 8 total years, the term "juvenile" is better defined by physiological progress of maturation rather than a threshold size.

Habitat and Biological Associations

Chinook salmon occur over abroad geographic range, encompassing different ecotypes and very diverse habitats. Across the geographic range that the species has colonized, populations of Chinook salmon have developed localized adaptations to site specific characteristics. These local adaptations result in different and diverse characteristics of biological importance, including timing of spawning, adult and juvenile migration timing, age and size at maturity, duration of freshwater residency, and ocean distribution. Chinook salmon have been studied and managed intensively for decades. There is a large body of literature describing their biology and ecology. For freshwater habitats, however, habitat-specific information for Chinook salmon in particular watersheds is sparse, especially in the northern portion of the range, and for estuarine and marine habitats, there is little data beyond presence/absence or density information. The range in the amount of habitat specific information by life-history stage is reflected in the information levels assigned the different life-history stages. EFH is defined for this species on the basis of watershed-specific information available about the species' distribution, and its known range of marine distribution within the EEZ.

Eggs/Spawning: Chinook salmon spawn in a broad range of habitats. They have been known to spawn in water ranging from a few centimeters deep to several meters deep, and in channel widths ranging from small tributaries 2 to 3 m wide to the main stems of large rivers such as the Columbia and Sacramento. Typically, redd (nest) size is 5 to 15 m^2, and water velocities are 40 to 60 cm/sec. The depth of the redd is inversely related to water velocity; generally the female buries her eggs in clean gravel, 20 to 36 cm deep. Because of their large size, Chinook salmon are able to spawn in higher water velocities and utilize coarser substrates than other salmon species. In general, female Chinook salmon select sections of the spawning stream with high subgravel flow. Because their eggs are the largest of the Pacific salmon, with a correspondingly small surface-volume ratio, they may be more sensitive to reduced oxygen levels and require a higher rate of irrigation. Fertilization of the eggs occurs simultaneous with deposition. Males compete for the right to breed with a spawning females. Chinook females remain on their redds 6 to 25 days after spawning, defending the area from superimposition of eggs from another female.

Larvae/Alevins: Fertilized eggs begin their 5- to 8-month period of embryonic development and growth in intragravel interstices. To survive successfully, the eggs, alevins and pre-emergent fry must first be protected from freezing, desiccation, stream bed scouring or shifting, mechanical injury, and predators. Water surrounding them must be non-toxic and of sufficient quality and quantity to provide basic requirements of suitable temperatures, adequate supply of oxygen, and removal of waste materials. Rates of egg development, survival, size of hatched alevins and percentage of deformed fry are related to temperature and oxygen levels during incubation. Generally, low oxygen levels are non-lethal early, but lethal late in development. Under natural conditions, 30 percent or less of the eggs survive to emerge from the gravel as fry.

Juveniles: Chinook salmon are typically 33 to 36 mm in length when they emerge from the incubation gravel. Residency in freshwater and size and timing of seawater migration are highly variable. Ocean-type fish can migrate seaward immediately after yolk absorption. The majority of ocean-type fish migrate at 30 to 90 days after emergence, but some fish move seaward as fingerlings in the late summer of their first year, while others overwinter and migrate as yearling fish. Stream-type fish, in contrast, generally spend at least 1 year in freshwater, migrating as 1- or 2-year-old fish. In Alaska, the stream-type life history predominates although ocean-type life histories have been documented in a few Alaska watersheds. Water and habitat quality and quantity determine the productivity of a watershed for Chinook salmon. Both stream- and ocean-type fish utilize a wide variety of habitats during their freshwater residency, and are dependent on the quality of the entire watershed, from headwater to salt water. The stream/river ecosystem must provide adequate rearing habitat, and migration corridors from spawning and rearing areas to the sea. Stream-type juveniles are more dependent on freshwater ecosystems because of their extended residence in these areas. The principal foods in freshwater are larval and adult insects. The seaward migration of smolts is timed so that the smolts arrive in the estuary when food is plentiful. Migration and rearing habitats overlap. Stream flows during the migratory period tend to be high, which facilitates seaward movement and provides some sheltering from predation.

After entering saltwater, Chinook juveniles disperse to oceanic feeding areas. Ocean-type fish have more extended estuarine residency, tend to be more coastal oriented, and do not generally migrate as far as stream-type fish. Food in estuarine areas include epibenthic organisms, insects, and zooplankton.

Adults: Chinook salmon typically remain at sea for 1 to 6 years. They have been found in oceanic waters at temperatures ranging from 1 to 15°C. They do not concentrate at the surface as do other Pacific salmon, but are most abundant at depths of 30 to 70 m. Fish make up the largest component of their diet at sea, although squid, pelagic amphipods, copepods, and euphausiids are also important at times.

Ocean distribution patterns have been shown to be influenced by both genetics and environmental factors. Migratory patterns in the ocean may have evolved as a balance between the benefits of accessing specific feeding grounds and the energy expenditure and dispersion risks necessary to reach them. Along the eastern Pacific rim, Chinook salmon originating north of Cape Blanco on the Oregon coast tend to migrate north towards and into the GOA, while those originating south of Cape Blanco migrate south and west into waters off Oregon and California. As a result, Chinook salmon that occur in the EEZ fishery in Alaska originate from the Oregon coast to southeast Alaska. Not all stocks within this large geographic area are distributed into the southeast Alaska fishery, however. For example, Puget Sound stocks do not normally migrate that far north.

Habitat Concerns

Habitat loss and alteration have reduced, and in some cases, extirpated Chinook salmon over a large portion of their range. Losses of Chinook habitat have occurred as a result of other resource development, such as hydroelectric power and logging, agriculture, and urbanization. Most habitat loss has occurred in freshwater ecosystems that support Chinook salmon development; estuarine rearing areas have also been affected in some areas by industrial development, urbanization, and dredging. The oceanic environment of Chinook salmon is considered largely unchanged by anthropogenic activities, although offshore petroleum production and local, transitory pollution events such as oil spills do pose some degree of risk.

Offshore petroleum production and large-scale transport of petroleum occurs in the Alaska EEZ, although at this time there is no offshore production of petroleum in the commercial troll area of the EEZ. Offshore oil and gas development and transport will inevitably result in some oil entering the environment at levels exceeding background amounts. The *Exxon Valdez* oil spill was shown to have direct effects on the survival and habitats of pink salmon. Chinook salmon were not directly affected, because of their different habitat utilization in the spill area. In general, the early life history stages of fish are more susceptible to oil pollution than juveniles or adults.

By far, the most serious habitat concern for Chinook salmon is the degradation of the freshwater watersheds that support those stages of their life history. Dams and impoundments for hydroelectric power and water diversion have caused large-scale extirpation of Chinook salmon in the Pacific Northwest by eliminating access to anadromous fish, and have altered the spawning, rearing, and migration corridors of Chinook salmon in many watersheds. There are presently no dams in place or in planning that would block rivers used by Chinook salmon in Alaska. However, because many Chinook salmon harvested under the FMP for Alaska originate in the Pacific Northwest, these types of habitat impacts in other regions directly affect the Alaska fishery.

Logging and associated road construction has resulted in degraded habitat by causing increased erosion and sedimentation, changes in temperature regimes, and changes in seasonal flow patterns. Timber harvest has been a major resource use in southeast Alaska, and it is increasing in southcentral Alaska. Timber harvest in the Pacific Northwest and British Columbia also impacts the Alaska fishery because of the presence of stocks from these regions in the Alaska EEZ.

Placer mining has caused serious degradation of Chinook habitats in some river systems, especially in Yukon River drainages. While these impacts are of concern, most of the stocks directly affected do not migrate into the Chinook fishery managed under the FMP.

Urbanization and coastal development can have pronounced effects on coastal ecosystems, particularly estuaries, through modification of the hydrography, biology, and chemistry in the developed area. Increased nutrient input, filling of productive wetlands, and influx of contaminants commonly occur with coastal development. These impacts can reduce or eliminate rearing potential for juvenile Chinook salmon. Increased levels of coastal development in Alaska as well as in the Pacific Northwest and British Columbia can be expected.

There is a definite south-north cline to the degree of habitat degradation and the status of Chinook populations in the eastern Pacific. Habitat degradation in Alaska is certainly a management concern, but to date has not had the degree of impacts on Chinook populations as in the Pacific Northwest. In southeast Alaska, logging is considered the largest potential threat to anadromous fish habitat. Relatively little logging has occurred, however, in watersheds supporting Chinook salmon in the region. However, because of the stock composition of the fish harvested in the EEZ of southeast Alaska, freshwater ecosystems in the Pacific Northwest represent essential fish habitat for sustaining the diversity and abundance of Chinook salmon in the Alaska EEZ.

SPECIES: Chinook Salmon, *Oncorhynchus tshawytscha*

Stage - EFH Level	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic/ Riverine Features**	**Other**
Eggs and larvae (alevins)	50 to 250 days	NA	late summer, fall, winter, early spring	streambeds	intragravel 20 to 80 cm deep	G	Riverbed	**DO**< 3 mg/l lethal, optimum >7 **Temp** 0-17 C, Optimum 4-12 C
Juveniles (freshwater)	days-years	insect larvae and adults, zooplankton	year-round, depending on race	streams, sloughs, rivers	surface to several meters	varied	Pools, stream and river margins, woody debris	Extremely varied freshwater life history. **DO**< 2 mg/l lethal, optimum >7 **Temp** 0-22 C, Optimum 8-12 C
Juveniles (Estuary)	days-6-months	copepods, euphausiids, amphipods, juvenile fish	spring, summer, fall	BCH, BAY	N, P	All bottom types	estuarine, littoral	Sea-type can be estuarine dependent **Temp** 2-22 C, Optimum 8-12 C **Salinity** 0-33 ppt
Juvenile (marine)	6 to 9 months: Up to first marine annulus	epipelagic fish, euphasiids, large copepods, pelagic amphipods	spring-winter	IP, ICS, MCS, OCS, USP, BSN	P	All bottom types	UP, F, G, CL, E	Initially surface oriented; some stocks move rapidly offshore, some remain nearshore. **Temp:** 1-15 C, Optimum 5-12 C

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic/ Riverine Features	Other **Page 2 of 2**
Immature and Maturing Adults (marine)	2 to 8 years of age	epipelagic fish (herring, sand lance, smelt, anchovy), shrimp, squid	Year Round	BAY, IP, ICS, MCS, OCS, USP, BSN	N, P	All bottom types	UP, F, G, CL, E	Not surface oriented until maturing. Use salinity gradients, olfaction for terminal homing. **Temp:** 5-22 C
Adults (freshwater)	2 weeks to 4 months	little or none	Spawning: (July-Feb) Freshwater Migration: Year round, varies greatly among populations	Rivers, large streams and tributaries	0.5-10 m	Alluvial bottom types; G for spawning	Deep pools for resting, Riffles, pool-riffle transition for spawning	Entry timing to freshwater highly variable. **Temp:** 1-26 C, Optimum 4-15 C

2.7 Habitat Description for Coho Salmon *(Oncorhynchus kisutch)*

General Distribution and Life History

Coho salmon are widely distributed in cool areas of the North Pacific Ocean and most adjoining fresh and estuarine waters. Coho use more diverse habitats than other anadromous salmonids. They spawn in most accessible freshwater streams throughout their range, rear for at least 1 year in fresh or estuarine waters, and spend about 18 months at sea before reaching maturity. In North America, coho range along the Pacific coast from Monterey Bay, California, to Point Hope, Alaska, through the Aleutians (Figure 1). The species is most abundant in coastal areas from central Oregon north through southeast Alaska. In the southern part of their range, coho stocks are generally depressed from historical levels, and hatcheries are often used to supplement wild runs. The Central California Coast ESU and the Southern Oregon/ Northern California Coast ESU are listed as threatened species under the Endangered Species Act. Coho are cultured for market in several countries; attempts to establish self-sustaining coho runs in other areas of the world have had limited success.

In the NMFS Alaska Region, most coho are wild fish with a distribution north to Point Hope on the eastern Chukchi Sea, west and south to the limits of United States territorial waters, and east to the Canadian border as far north as the Yukon River drainage. Coho catch in the Alaska Region is at historically high levels, and trends in abundance of most stocks are rated as stable.

Fishery

Important commercial, sport, and subsistence fisheries for coho occur from the Soviet Far East through the BS and along the west coast of North America as far south as central California. Trolling, gill nets, and purse seines are the primary commercial gear types. Gill nets, dip nets, rod and reel, traps, fish wheels, long lines, and snagging gear are used to harvest coho for subsistence and personal use. Subsistence fisheries are often cultural or traditional and take precedence over other fisheries. Personal use fisheries require a sport fishing license or exemption. Both subsistence and personal use fisheries are restricted to designated locations and specified bag limits. Sport catches of coho are taken by hook and line and snagging.

Most coho from the Alaska Region recruit to fisheries after 1 to 2 years in fresh water and about 16 months at sea. Fisheries in the Alaska Region primarily target adult coho and take place in coastal marine migration corridors, near the mouths of rivers and streams, and in freshwater migration areas. Those fisheries coincide with migrations toward spawning areas from July through October. A few areas are stocked annually with juvenile coho to provide put-and-take sport fishing.

Bycatch depends on gear type, but is usually limited to other salmon species. Chinook salmon bycatch is limited by regulation or treaty in most coho fisheries, but other salmon species are often targeted as part of the fishery. Species such as steelhead, Dolly Varden, pollock, Pacific cod, halibut, salmon sharks, and coastal rockfish make up a small part of the catch.

Directed fisheries on coho 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) bycatch 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. Bycatch and entanglement of non-target species can occur in the marine fisheries, such as bycatch of demersal rockfish in hook-and-line fisheries, and entanglement of seabirds and marine mammals in net fisheries. In the estuarine and riverine fisheries, direct impacts on riparian vegetation and channel morphology can occur from fishing activities, such as damage to the stream bank from boat wakes and removal of woody debris to provide access. Trampling of stream banks and the stream channel can also damage coho 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.

Relevant Trophic Information

Adult coho provide important food for bald eagles, terrestrial mammals (e.g., brown bear, black bear, and river otter), marine mammals (e.g., Steller sea lion, harbor seal, beluga, and orca), and salmon sharks. Adults also transfer essential nutrients from marine to freshwater environments. Juveniles are eaten by a variety of birds (e.g., gulls, terns, kingfishers, cormorants, mergansers, herons), fish (e.g., Dolly Varden, steelhead, cutthroat trout, and arctic char), and mammals (e.g., mink and water shrew). Juvenile coho are also significant predators of pink salmon fry during their seaward migration.

Approximate Upper Size Limit of Juvenile Fish (in cm): 35 cm

Habitat and Biological Associations

Juvenile and adult coho are highly migratory and depend on suitable habitat in their migration routes. Unobstructed passage and suitable water depth, water velocity, water quality, and cover are important elements in all migration habitat. Soon after emergence in spring, fry may move around considerably seeking optimal, unoccupied habitat for rearing. In fall, juveniles may migrate from summer rearing areas to areas with winter habitat. Such juvenile migrations may be extensive within the natal stream basin or between basins through salt water or connecting estuaries. Seaward migration of coho smolts occurs usually after 1-2 years in fresh water. The migration is timed primarily by photoperiod and occurs in spring, usually coincident with a spring freshet. During this transition, coho undergo major physiological changes to enable them to osmoregulate in salt water and are at that time, especially sensitive to environmental stress. At sea, juvenile Alaska coho generally migrate north and offshore into the North Pacific Ocean and BS. After 12 to 14 months at sea, they migrate to coastal areas and then along the coast to their natal streams.

Egg/Larvae: Fertilized eggs and larvae require incubation in porous substrate that allows constant circulation of cool, high-quality water that provides oxygen and removes waste. Interstitial space in the substrate must be great enough to allow growth and movement through the gravel to accommodate emergence. Sand or silt in the substrate can limit intragravel flow and trap emerging fry. As the yolk sac is absorbed, the larvae become photopositive and move through the substrate into the water column. Fry emerge between March and July, depending on when the eggs were fertilized and water temperature during development.

Juveniles (Fresh Water): In Alaska, juvenile coho usually spend 1-2 years in fresh or estuarine waters before migrating to sea, although they may spend up to 5 years where growth is slow. Coho need to attain a length of about 85 mm to become smolts. Coho smolt production is most often limited by the productivity of freshwater and estuarine habitats used for juvenile rearing. Survival from eggs to smolts is usually less than 2 percent. If spawning escapement is adequate, sufficient fry are usually produced to exceed the carrying capacity of rearing habitat. In this case, carrying capacity of summer habitat sets a density-dependent limit on the juvenile population. This summer population is then reduced by density-independent mortality over winter depending on the severity of winter conditions, fish size, and quality of winter habitat.

Coastal streams, lakes, estuaries, and tributaries to large rivers can all provide coho rearing habitat. The most productive habitats are in smaller streams less than fourth order having low-gradient alluvial channels with abundant pools often formed by large woody debris or fluvial processes. Beaver ponds can provide some of the best summer rearing areas for juvenile coho. Coho juveniles also may use brackish-water estuarine areas in summer and migrate upstream to fresh water to overwinter.

During the summer rearing stage, fish density tends to be highest in areas with abundant food (drifting aquatic invertebrates and terrestrial insects that fall into the water) and structural habitat elements (e.g., large woody debris and associated pools). Preferred habitats include a mixture of different types of pools, glides, and riffles with large woody debris, undercut banks, and overhanging vegetation, which provide advantageous positions for feeding. Coho grow best where water temperature is between 10 and 15°C, and dissolved oxygen (DO) is near saturation. Juvenile coho can tolerate temperatures between 0° and 26°C if changes are not abrupt. Their growth and stamina decline significantly when DO levels drop below 4 mg/l, and a sustained concentration less that 2 mg/l is lethal. Summer populations are usually constrained by density-dependent effects mediated through territorial behavior. In flowing water, juvenile coho usually establish individual feeding territories, whereas in lakes, large pools, and estuaries they are less likely to establish territories and may aggregate where food is abundant. Growth in summer is often density-dependent, and the size of juveniles in late summer is often inversely related to population density.

In winter, food is less important and territorial behavior fades. Juveniles aggregate in freshwater habitats that provide cover with relatively stable temperature, depth, velocity, and water quality. Winter mortality factors include hazardous conditions during winter peak stream flow, stranding of fish by ice damming, physiological stress from low temperature, and progressive starvation. In winter, juveniles prefer a narrower range of habitats than in summer, especially large mainstream pools, backwaters, and secondary channel pools with abundant large woody debris, and undercut banks and debris along riffle margins. Survival in winter, in contrast to summer, is generally not density-dependent, and varies directly with fish size and amount of cover and ponded water, and inversely with the magnitude of the peak stream flow.

The seaward migration of smolts in native stocks is typically in May and June, and is presumably timed so that the smolts arrive in the estuary when food is plentiful. Habitat requirements during seaward migration are similar to those of rearing juveniles, except that smolts tend to be more fragile and more susceptible to predation. High streamflow aids their migration by assisting them downstream and reducing their vulnerability to predators. Turbidity from melting glaciers may also provide cover from predators. Migration cover is also provided by woody debris and submerged riparian vegetation. Migrating smolts are particularly vulnerable to predation because they are concentrated and moving through areas of reduced cover where predators congregate. Mortality during seaward migration can exceed 50 percent.

Juveniles (Estuarine): Juvenile coho primarily use estuarine habitat during their first summer and also as they are leaving fresh water during their seaward migration. Intertidal sections of freshwater streams (i.e., stream-estuary ecotones) can be important rearing habitat for age 0 coho from May to October. These areas may account for one-quarter of the juvenile production in small streams. Growth in these areas is particularly rapid because of abundant invertebrate food. Habitats used include glides and pools during low tide, and coho occupy the freshwater lens during high tide. In fall, juvenile coho move upstream to fresh water to overwinter.

During seaward migration, coho smolts may be present in the estuary from May to August. Rapid growth during the early period in the estuary is critical to survival because of high size-dependent mortality from predation.

Juveniles (Marine): After leaving fresh water, coho in the Alaska Region spend up to 4 months in coastal waters before migrating offshore and dispersing throughout the North Pacific Ocean and BS. Southeast Alaska juvenile coho are ubiquitous in inside waters from June to August at depths up to 50 m, and move offshore by September. Offshore, juvenile salmon are concentrated over the continental shelf within 37 km of shore where the shelf is narrow, but may extend to at least 74 km from shore in some areas. Stock-specific aggregations have not been noted at this stage. Marine invertebrates are the primary food when coho first enter salt water, and fish prey increase in importance as the coho grow.

Immature and Maturing Adults (Marine): Most coho occupy epipelagic areas in the central GOA and BS during the 12 to 14 months after leaving coastal areas. Some coho also use coastal and inshore waters at this life stage, but those are likely to be smaller at maturity. The spatial distribution of suitable habitat conditions is affected by annual and seasonal changes in oceanographic conditions; however, coho generally use offshore areas of the North Pacific Ocean and the BS from lat. 40 to 60° N (Figure 2). The distribution of ocean harvest is generally more northerly than that for stocks from other regions (Figure 3).

Growth is the objective at this stage of the coho life cycle, and bioenergetics are controlled mainly by food quantity, food quality, and temperature. Food for salmon is most abundant above the halocline, which may range from 100 to 200 m in depth in the North Pacific. The bioenergetics of growth is best in epipelagic offshore habitat where forage is abundant and sea surface temperature is between 12 and 15°C. Coho rarely use areas where sea surface temperature exceeds 15°C.

Most coho remain at sea for about 16 months before returning to coastal areas and entering fresh water to spawn, although some precocious males will return to spawn after about 6 months at sea. Before entering fresh water to spawn, most coho slow their feeding and begin to lose weight as they develop secondary sex characteristics. Survival from smolt to adult averages about 10 percent.

Adults (Freshwater): Adult coho enter fresh water from early July through December and spawn from September through January. Fidelity to natal streams is high and straying rates are generally less than 5 percent. The fish feed little and migrate upstream using olfactory cues that were imprinted in early development.

Adult coho may travel for a short time and distance upstream to spawn in small streams or may enter large river systems and travel for weeks to reach spawning areas more than 2,000 km upstream. Upstream migrations are blocked where fall heights exceed 3.3 m or falls more than 1.2 m high have jumping pools less than 1.25 times the falls height. Blockages also occur where stream gradient exceeds 12 percent for more than 70 m, or 16 percent for more than 30 m, or 20 percent for more than 15 m, or 24 percent for more than 8 m.

Spawning sites selected for use have relatively silt-free gravels ranging from 2 mm to 10 cm in diameter, well-oxygenated intragravel flow, and nearby cover. In Alaska streams, between 2,500 and 4,000 eggs are deposited among several nests by each female coho. Several males may attend each female, but larger males usually dominate by driving off smaller males. Soon after spawning, adult coho die in or near the spawning areas.

SPECIES: Coho Salmon *(Oncorhynchus kisutch)*

Stage -EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic/ Riverine Features	Other
Eggs/Larvae	150 days at optimum temperature	NA	Fall/winter	WC, LK	Intra-gravel	G	Streambed	DO < 2 mg/l lethal, optimum >8 mg/l; Temperature 0-17°C; optimum 4.4-13.3°C; substrate 2-10 cm with <15 percent fines (<3.3 mm), optimum <5 percent fines
Juveniles, Fresh water (fry to smolt)	1 to 5 years, most (>90 percent) 1 to 2 years	invertebrates and fish	Entire year	WC, LK	Entire column	N/A	Pools, woody debris, currents for migration	DO lethal at <3 mg/l, optimum at saturation; Temperature 0-26°C; optimum 12-14°C.
Juveniles, Estuarine	1 to 6 months	Invertebrates and fish	Rearing - summer, Migration - spring	EST	Mid-water and surface, P, N	N/A	Pools, glides, etc.	
Juveniles, Marine	up to 4 months	fish and invertebrates	June - September	BCH, ICS, MCS, BA, IP	P, N	N/A	UP, CL	Temperature <15°C; Depth <10 m
Immature/ Maturing Adults, Marine	12 to 14 months	Fish (e.g., herring, sand lance)		BCH, ICS, MCS, OCS, USP, LSP, BSN, BAY, IP	P, N	N/A	U	Temperature range 1-26°C; optimum 12-14°C
Adults, Fresh water	up to 2 months	little or none	migration - fall; spawning - fall, winter	WC, LK	Deep parts of streams and lakes	Alluvial bottom types	Deep pools, Pool-riffle transition	Temperature range 1-26°C; optimum 12-14°C

3.0 Essential Fish Habitat

Essential Fish Habitat (EFH) is defined in the Magnuson-Stevens Act as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." For the purpose of interpreting the definition of essential fish habitat: "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

EFH is the general distribution of a species described by life stage. General distribution is a subset of a species population and is 95 percent of the population for a particular life stage, if life history data are available for the species. Where information is insufficient and a suitable proxy cannot be inferred, EFH is not described. General distribution is used to describe EFH for all stock conditions whether or not higher levels of information exist, because the available higher level data are not sufficiently comprehensive to account for changes in stock distribution (and thus habitat use) over time.

EFH is described for FMP-managed species by life stage as general distribution using guidance from the EFH Final Rule (67 FR 2343), such as the EFH Level of Information definitions. Analytical tools are used and recent scientific information is incorporated for each life history stage from scientific habitat assessment reports. EFH descriptions include both text (see section 3.1) and a map (see section 3.2), if information is available for a species' particular life stage. These descriptions are risk averse, supported by scientific rationale, and account for changing oceanographic conditions, regime shifts, and the seasonality of migrating salmon stocks. The methodology and data sources for the EFH descriptions are described in Appendix D to the EFH EIS (NMFS 2005).

3.1 Description of Essential Fish Habitat

EFH descriptions are based on the best available scientific information. In support of this information, a thorough review of FMP species is contained in this Appendix and in the EFH EIS (NMFS 2005). A summary of the habitat information levels for each species, as described in the EFH regulations at 50 CFR 600.815(a)(1)(iii), is listed in the table below. A "1" indicates that distribution data are available for some or all portions of the geographic range of the species.

EFH Information Levels for Alaska Stocks of Pacific Salmon

Salmon Species	Freshwater Eggs	Freshwater Larvae and Juveniles	Estuarine Juveniles	Marine Juveniles	Marine Immature and Maturing Adults	Freshwater Adults
Pink	1	1	1	1	1	1
Chum	1	1	1	1	1	1
Sockeye	1	1	1	1	1	1
Chinook	1	1	1	1	1	1
Coho	1	1	1	1	1	1

3.1.1 Pink Salmon

Freshwater Eggs
EFH for pink salmon eggs is the general distribution area for this life stage, located in gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), as depicted in Figures 3 through 8.

Freshwater Larvae and Juveniles
EFH for larval and juvenile pink salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water during the spring, generally migrate in darkness in the upper water column. Fry leave streams in within 15 days and the duration of migration from a stream towards sea may last 2 months, as depicted in Figures 3 through 8.

Estuarine Juveniles
Estuarine EFH for juvenile pink salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters and generally present from late April through June, as depicted in Figures 3 through 8.

Marine Juveniles
Marine EFH for juvenile pink salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nautical mile (nm) limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure 9.

Marine Immature and Maturing Adults
EFH for immature and maturing adult pink salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean. Mature adult pink salmon frequently spawn in intertidal areas and are know to associate with smaller coastal streams, as depicted in Figure 9.

Freshwater Adults
EFH for pink salmon is the general distribution area for this life stage, located in freshwaters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting of medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diameter), 15 to 50 cm in depth from June through September, as depicted in Figures 3 through 8.

3.1.2 Chum Salmon

Freshwater Eggs
EFH for chum salmon eggs is the general distribution area for this life stage, located in gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), as depicted in Figures 10 through 15.

Freshwater Larvae and Juveniles
EFH for larval and juvenile chum salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water and contiguous rearing areas within the boundaries of ordinary high water during the spring, generally migrate in darkness in the upper water column. Fry leave streams in within 15 days and the duration of migration from a stream towards sea may last 2 months, as depicted in Figures 10 through 15.

Estuarine Juveniles
Estuarine EFH for juvenile chum salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters from late April through June, as depicted in Figures 10 through 15.

Marine Juveniles
Marine EFH for juvenile chum salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to approximately 50 m in depth from the mean higher tide line to the 200-nm limit of the EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure 16.

Marine Immature and Maturing Adults
EFH for immature and maturing adult chum salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and ranging from the mean higher tide line to the 200-nm limit of the EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure 16.

Freshwater Adults
EFH for chum salmon is the general distribution area for this life stage, located in freshwaters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting of medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diameter) and finer substrates can be used in upwelling areas of streams and sloughs from June through January, as depicted in Figures 10 through 15.

3.1.3 Sockeye Salmon

Freshwater Eggs
EFH for sockeye salmon eggs is the general distribution area for this life stage, located in gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), as depicted in Figures 17 through 22.

Freshwater Larvae and Juveniles
EFH for larval and juvenile sockeye salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water. Juvenile sockeye salmon require year-round rearing habitat. Fry generally migrate downstream to a lake or, in systems lacking a freshwater lake, to estuarine and riverine rearing areas for up to 2 years. Fry out migration occurs from approximately April to November and smolts generally migrate during the spring and summer, as depicted in Figures 17 through 22.

Estuarine Juveniles

Estuarine EFH for juvenile sockeye salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Under-yearling, yearling, and older smolts occupy estuaries from March through early August, as depicted in Figures 17 through 22.

Marine Juveniles
Marine EFH for juvenile sockeye salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to depths of 50 m and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean from mid-summer until December of their first year at sea, as depicted in Figure 23.

Marine Immature and Maturing Adults
EFH for immature and maturing adult sockeye salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure 23.

Freshwater Adults
EFH for sockeye salmon is the general distribution area for this life stage, located in freshwaters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting of medium to course gravel containing less than 15 percent fine sediment (less than 2-mm diam.) and finer substrates can be used in upwelling areas of streams and sloughs from June through September. Sockeye often spawn in lake substrates, as well as in streams, as depicted in Figures 17 through 22.

3.1.4 Chinook Salmon

Freshwater Eggs
EFH for Chinook salmon eggs is the general distribution for this life stage, located in gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) (see Figures 24 through 29).

Freshwater Larvae and Juveniles
EFH for larval and juvenile Chinook salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water. Juvenile Chinook salmon out-migrate from freshwater areas in April toward the sea and may spend up to a year in a major tributaries or rivers, such as the Kenai, Yukon, Taku, and Copper Rivers (see Figures 24 through 29).

Estuarine Juveniles
Estuarine EFH for juvenile Chinook salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Chinook salmon smolts and post-smolt juveniles may be present in these estuarine habitats from April through September (see Figures 24 through 29).

Marine Juveniles
Marine EFH for juvenile Chinook salmon is the general distribution area for this life stage, located in all

marine waters off the coast of Alaska from the mean higher tide line to the 200-nm limit of the EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean. Juvenile marine Chinook salmon are at this life stage from April until annulus formation in January or February during their first winter at sea (see Figure 30).

Marine Immature and Maturing Adults
EFH for immature and maturing adult Chinook salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska and ranging from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean (see Figure 30).

Freshwater Adults
EFH for adult Chinook salmon is the general distribution area for this life stage, located in fresh waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) wherever there are spawning substrates consisting of gravels from April through September (see Figures 24 through 29).

3.1.5 Coho Salmon

Freshwater Eggs
EFH for coho salmon eggs is the general distribution area for this life stage, located in gravel substrates in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), as depicted in Figures 31 through 36.

Freshwater Larvae and Juveniles
EFH for larval and juvenile coho salmon is the general distribution area for this life stage, located in those waters identified in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and contiguous rearing areas within the boundaries of ordinary high water. Fry generally migrate to a lake, slough, or estuary and rear in these areas for up to 2 years, as depicted in Figures 31 through 36.

Estuarine Juveniles
Estuarine EFH for juvenile coho salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Juvenile coho salmon require year-round rearing habitat and also migration habitat from April to November to provide access to and from the estuary.

Marine Juveniles
Marine EFH for juvenile coho salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure 37.

Marine Immature and Maturing Adults
EFH for immature and maturing adult coho salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to 200 m in depth and range from the mean higher tide line to the 200-nm limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, as depicted in Figure 37.

Freshwater Adults
EFH for coho salmon is the general distribution area for this life stage, located in freshwaters as identified in

ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a) and wherever there are spawning substrates consisting mainly of gravel containing less than 15 percent fine sediment (less than 2-mm diameter) from July to December, as depicted in Figures 31 through 36.

3.2 Maps of Essential Fish Habitat

[insert Figures 3 through 37]

Figure 3. EFH Distribution for Pink Salmon - Southeastern Region

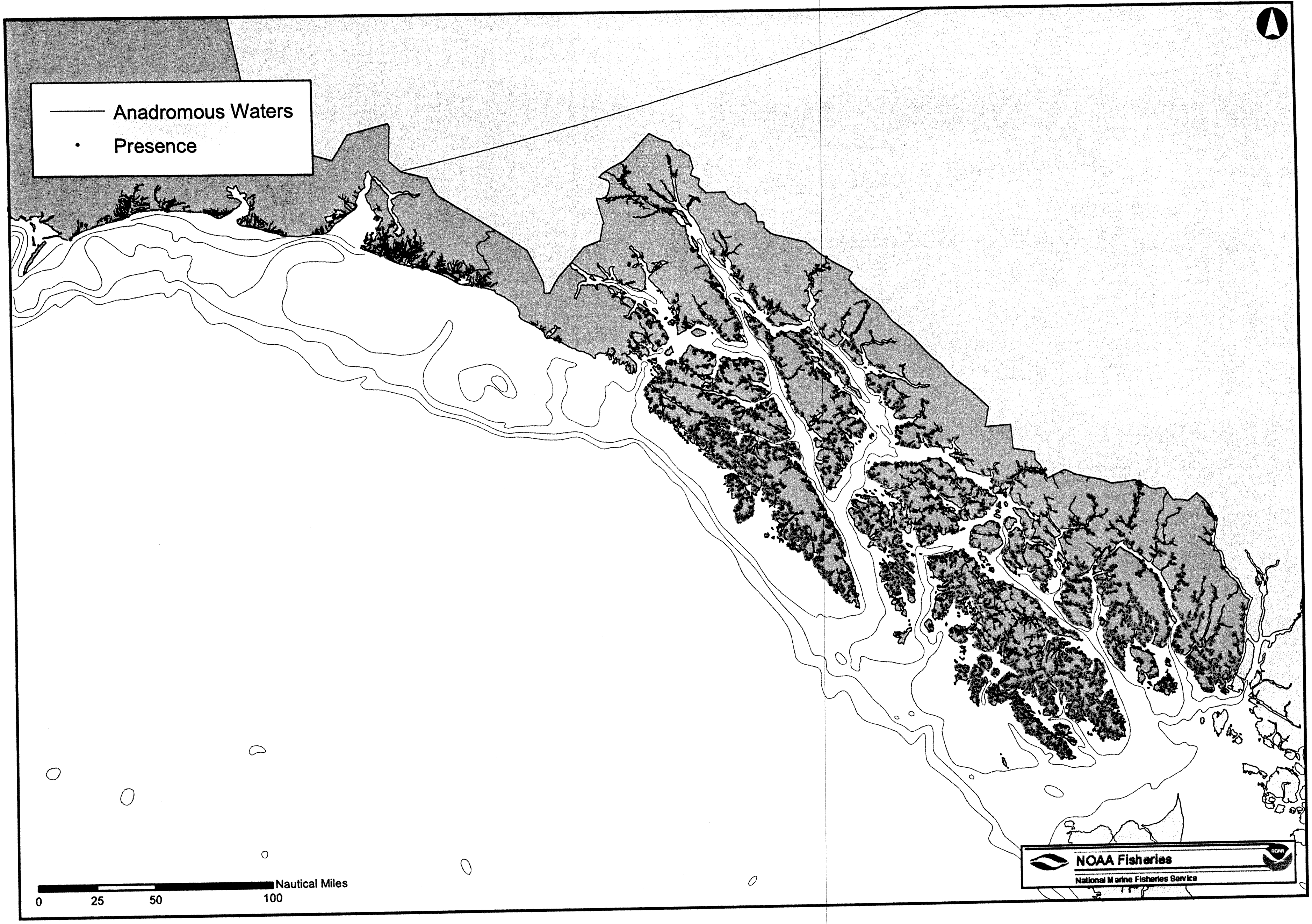


Figure 4. EFH Distribution for Pink Salmon - South-Central Region

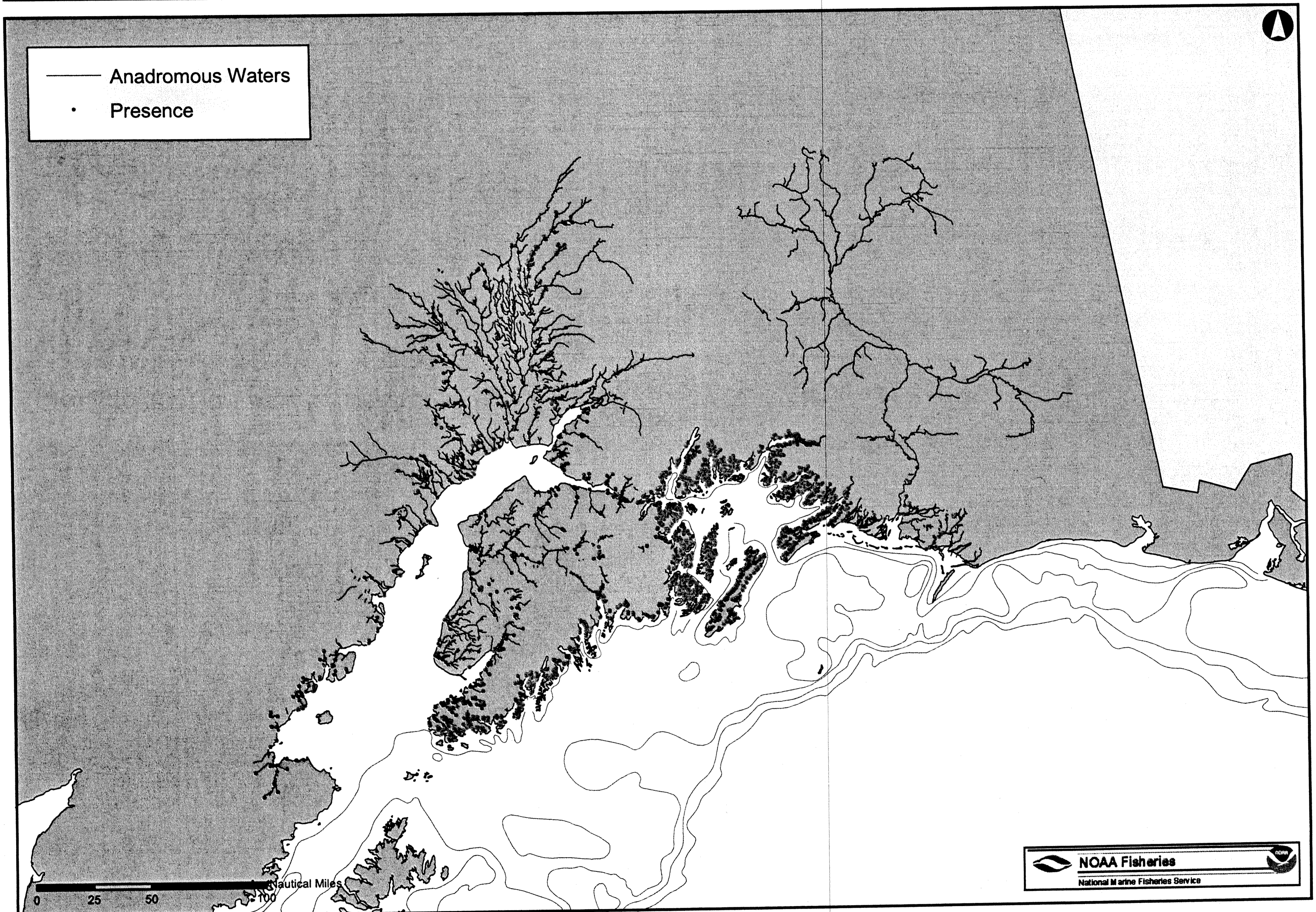


Figure 5. EFH Distribution for Pink Salmon- SouthwesternRegion

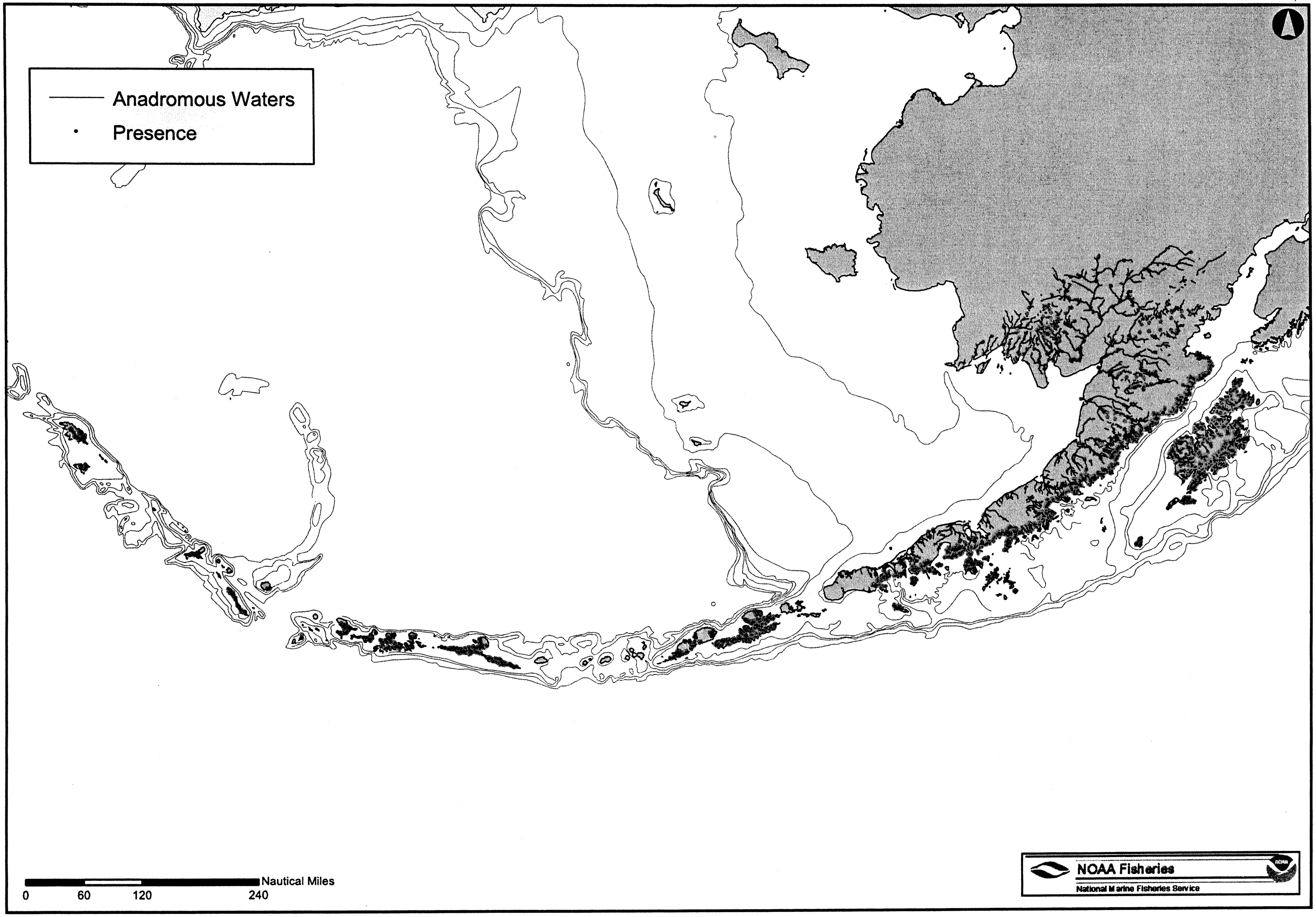


Figure 6. EFH Distribution for Pink Salmon - Western Region

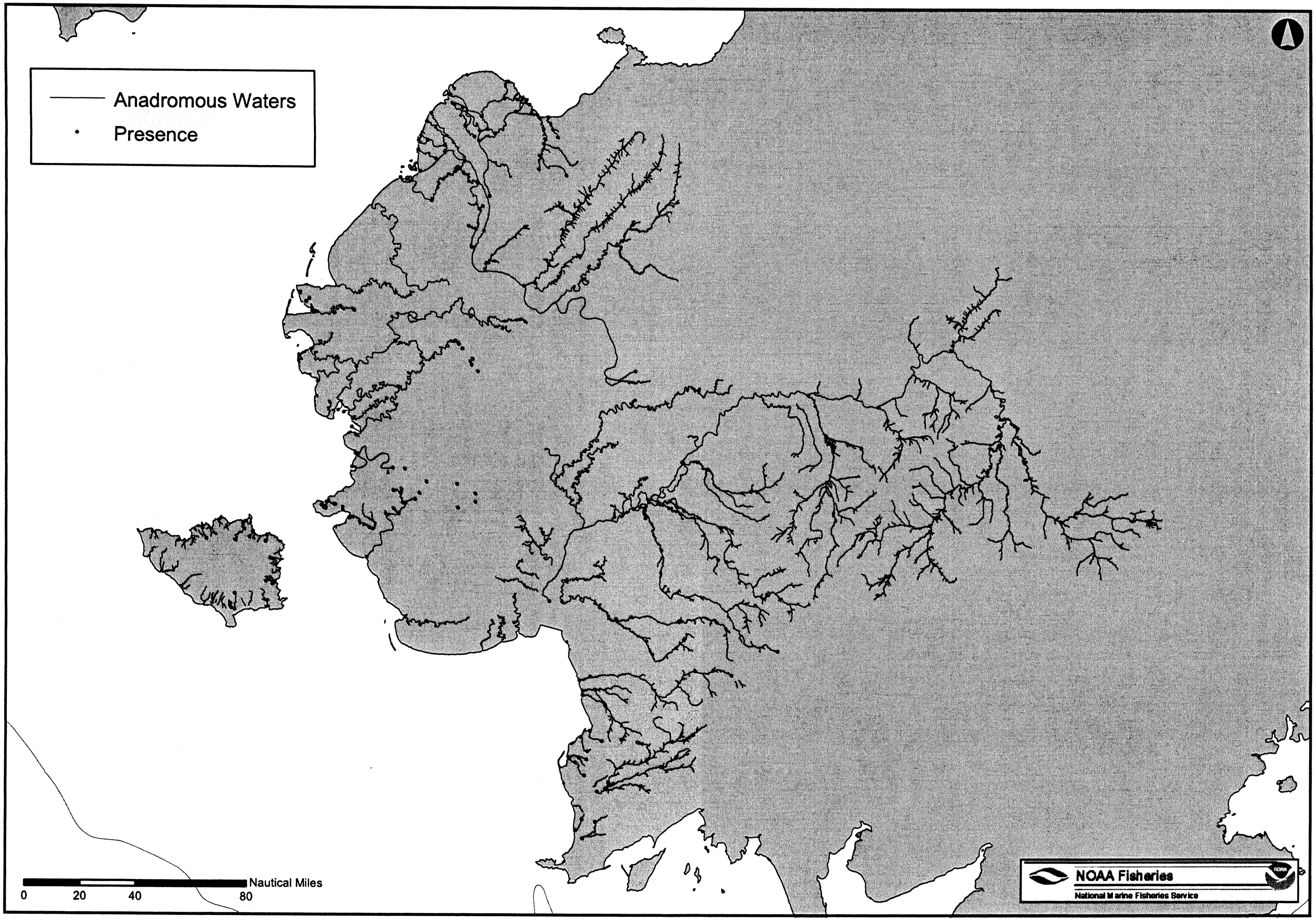


Figure 7. EFH Distribution for Pink Salmon - Arctic Region

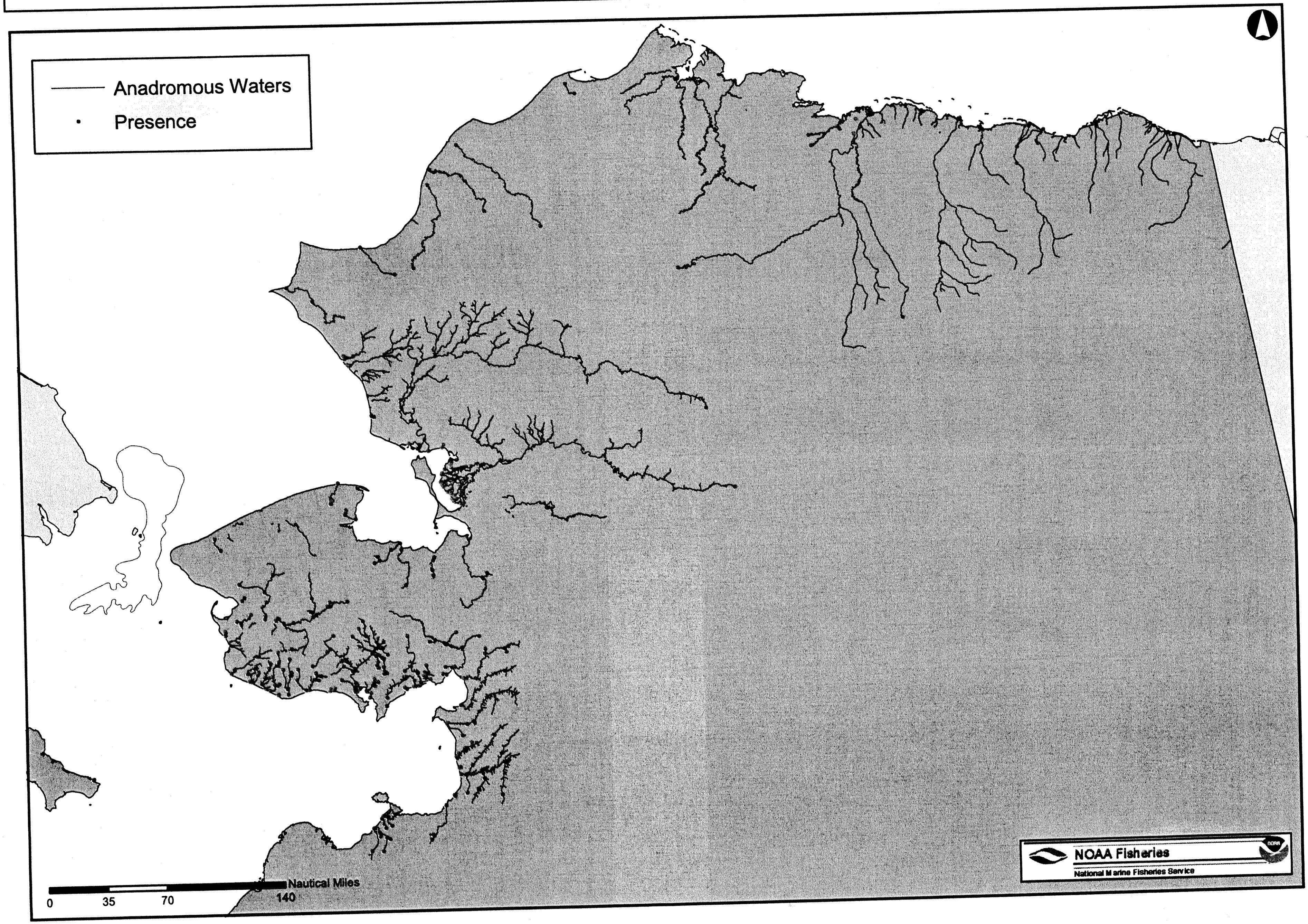


Figure 8. EFH Distribution for Pink Salmon - Interior Region

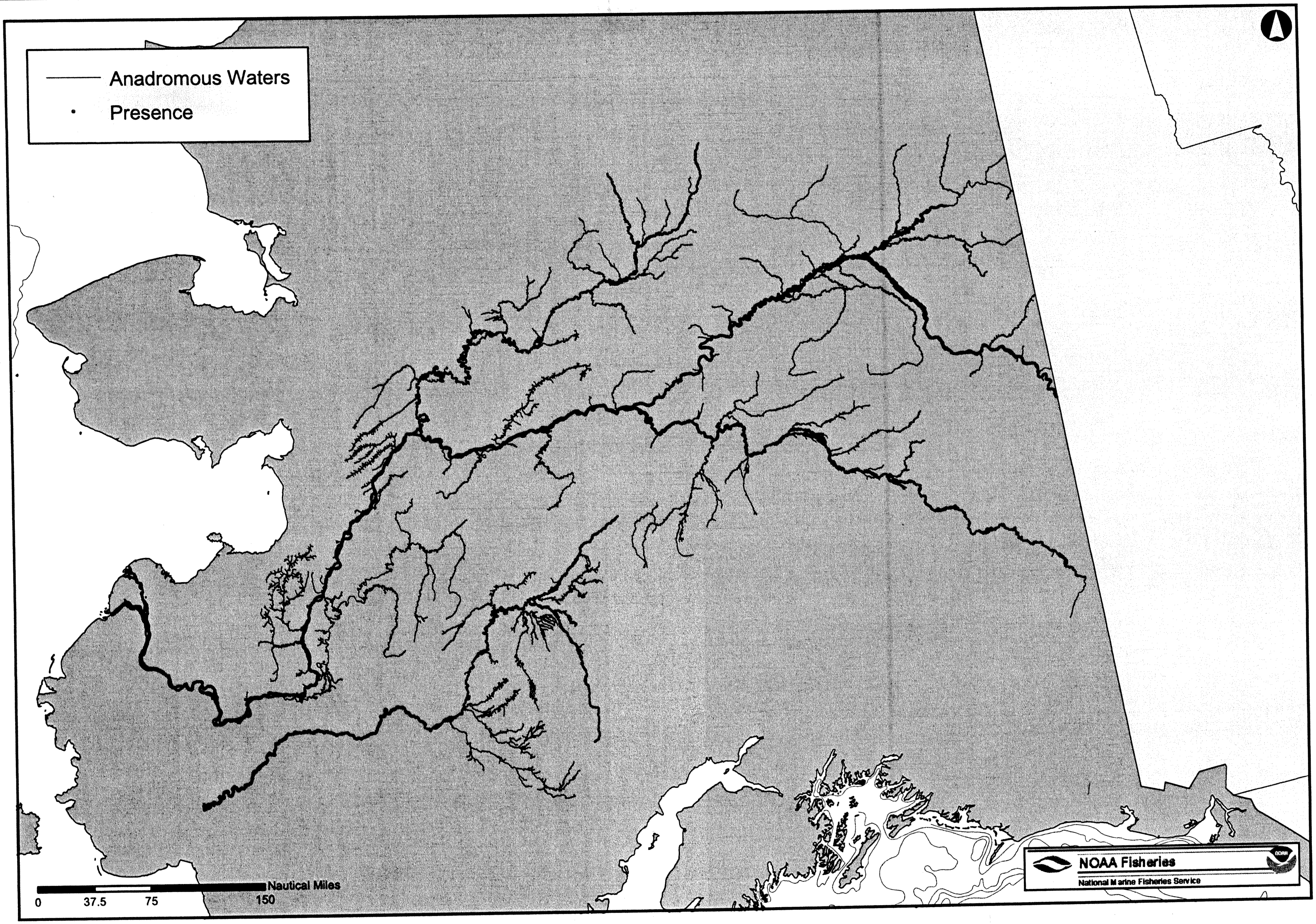


Figure 9. EFH Distribution for Pink Salmon - Marine

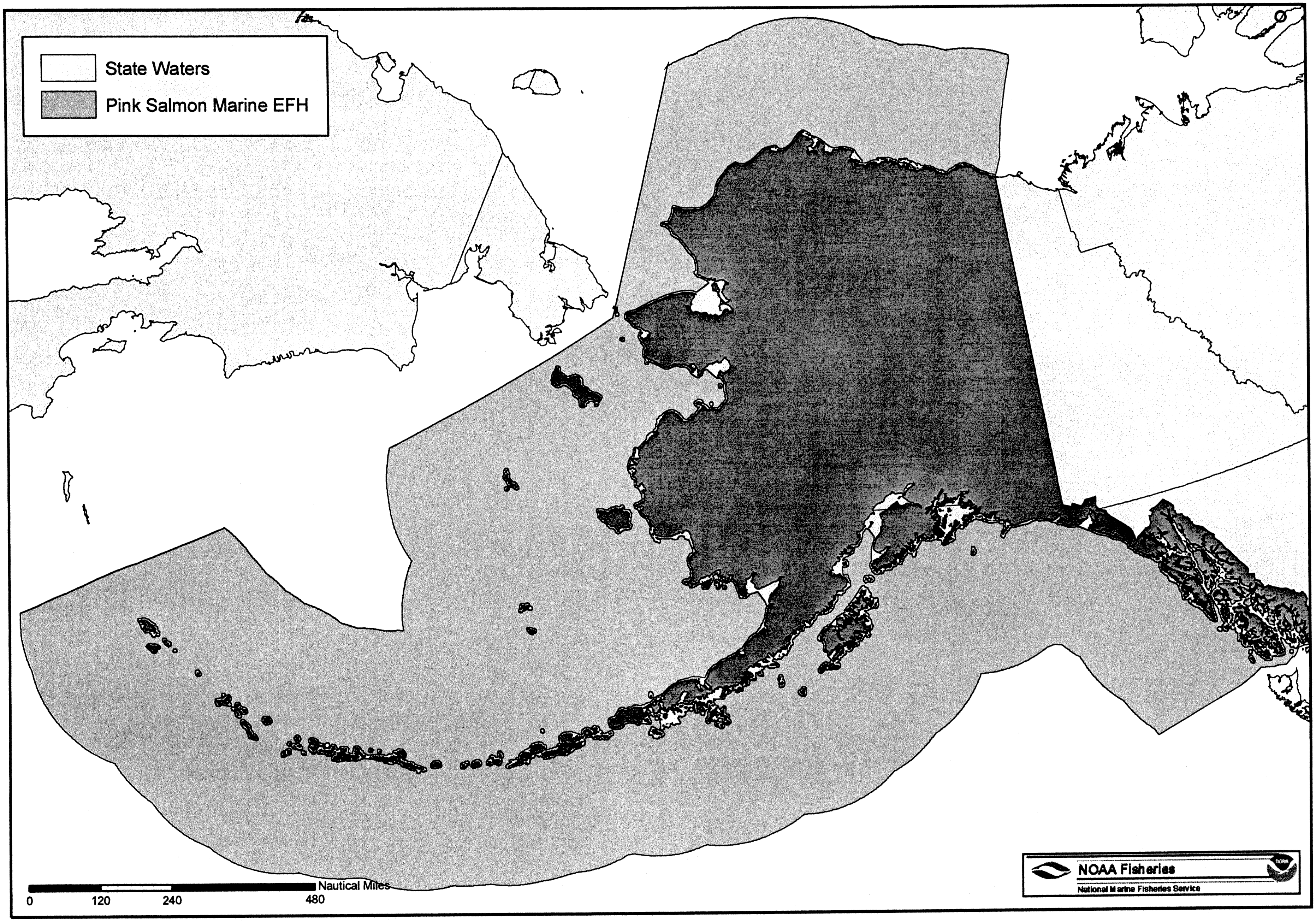


Figure 10. EFH Distribution for Chum Salmon - Southeastern Region

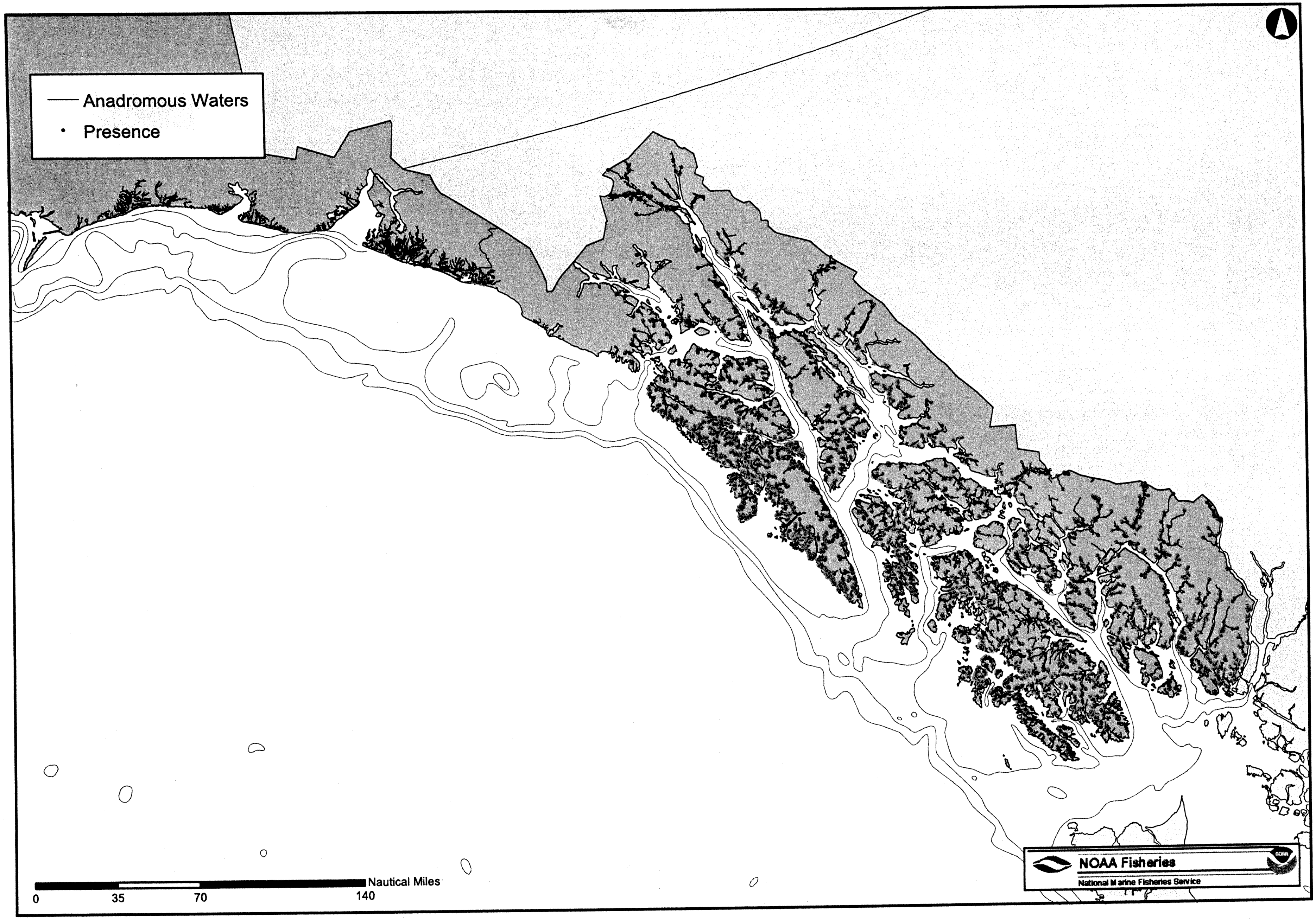


Figure 11. EFH Distribution for Chum Salmon - South-Central Region

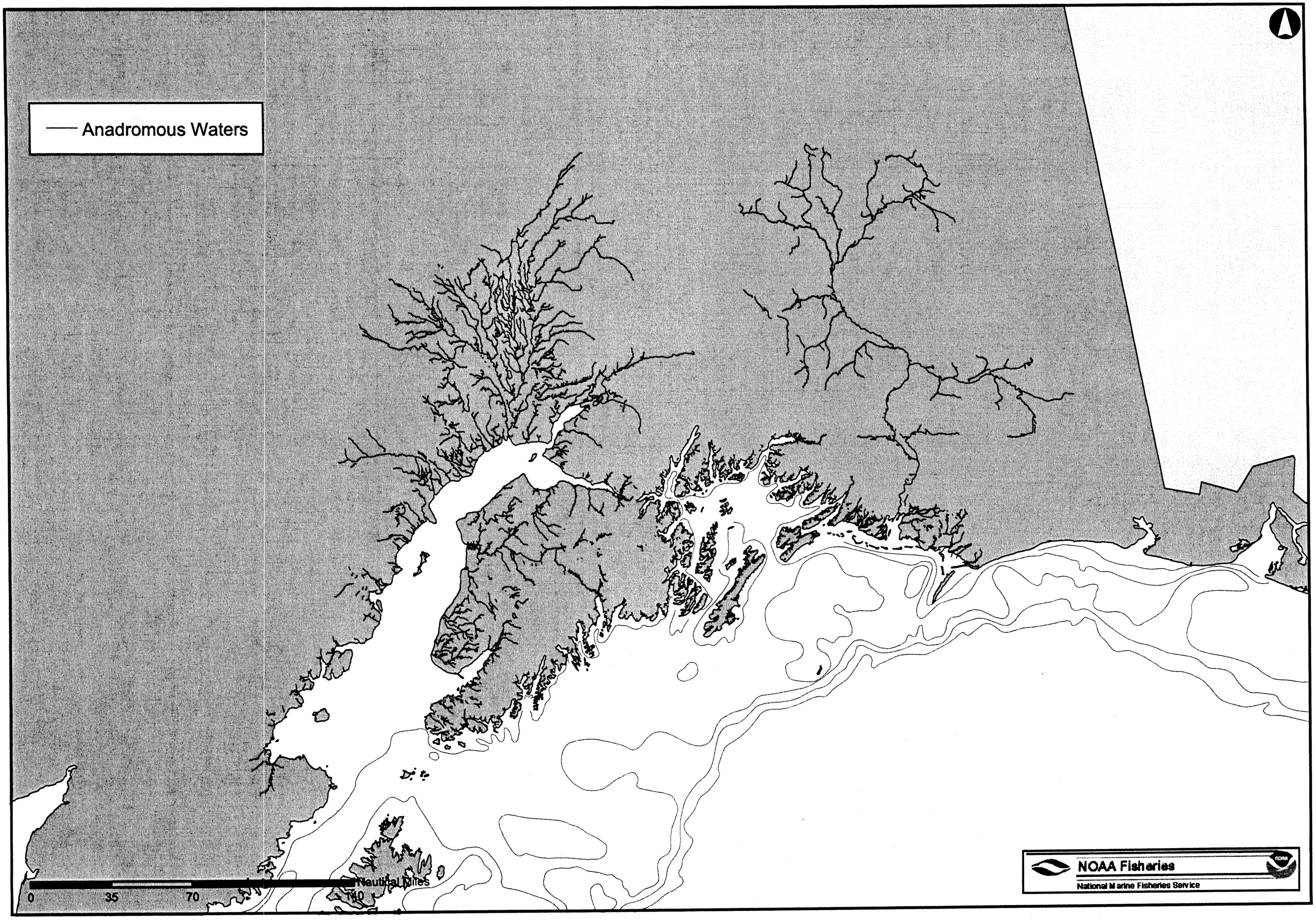


Figure 12. EFH Distribution for Chum Salmon - Southwestern Region

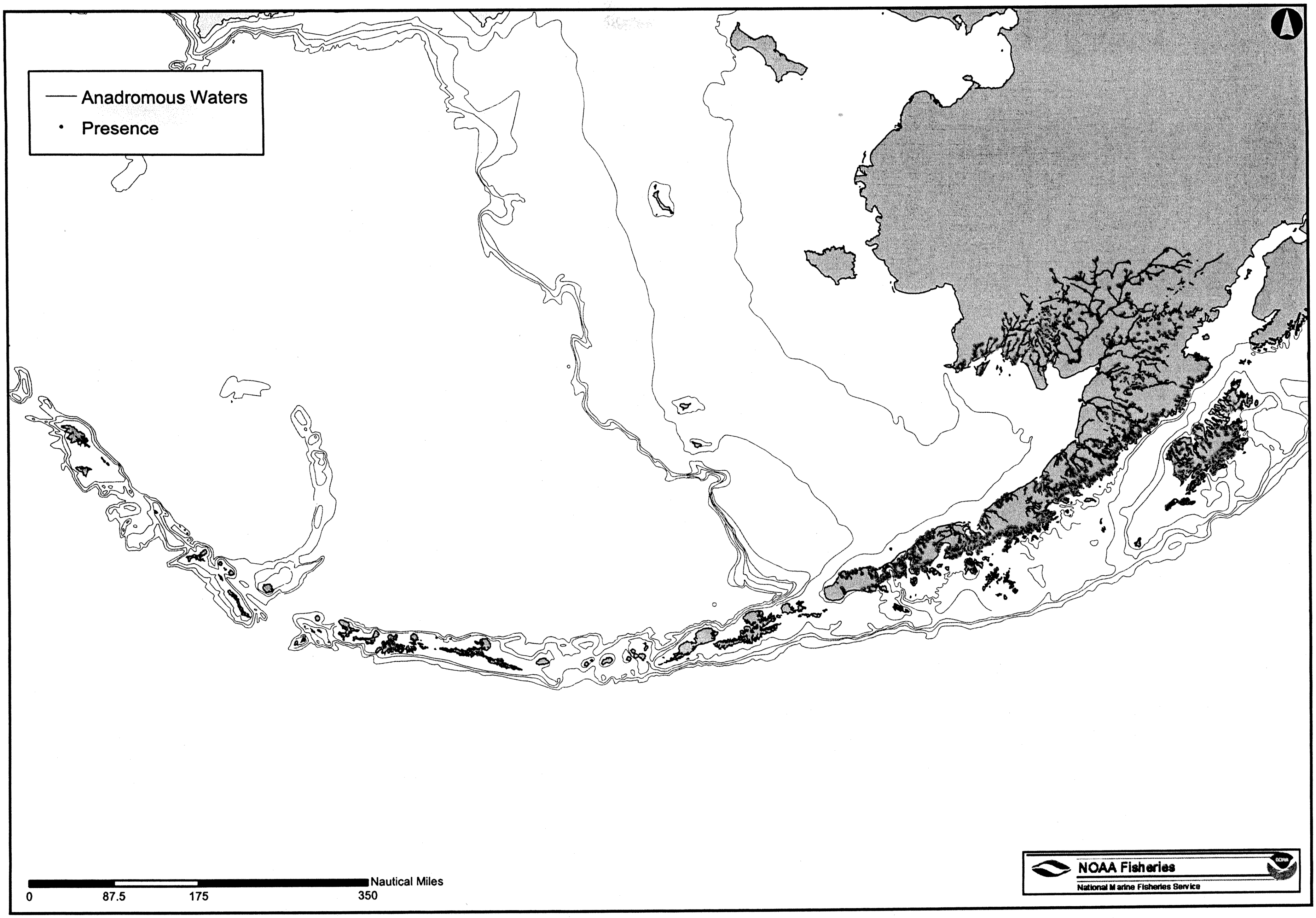


Figure 13. EFH Distribution for Chum Salmon - Western Region

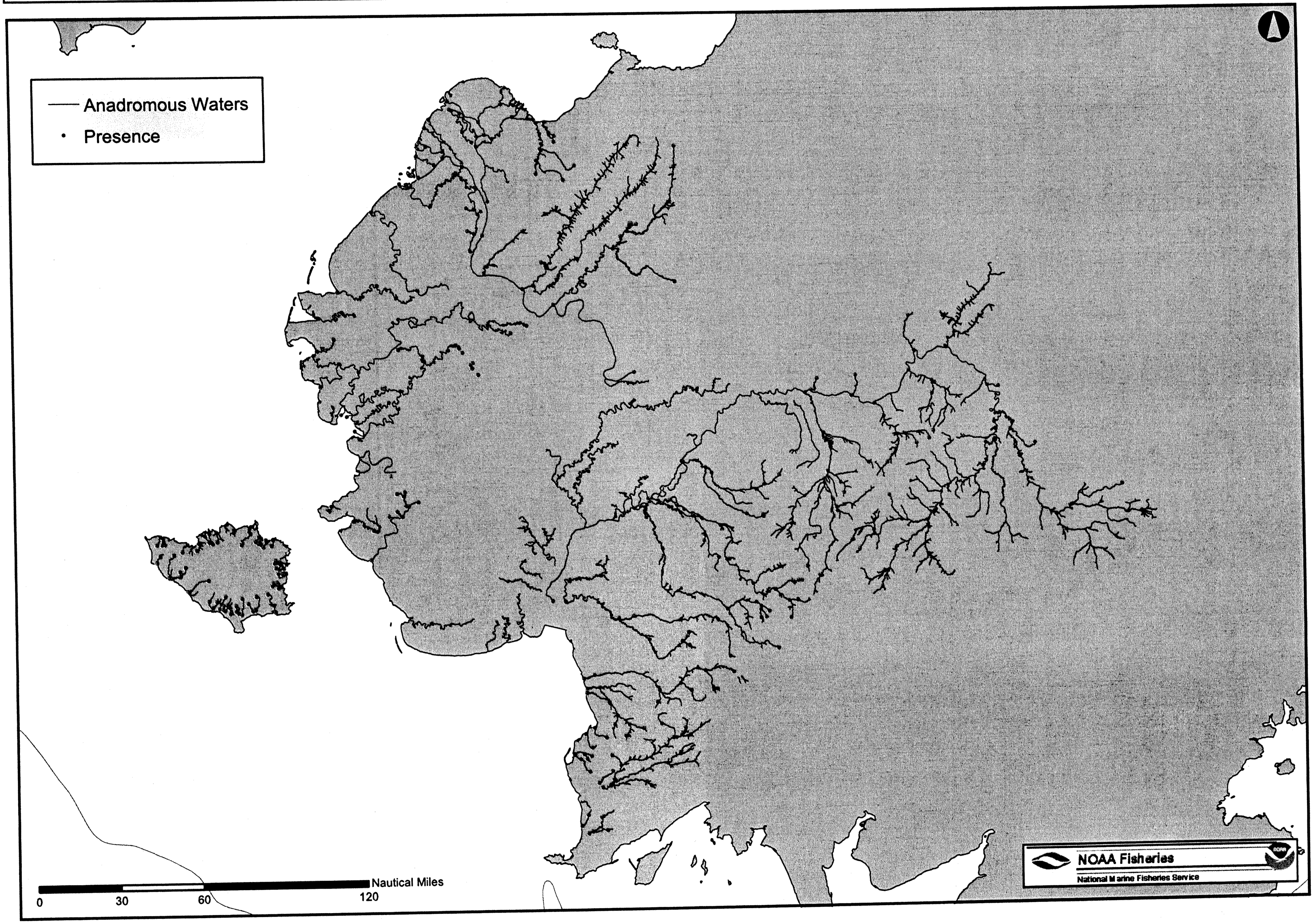


Figure 14. EFH Distribution for Chum Salmon - Arctic Region

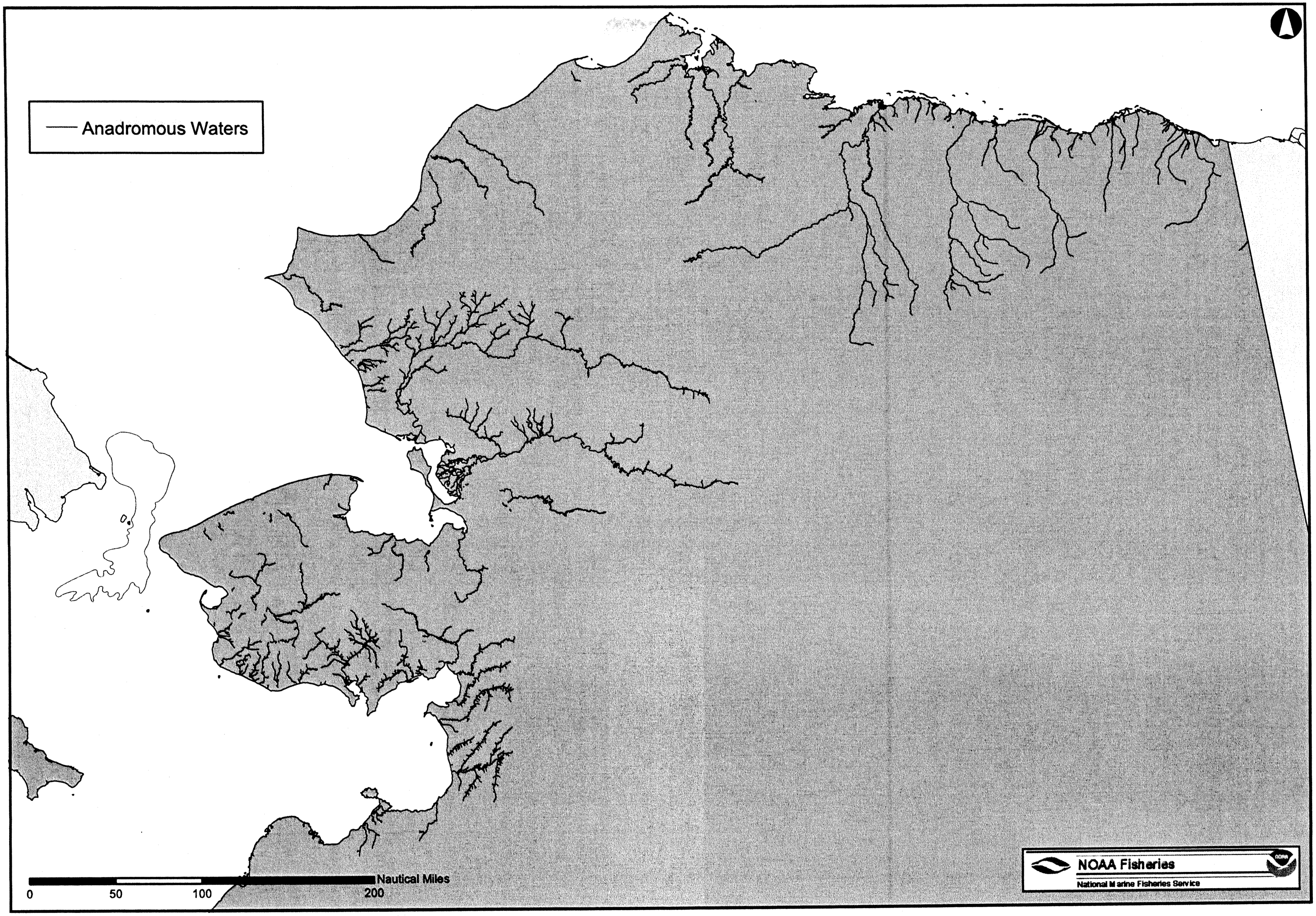


Figure 15. EFH Distribution for Chum Salmon - Interior Region

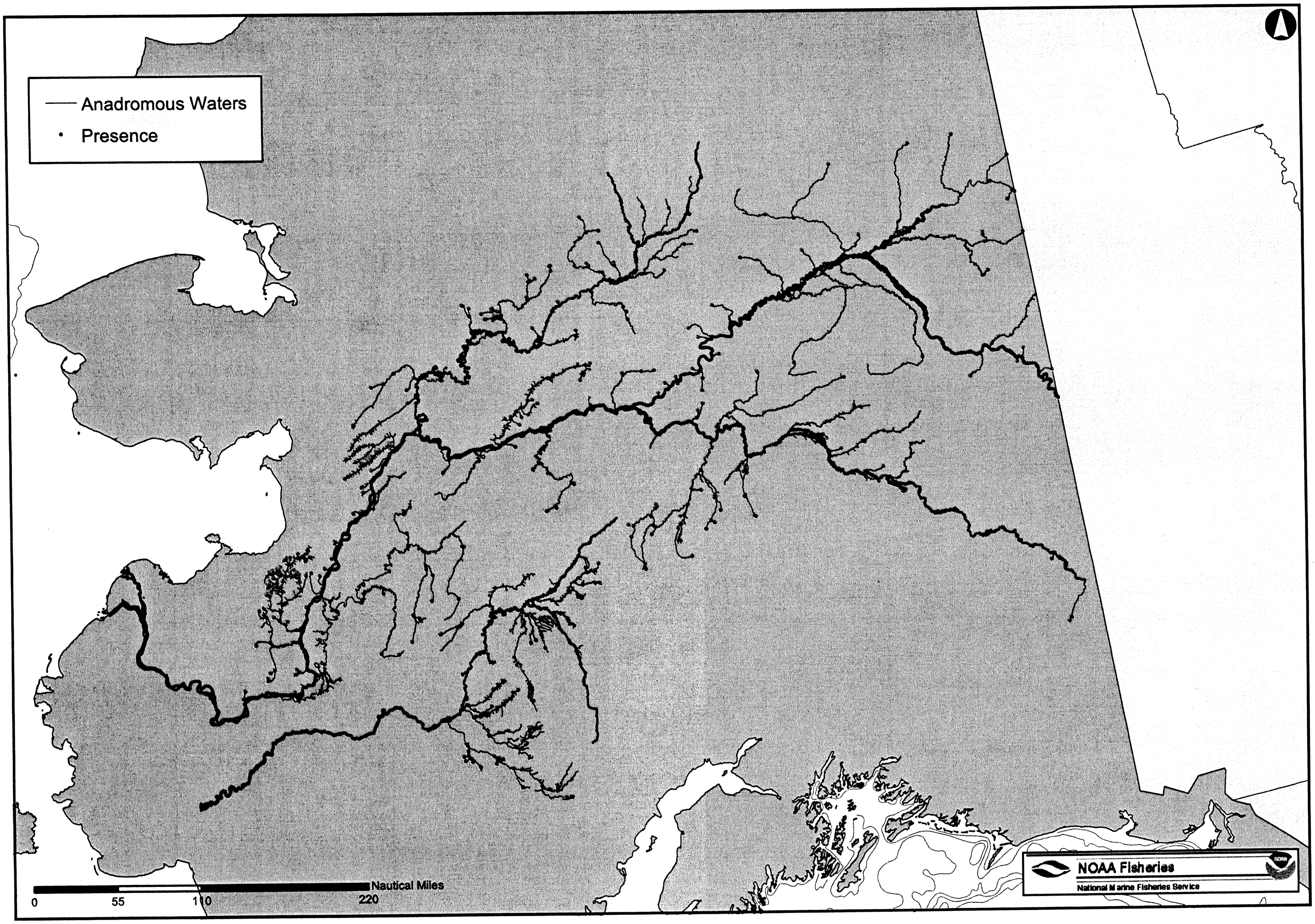


Figure 16. EFH Distribution for Chum Salmon - Marine

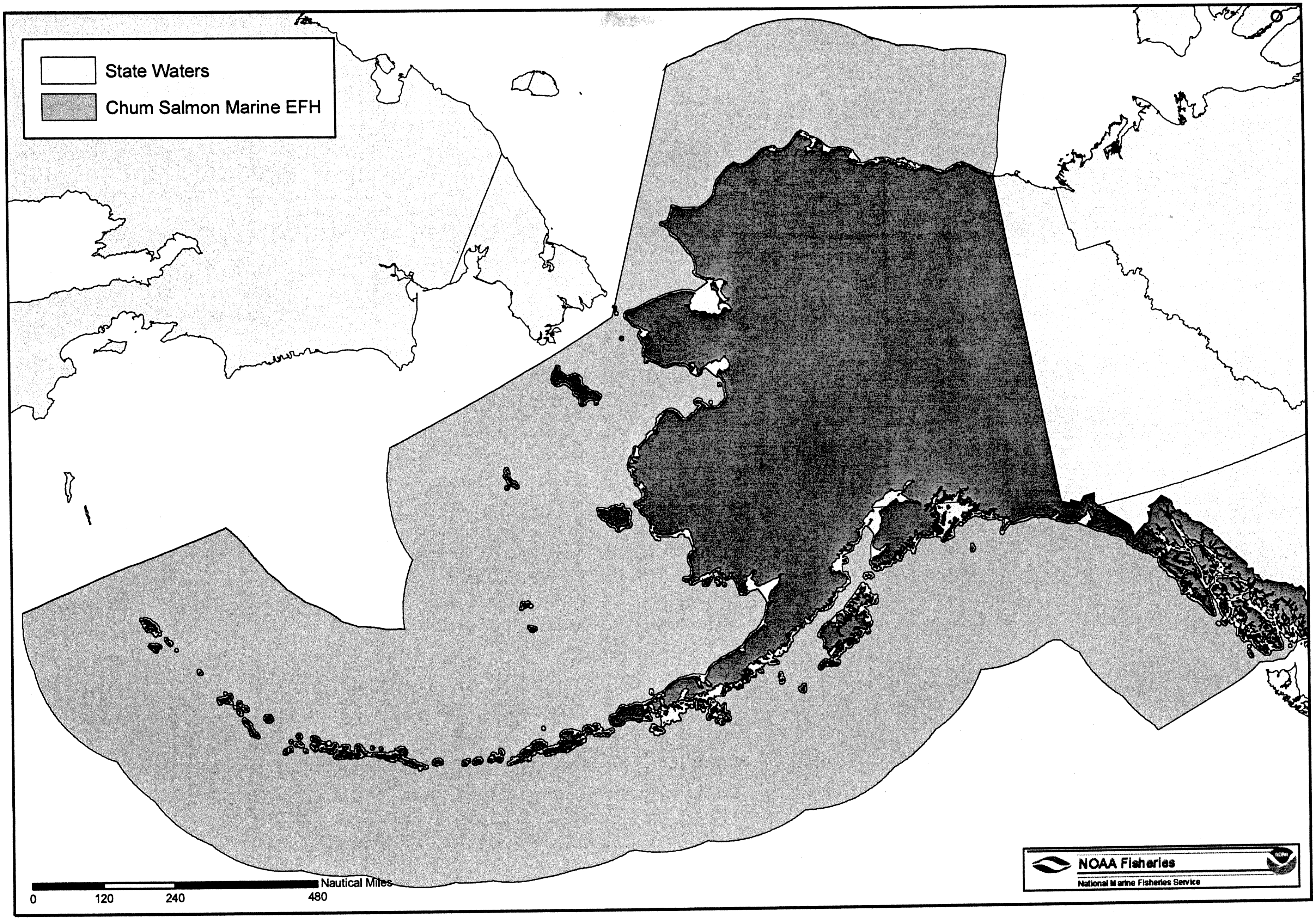


Figure 17. EFH Distribution for Sockeye Salmon - Southeastern Region

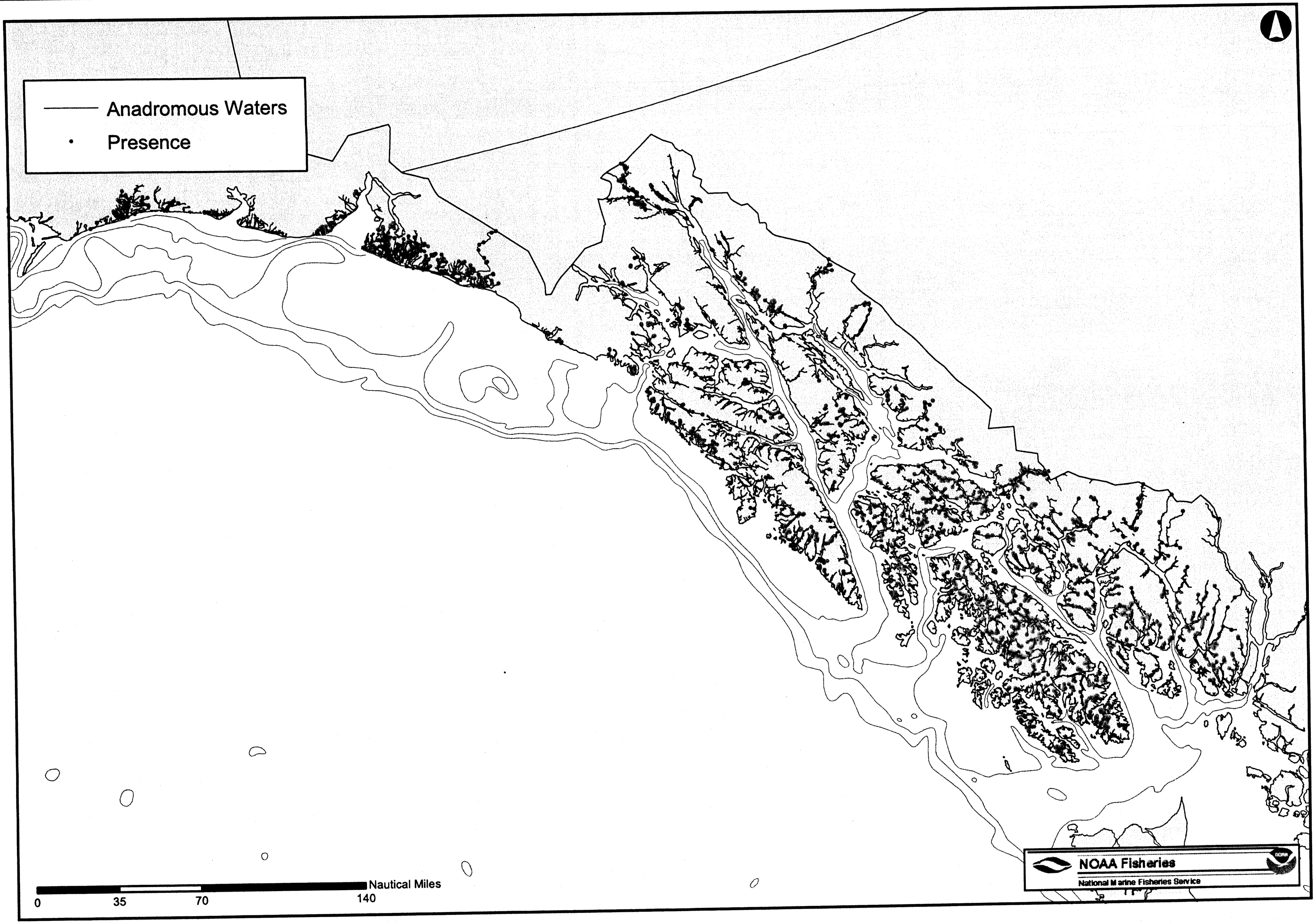


Figure 18. EFH Distribution for Sockeye Salmon - South-Central Region

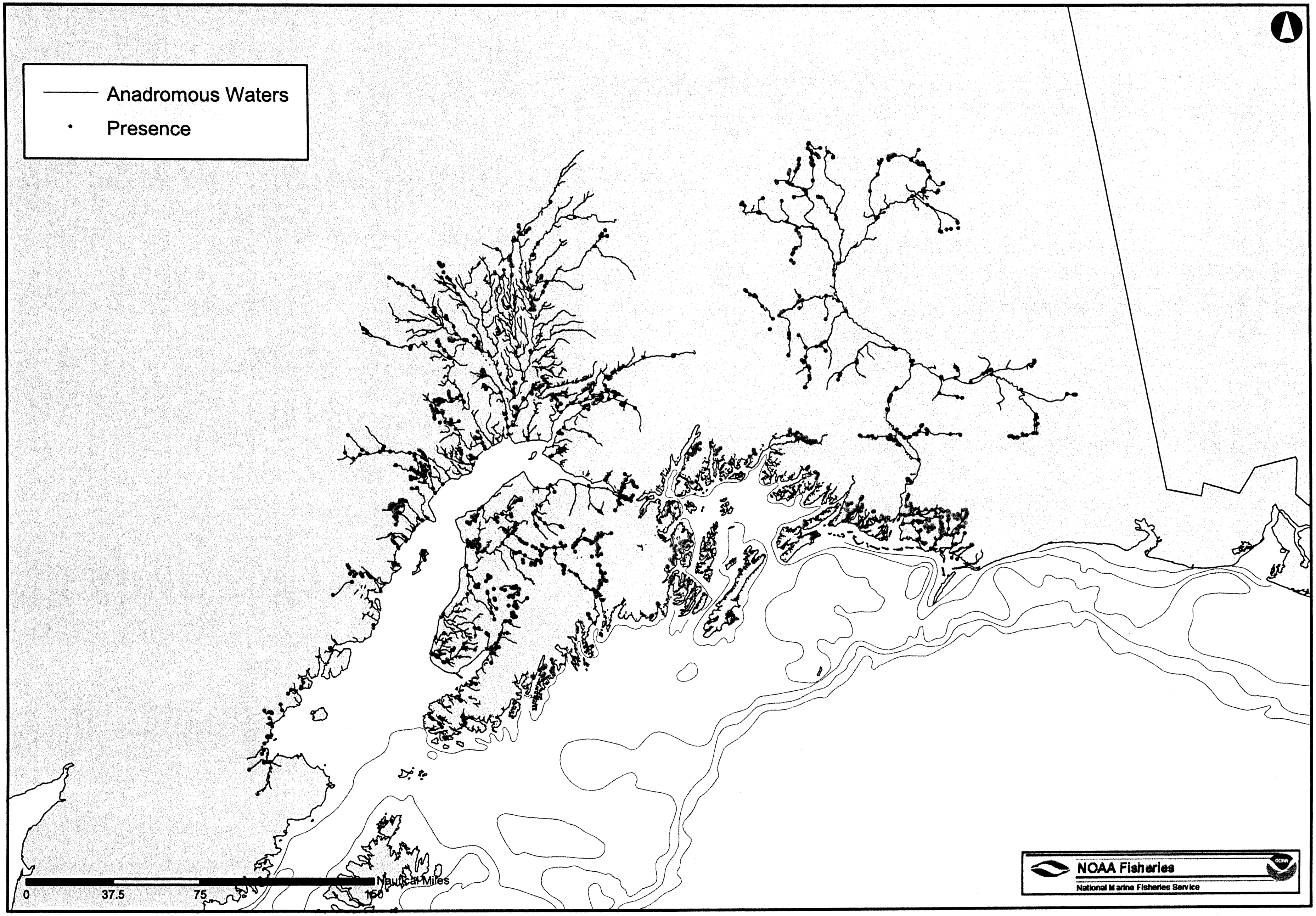


Figure 19. EFH Distribution for Sockeye Salmon - Southwestern Region

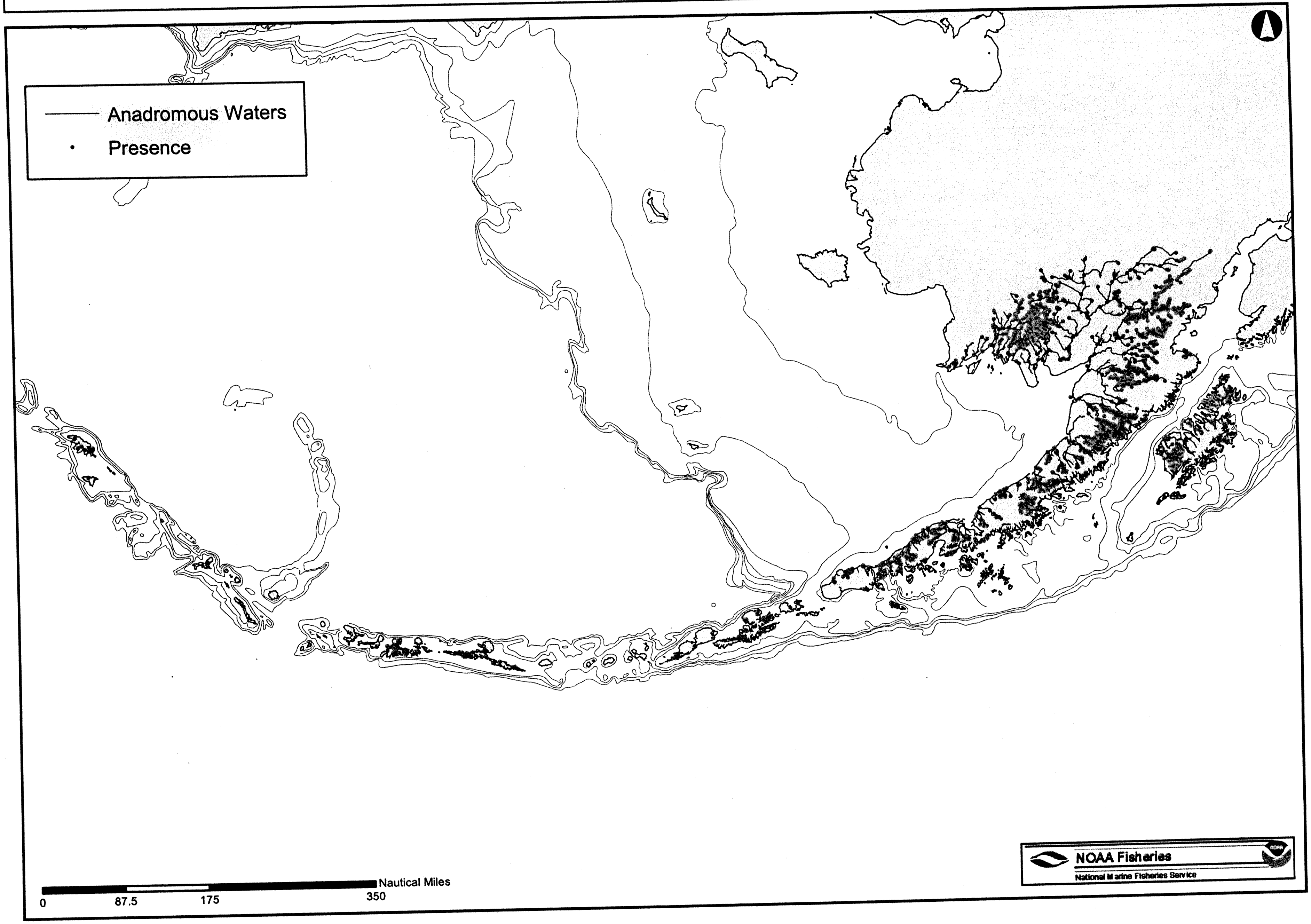


Figure 20. EFH Distribution for Sockeye Salmon - Western Region

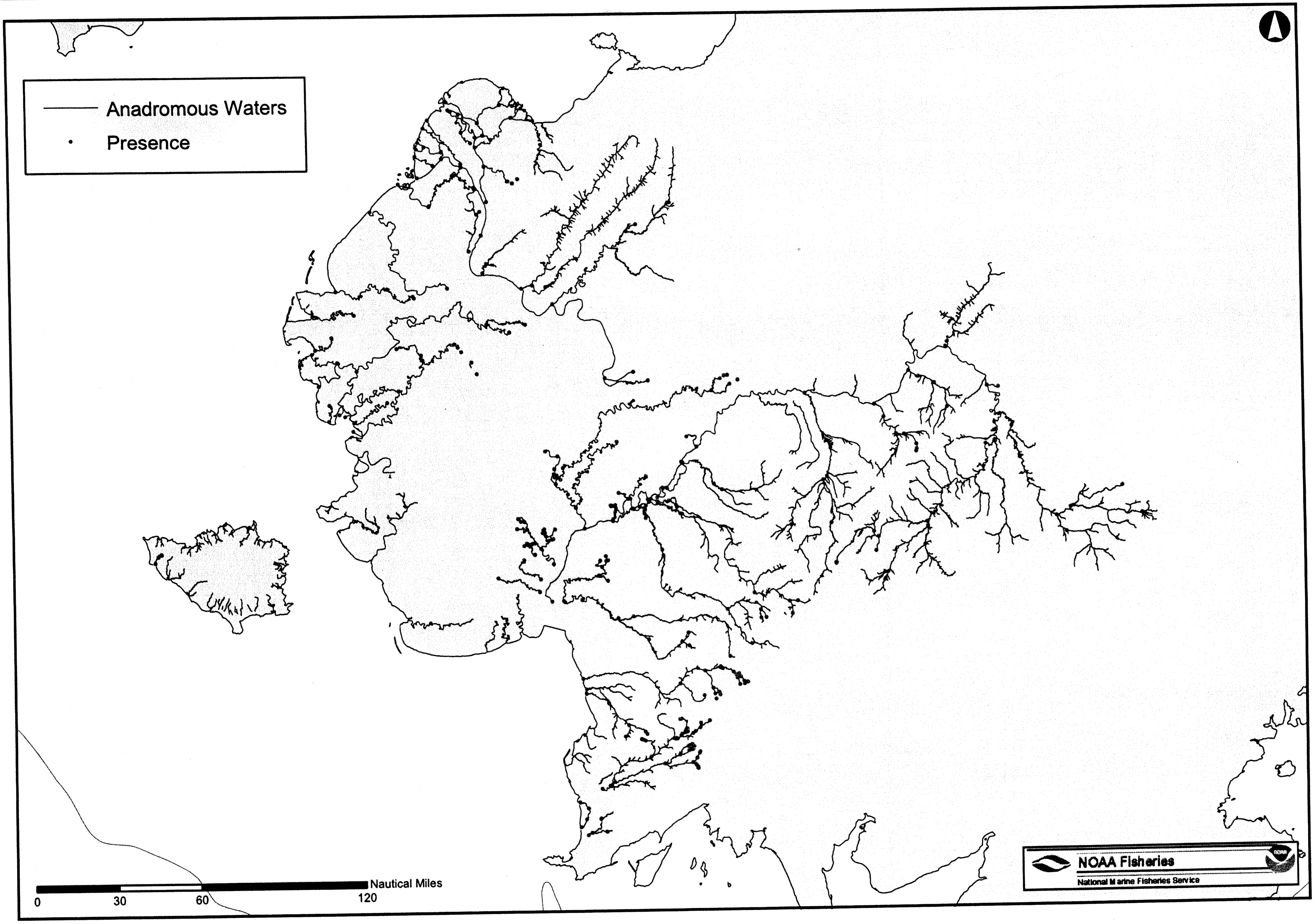


Figure 21. EFH Distribution for Sockeye Salmon - Arctic Region

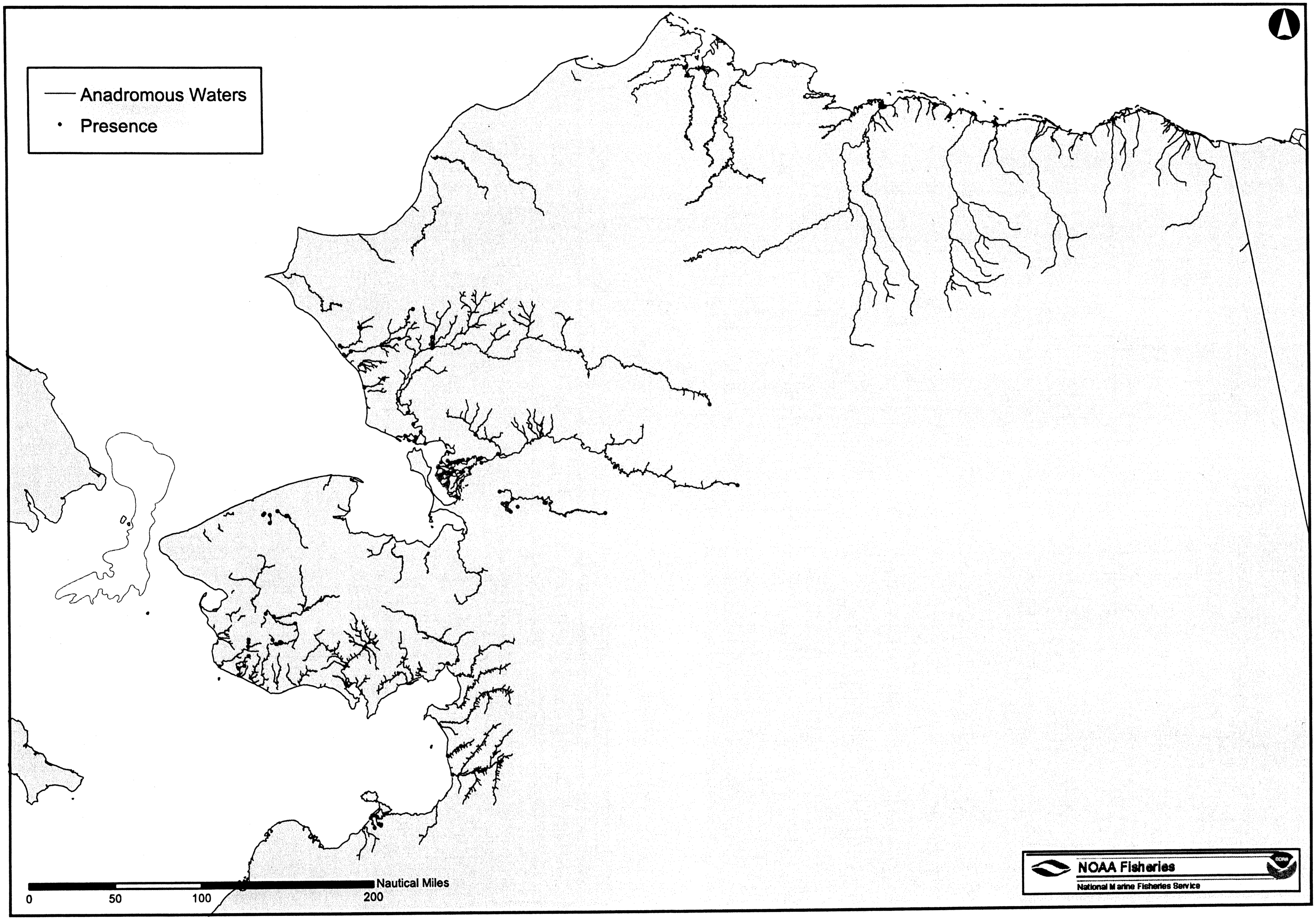


Figure 22. EFH Distribution for Sockeye Salmon - Interior Region

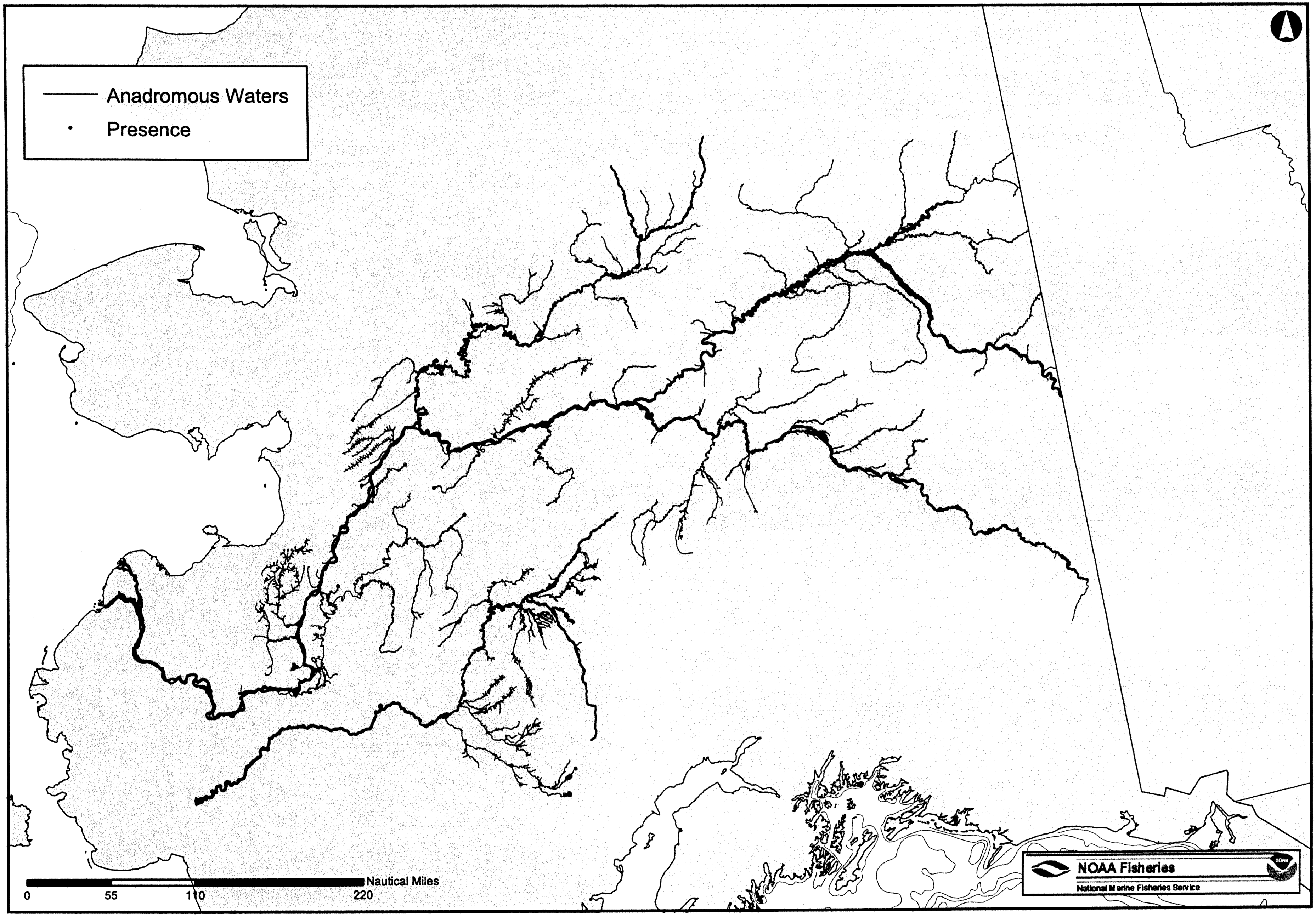


Figure 23. EFH Distribution for Sockeye Salmon - Marine

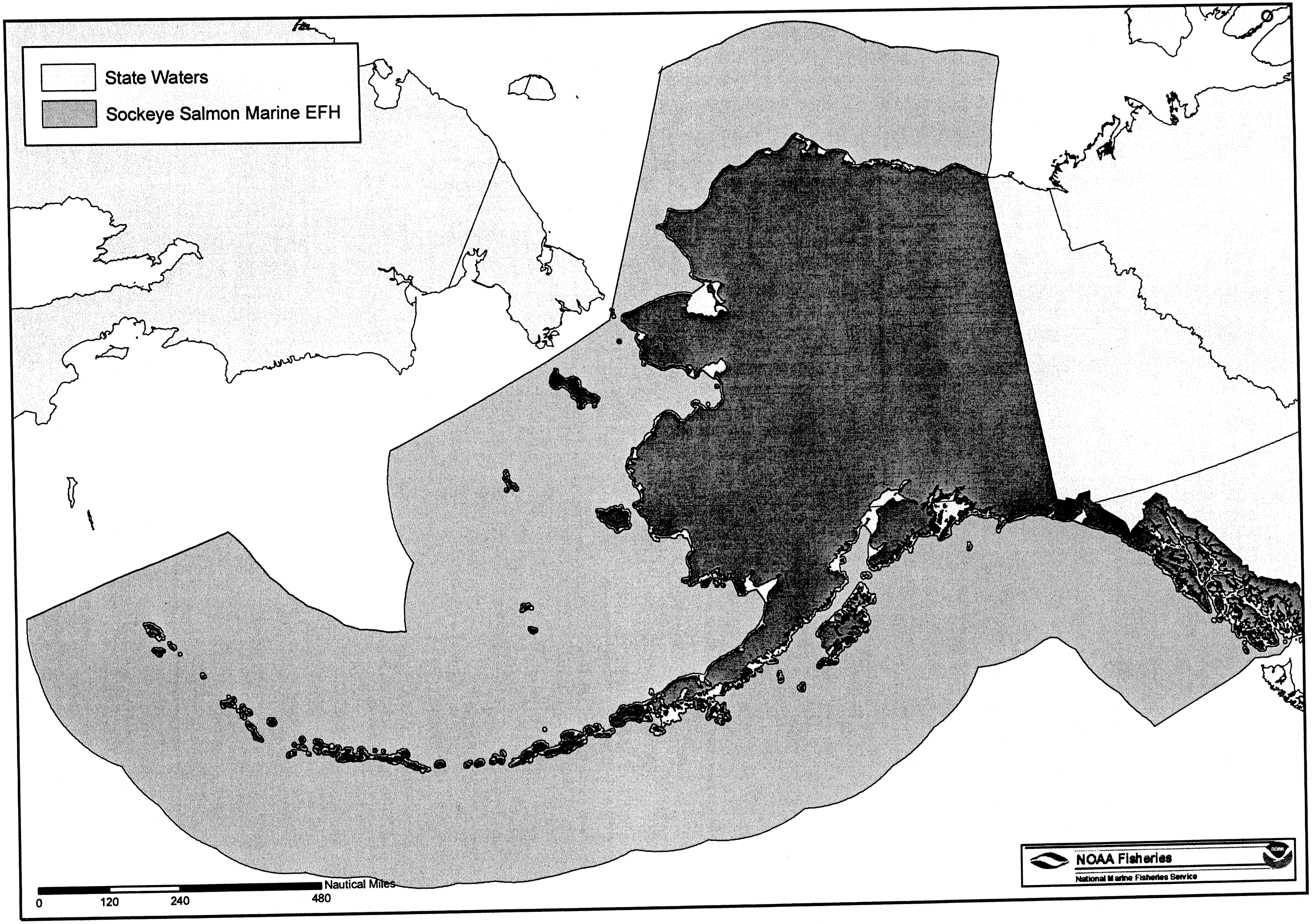


Figure 24. EFH Distribution for Chinook Salmon - Southeastern Region

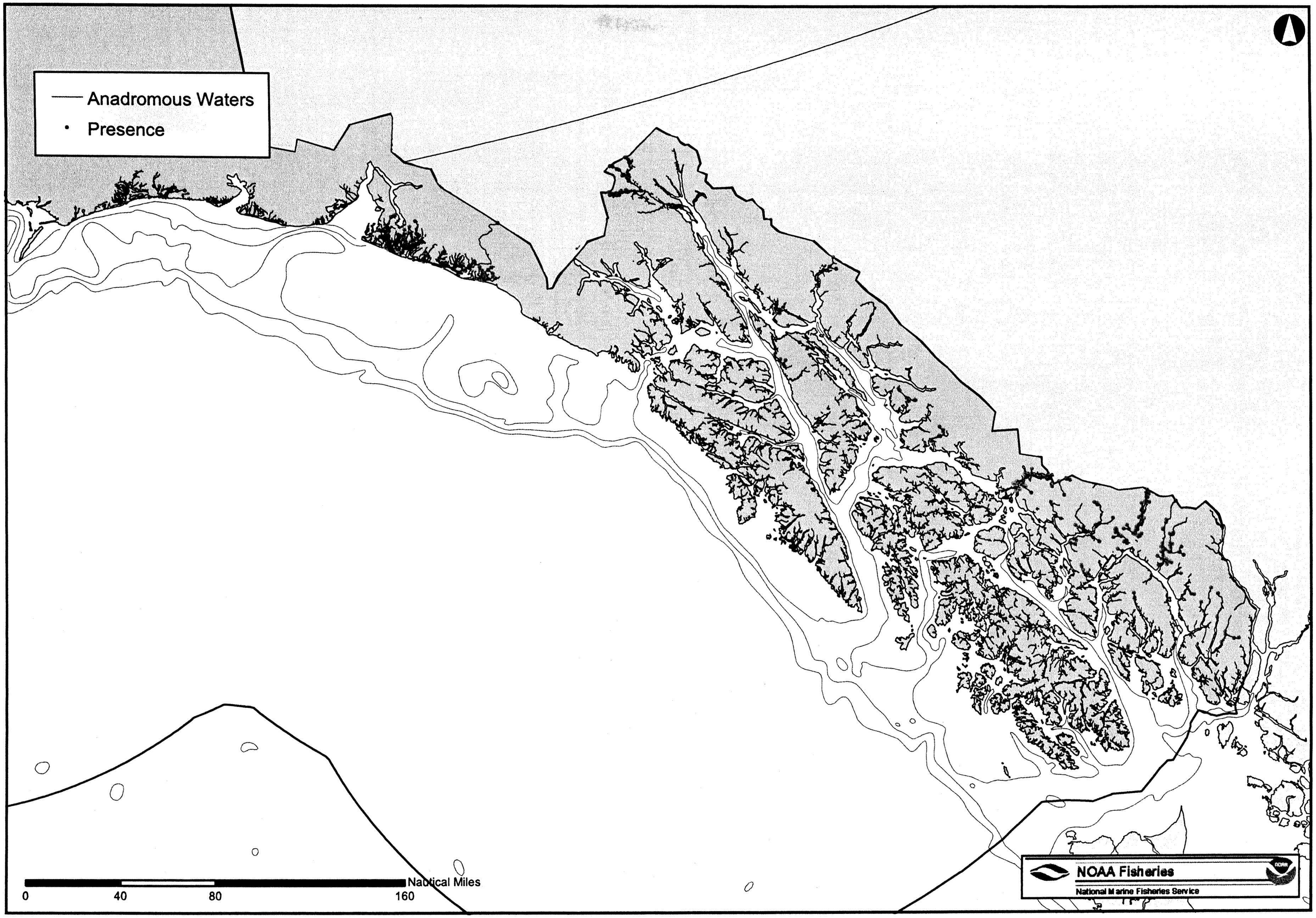


Figure 25. EFH Distribution for Chinook Salmon - South-Central Region

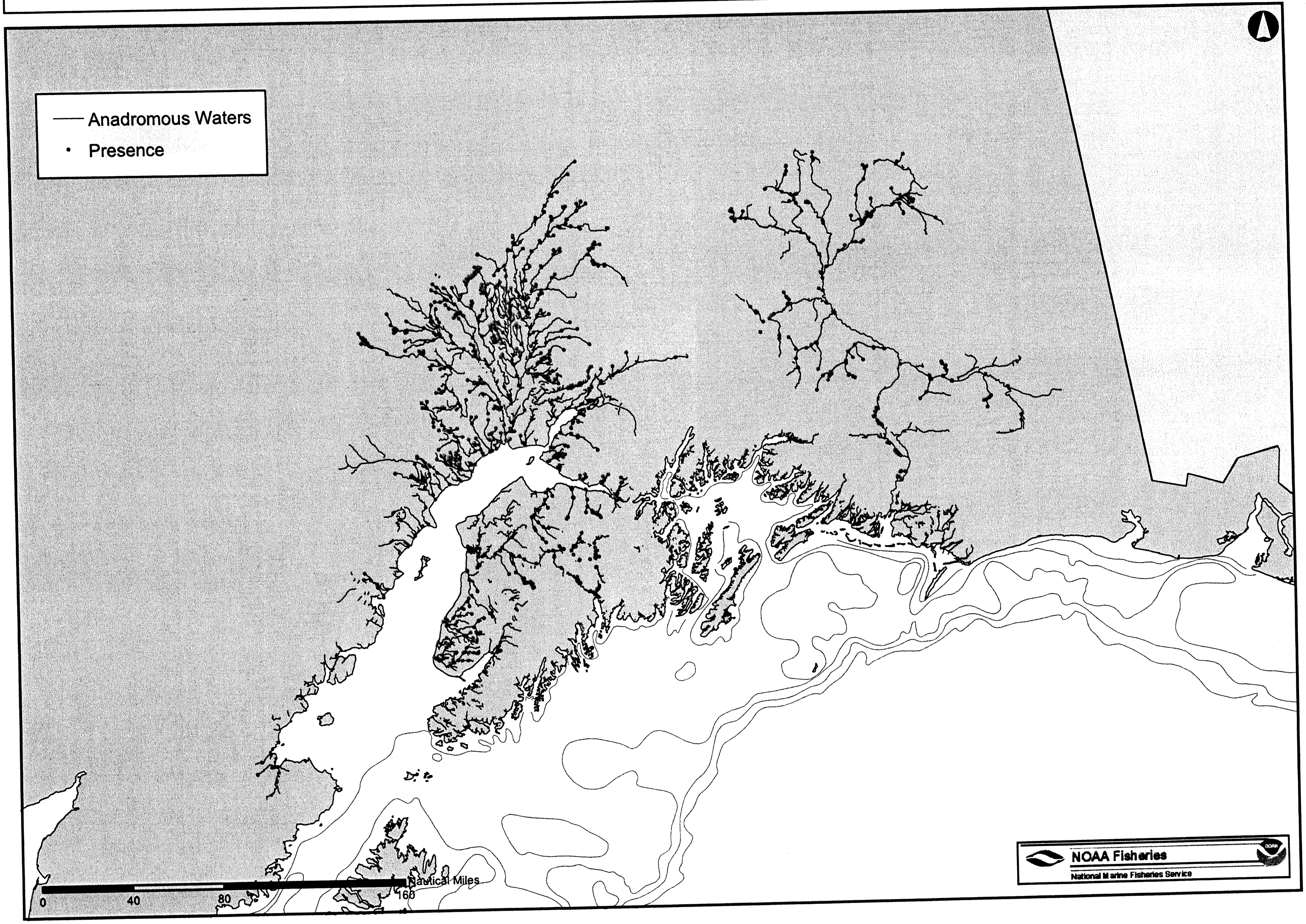


Figure 26. EFH Distribution for Chinook Salmon - Southwestern Region

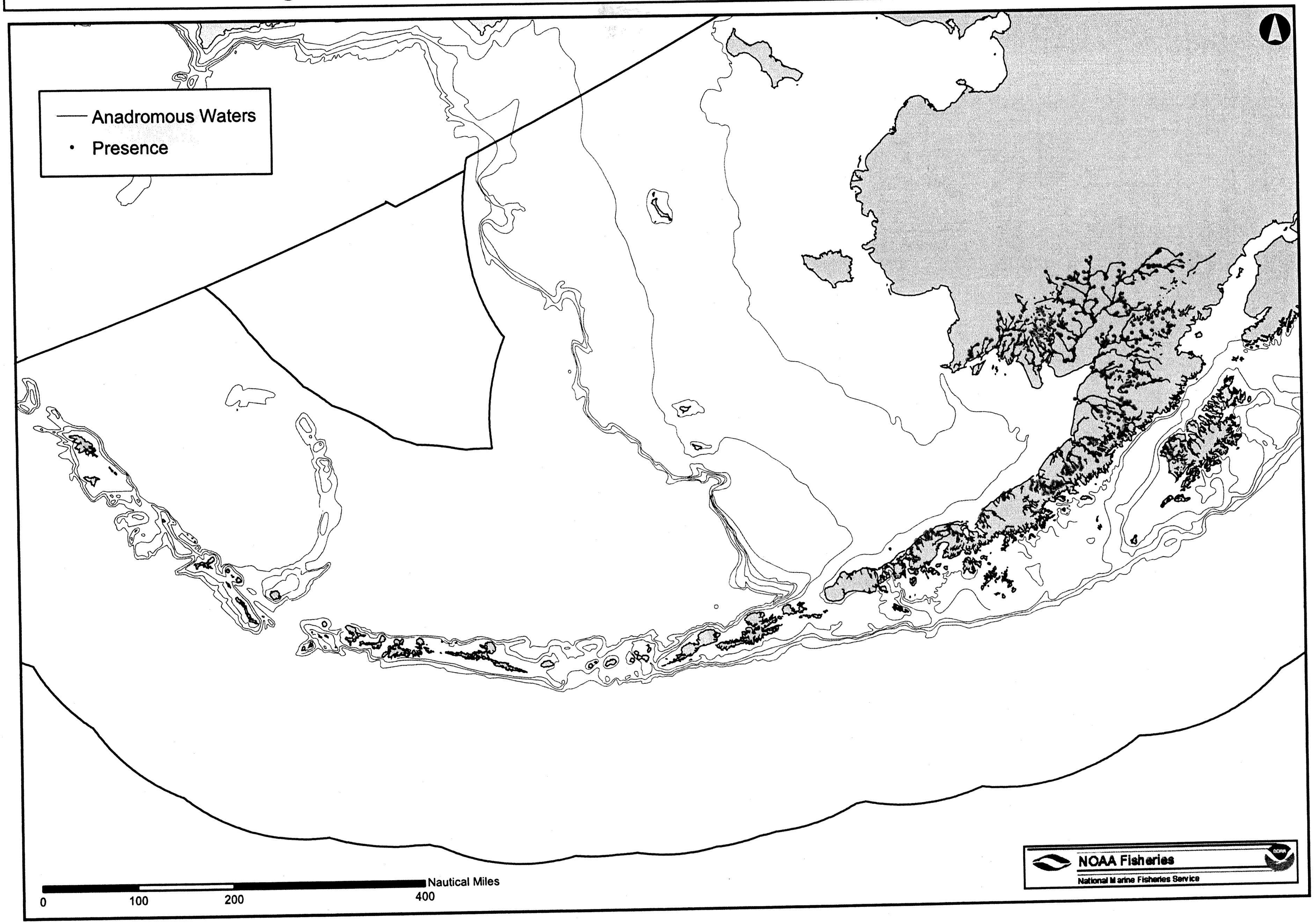


Figure 27. EFH Distribution for Chinook Salmon - Western Region

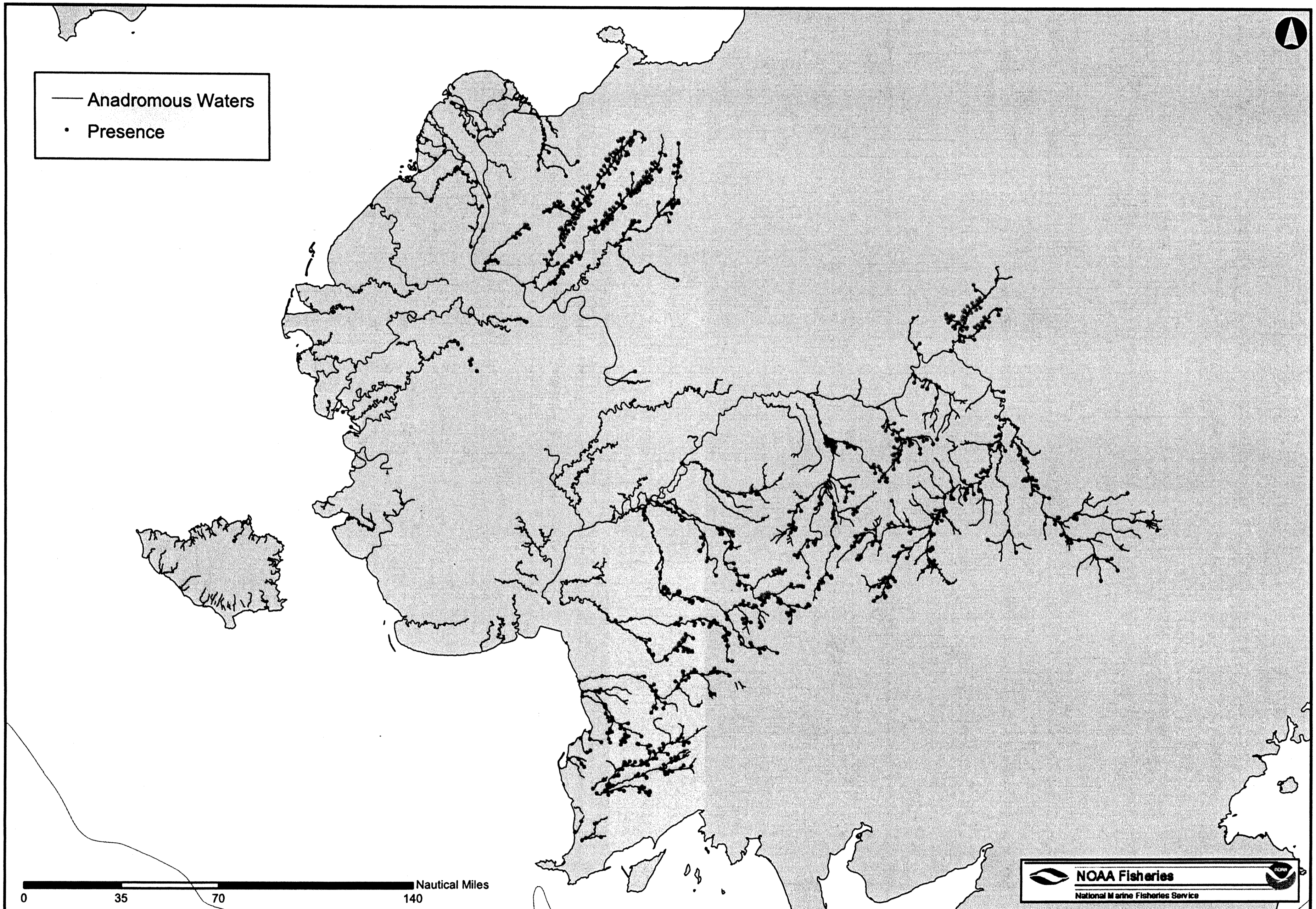


Figure 28. EFH Distribution for Chinook Salmon - Arctic Region

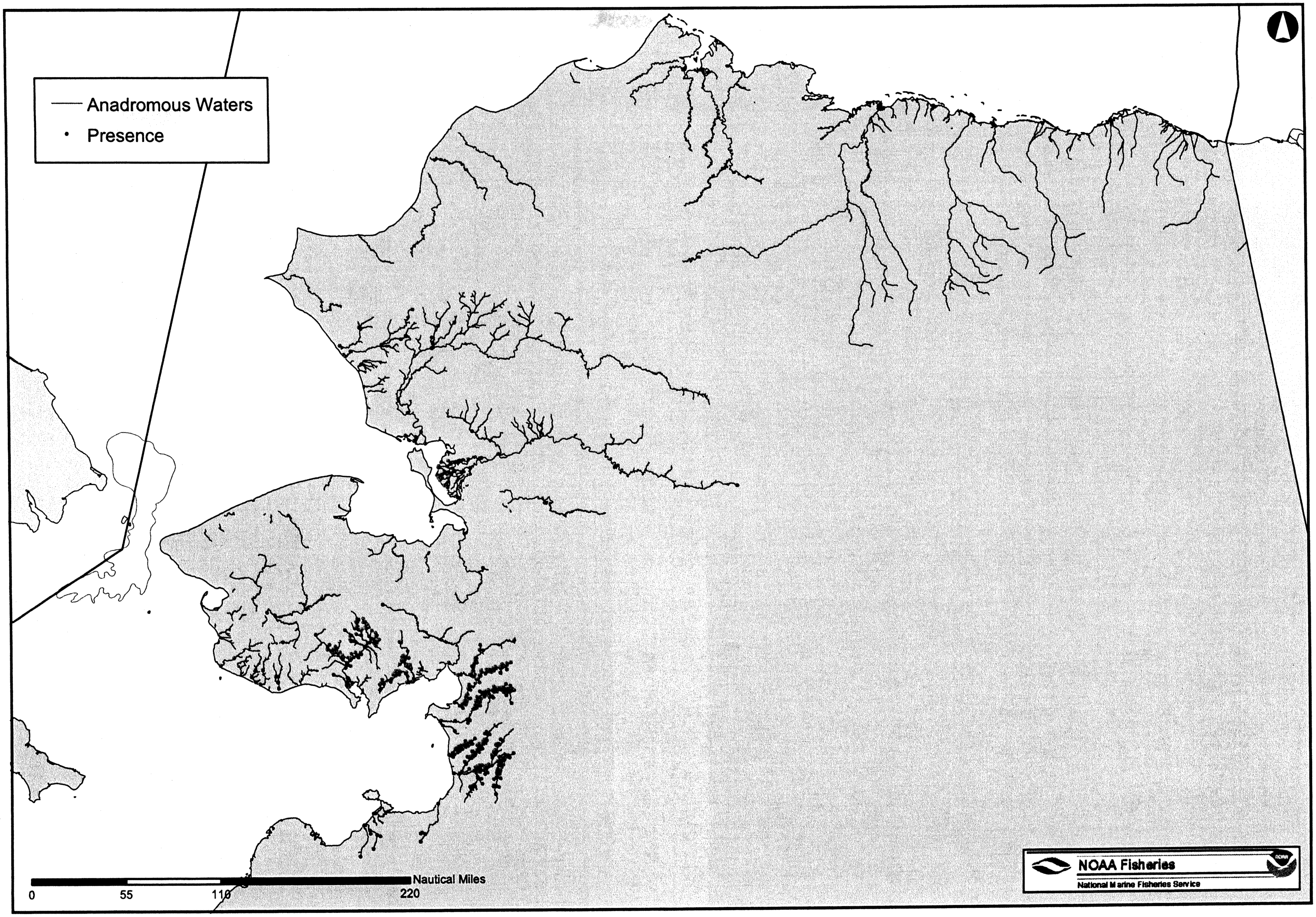


Figure 29. EFH Distribution for Chinook Salmon - Interior Region

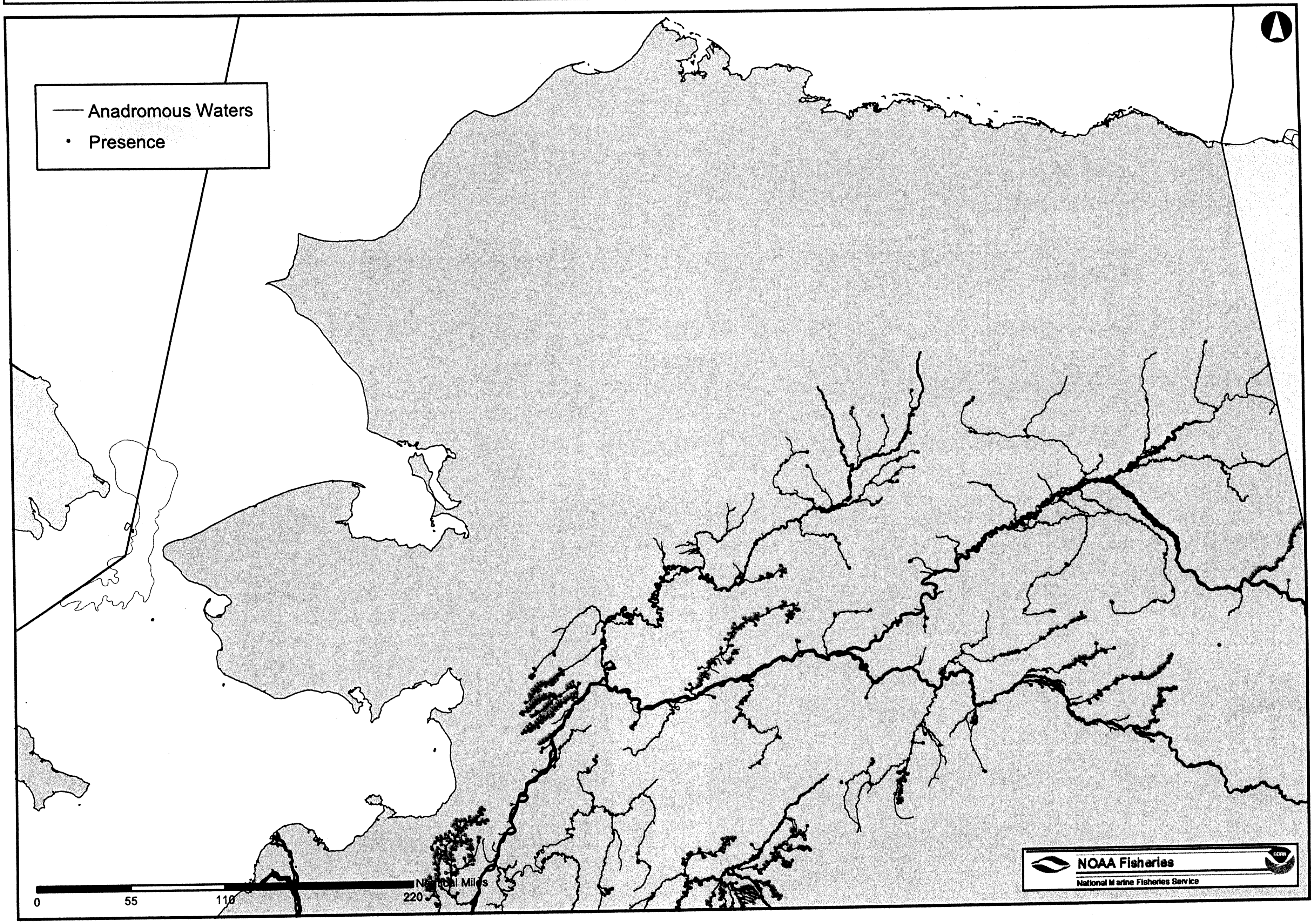


Figure 30. EFH Distribution for Chinook Salmon - Marine

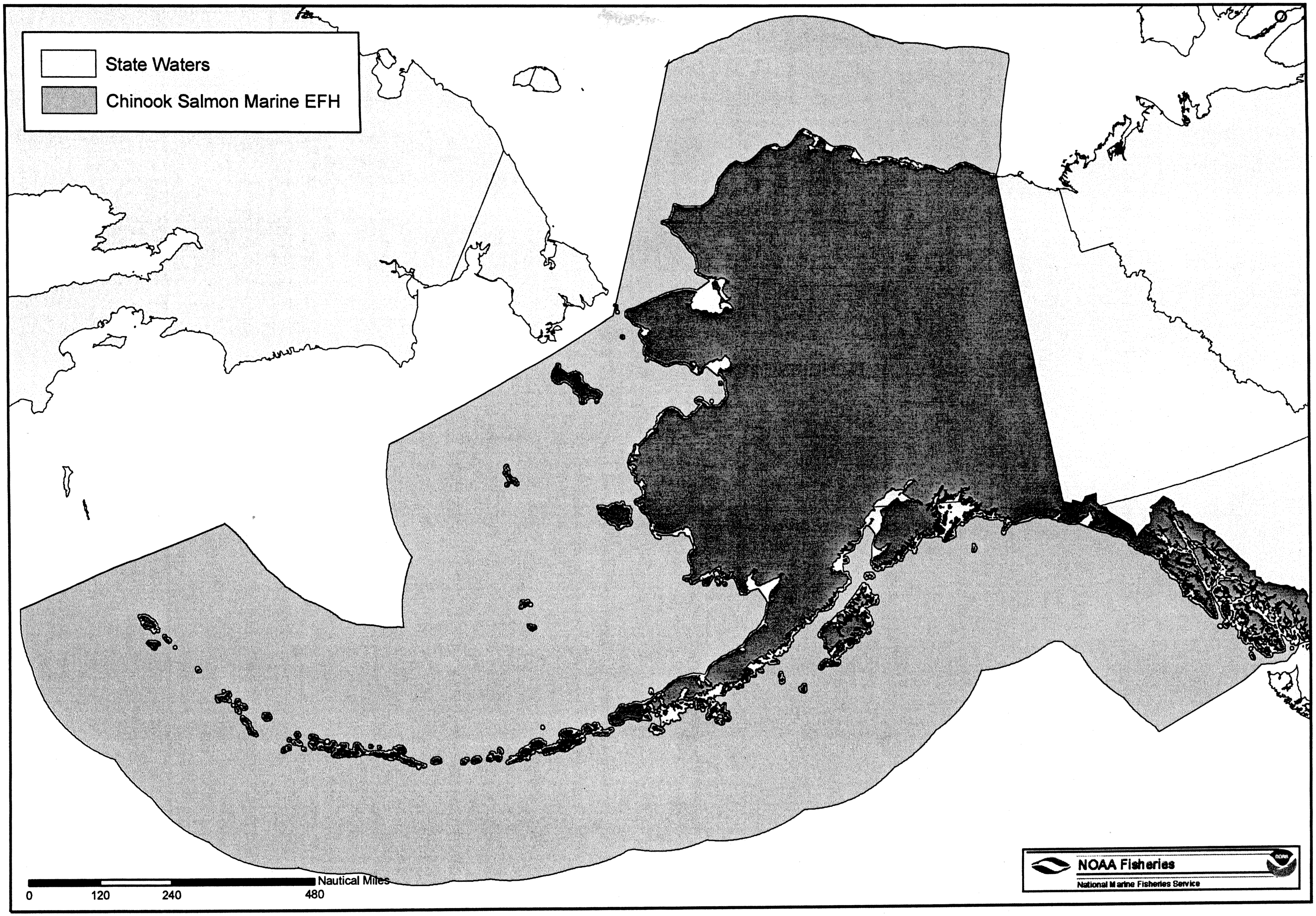


Figure 31. EFH Distribution for Coho Salmon - Southeastern Region

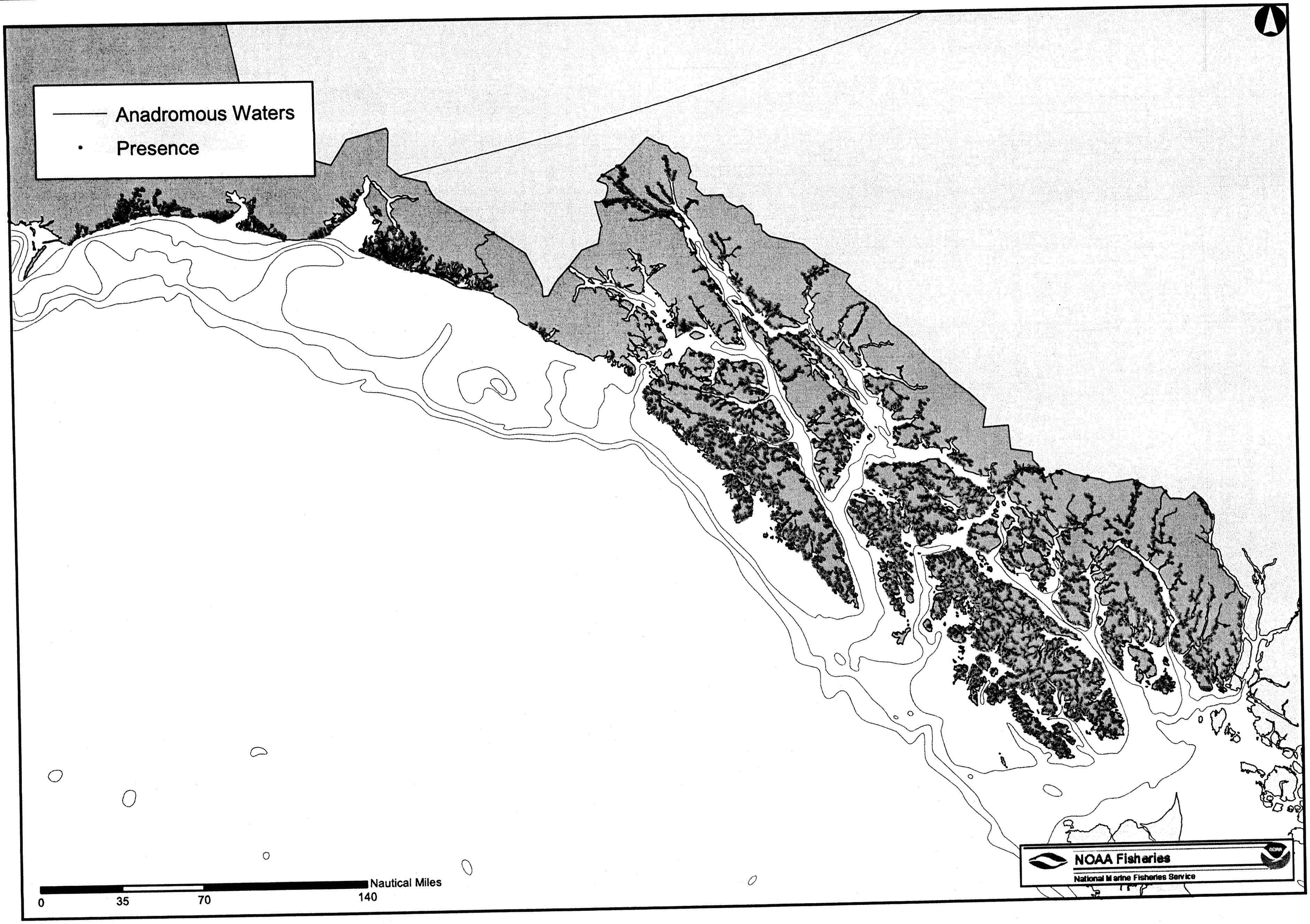


Figure 32. EFH Distribution for Coho Salmon - South-Central Region

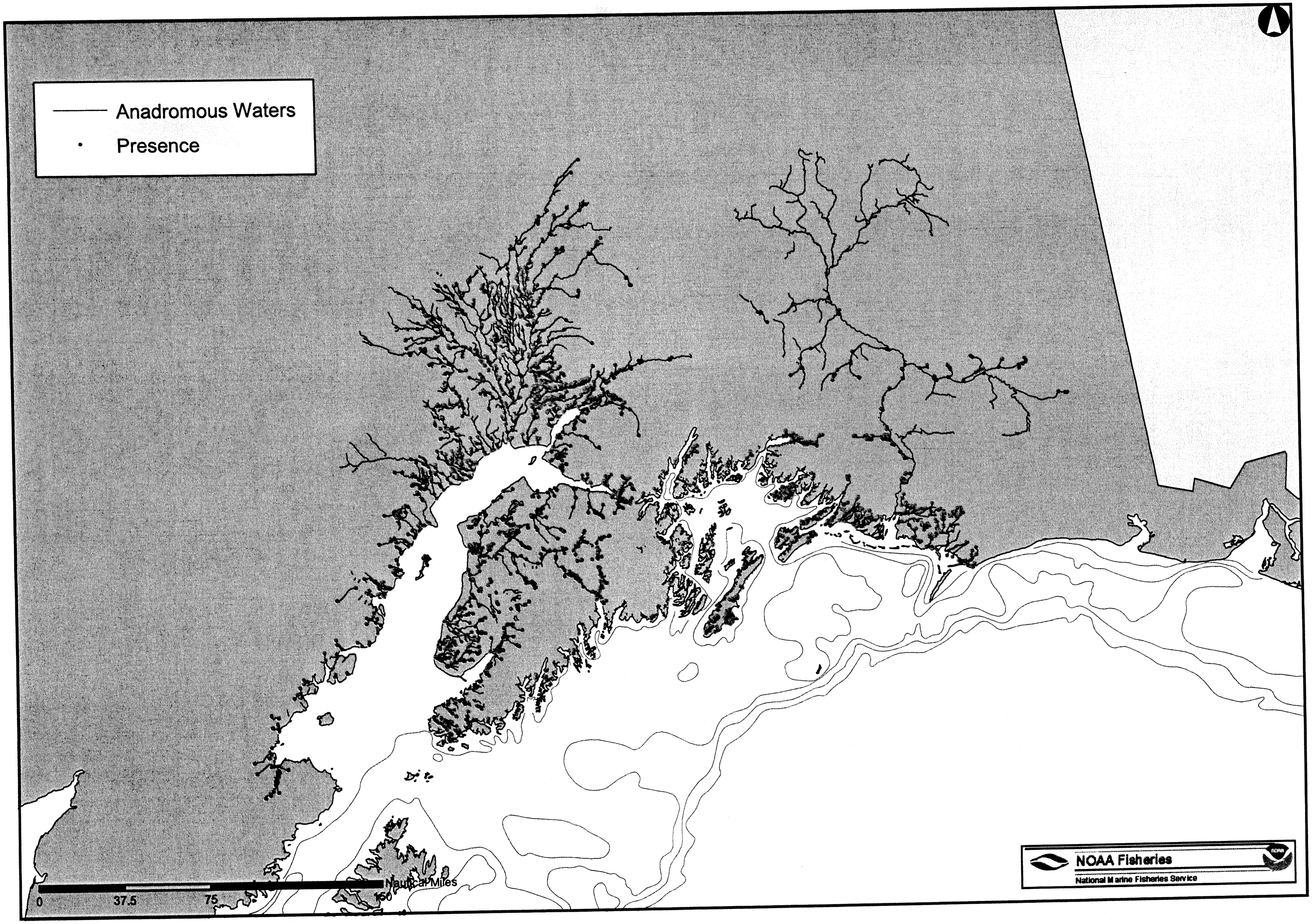


Figure 33. EFH Distribution for Coho Salmon - Southwestern Region

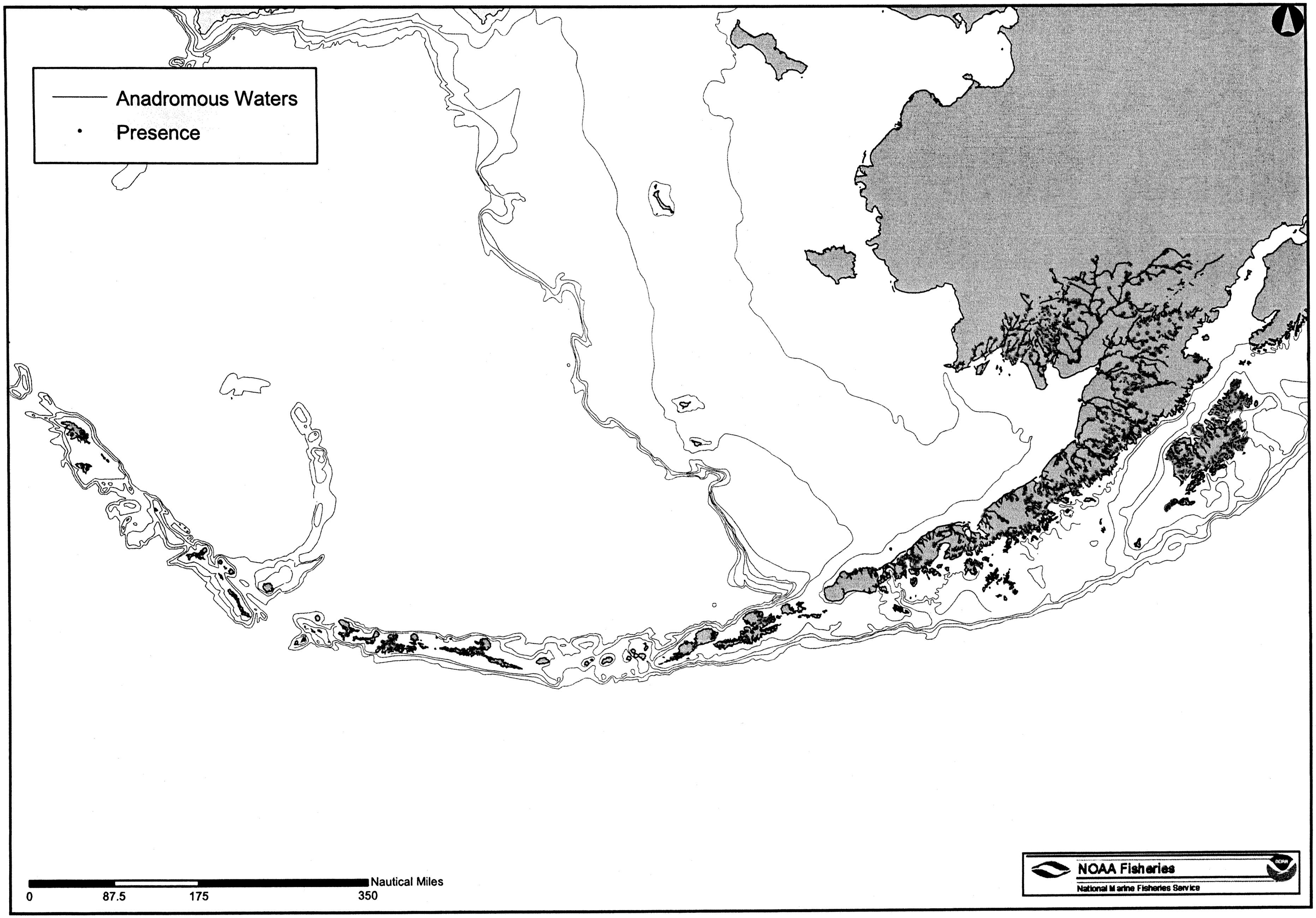


Figure 34. EFH Distribution for Coho Salmon - Western Region

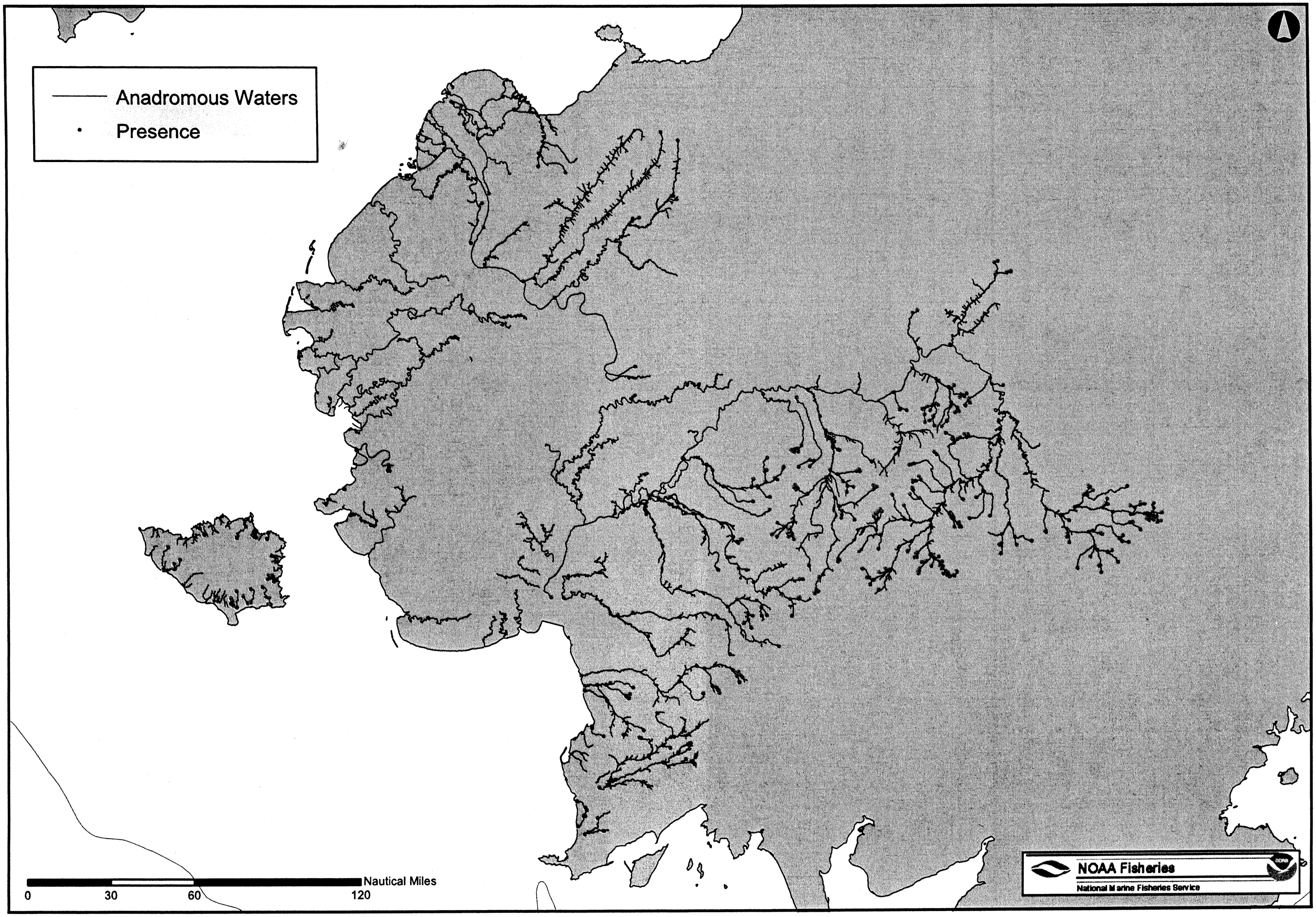


Figure 35. EFH Distribution for Coho Salmon - Arctic Region

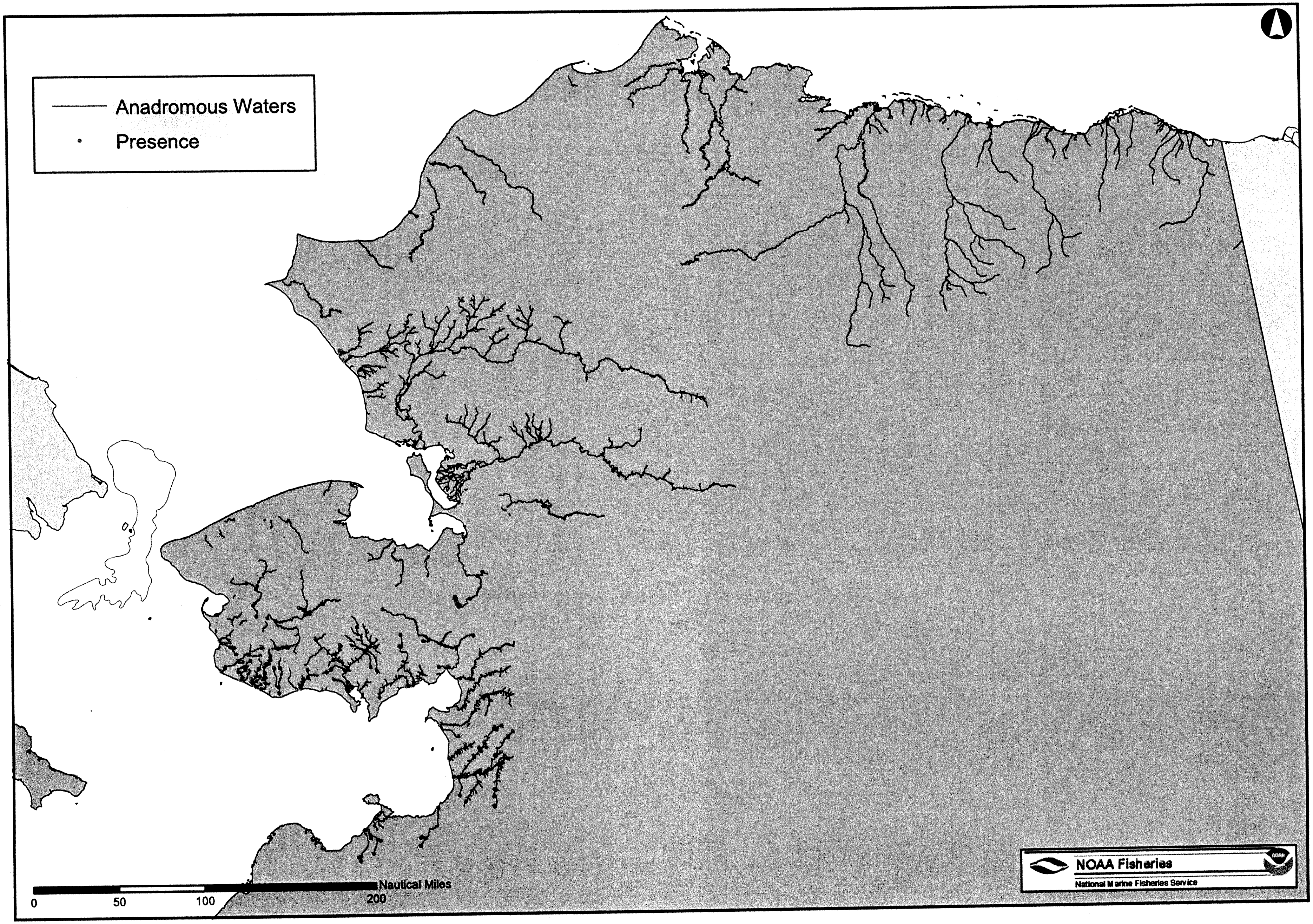


Figure 36. EFH Distribution for Coho Salmon - Interior Region

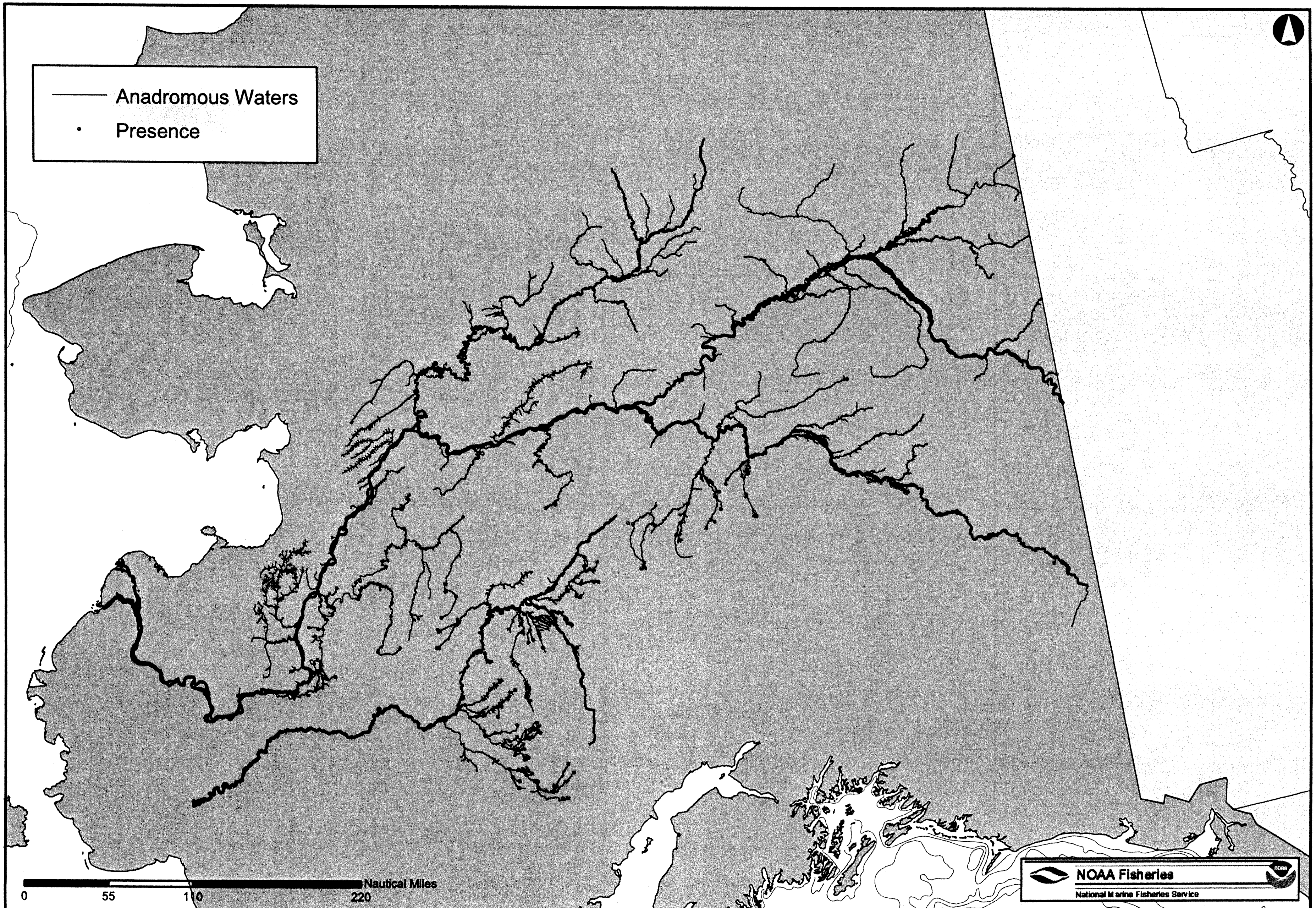
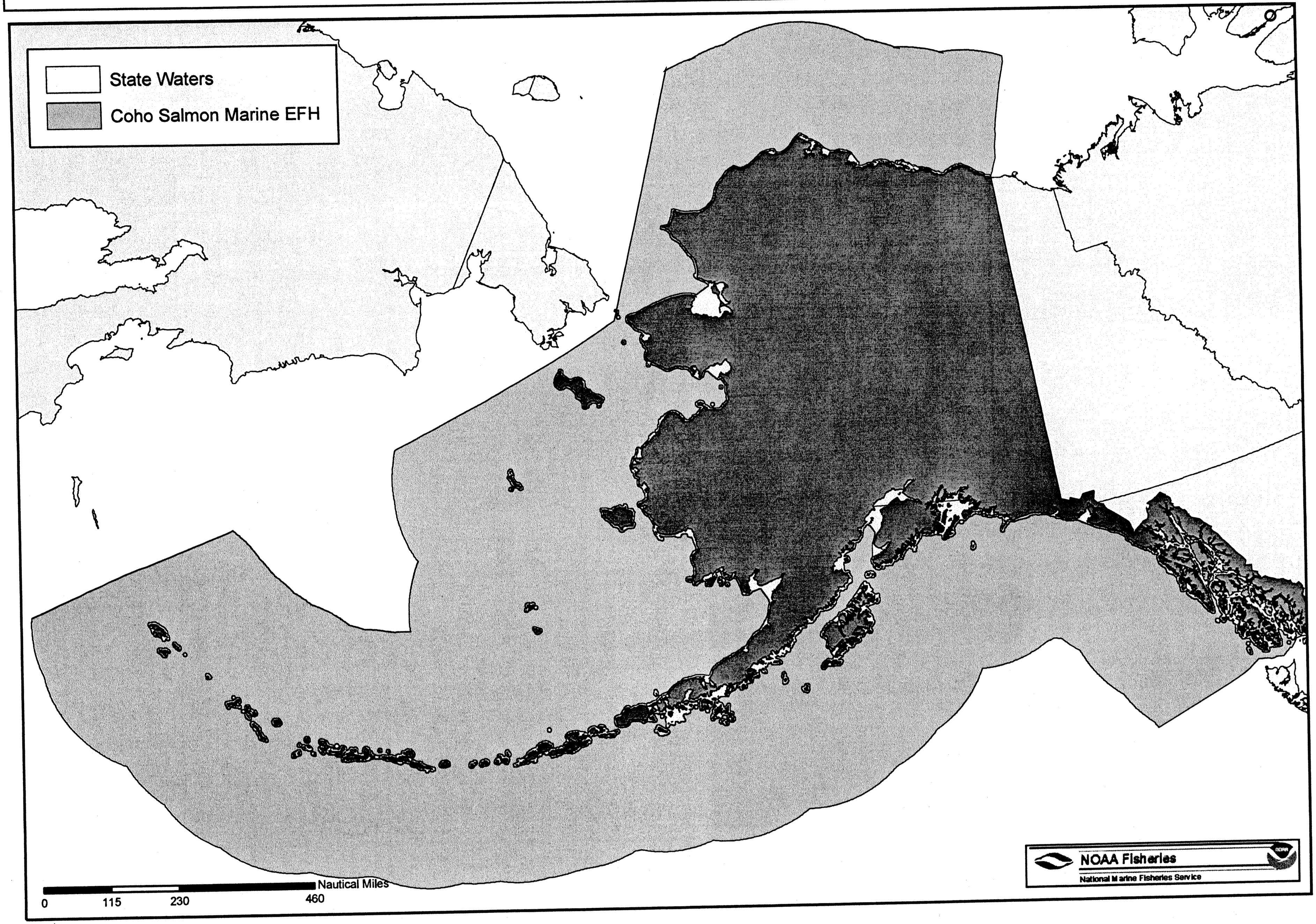


Figure 37. EFH Distribution for Coho Salmon - Marine



3.3 Essential Fish Habitat Conservation and Habitat Areas of Particular Concern

The Council established the Aleutian Islands Habitat Conservation Area, the Aleutian Islands Coral Habitat Protection Areas, and the GOA Slope Habitat Conservation Areas to protect EFH from fishing threats. The Council also established Habitat Areas of Particular Concern (HAPCs) within EFH to protect those areas from fishing threats: the Alaska Seamount Habitat Protection Areas, the Bowers Ridge Habitat Conservation Zone, and the GOA Coral Habitat Protection Areas (NPFMC 2005). Maps of these areas, as well at the coordinates, are provided below.

HAPCs are specific sites within EFH that are of particular ecological importance to the long-term sustainability of managed species, are of a rare type, or are especially susceptible to degradation or development. HAPCs are meant to provide greater focus to conservation and management efforts and may require additional protection from adverse effects.

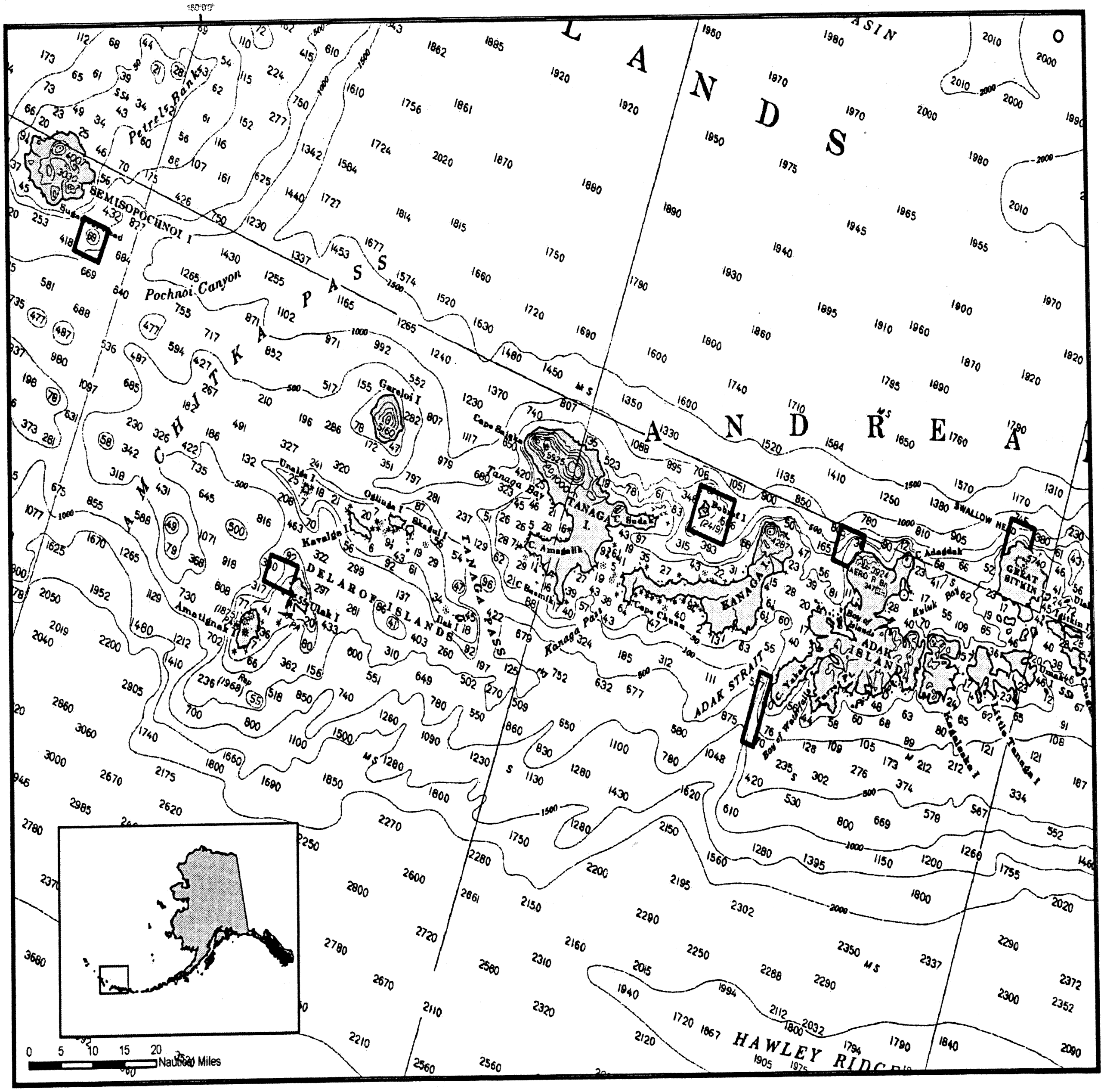
3.3.1 Aleutian Islands Coral Habitat Protection Area

The use of bottom contact gear, as described in 50 CFR part 679, is prohibited year-round in the Aleutian Islands Coral Habitat Protection Areas, see Figure 38. Anchoring by a federally permitted fishing vessel, as described in 50 CFR part 679, is also prohibited. The coordinates for the areas are listed in the table below.

Area Number	Name	Latitude			Longitude		
1	Great Sitkin Is	52	9.56	N	176	6.14	W
	Great Sitkin Is	52	9.56	N	176	12.44	W
	Great Sitkin Is	52	4.69	N	176	12.44	W
	Great Sitkin Is	52	6.59	N	176	6.12	W
2	Cape Moffett Is	52	0.11	N	176	46.65	W
	Cape Moffett Is	52	0.10	N	176	53.00	W
	Cape Moffett Is	51	55.69	N	176	53.00	W
	Cape Moffett Is	51	55.69	N	176	48.59	W
	Cape Moffett Is	51	57.96	N	176	46.52	W
3	Adak Canyon	51	39.00	N	177	0.00	W
	Adak Canyon	51	39.00	N	177	3.00	W
	Adak Canyon	51	30.00	N	177	3.00	W
	Adak Canyon	51	30.00	N	177	0.00	W
4	Bobrof Is	51	57.35	N	177	19.94	W
	Bobrof Is	51	57.36	N	177	29.11	W
	Bobrof Is	51	51.65	N	177	29.11	W
	Bobrof Is	51	51.71	N	177	19.93	W
5	Ulak Is	51	25.85	N	178	59.00	W
	Ulak Is	51	25.69	N	179	6.00	W
	Ulak Is	51	22.28	N	179	6.00	W
	Ulak Is	51	22.28	N	178	58.95	W
6	Semisopochnoi Is	51	53.10	N	179	53.11	E
	Semisopochnoi Is	51	53.10	N	179	46.55	E
	Semisopochnoi Is	51	48.84	N	179	46.55	E
	Semisopochnoi Is	51	48.89	N	179	53.11	E

Note: Each area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates for each area is connected to the first set of coordinates for the area by a straight line. The projected coordinate system is North American Datum 1983, Albers.

Figure 38 Aleutian Islands Coral Habitat Protection Areas



3.3.2 Aleutian Islands Habitat Conservation Area

Nonpelagic trawl gear fishing is prohibited year-round in the Aleutian Islands Habitat Conservation Area, except for designated areas open to nonpelagic trawl gear. The Aleutian Islands Habitat Conservation Area is defined as the entire Aleutian Islands groundfish management subarea, as defined in 50 CFR 679. Areas open to nonpelagic trawl gear fishing in the Aleutian Islands are delineated by the table below and shown in Figure 39.

Area Number	Name	Latitude			Longitude			Footnote
1	Islands of 4 Mountains North	52	54.00	N	170	18.00	W	
	Islands of 4 Mountains North	52	54.00	N	170	24.00	W	
	Islands of 4 Mountains North	52	42.00	N	170	24.00	W	
	Islands of 4 Mountains North	52	42.00	N	170	18.00	W	
2	Islands of 4 Mountains West	53	12.00	N	170	0.00	W	
	Islands of 4 Mountains West	53	12.00	N	170	12.00	W	
	Islands of 4 Mountains West	53	6.00	N	170	12.00	W	
	Islands of 4 Mountains West	53	6.00	N	170	30.00	W	
	Islands of 4 Mountains West	53	0.00	N	170	30.00	W	
	Islands of 4 Mountains West	53	0.00	N	170	48.00	W	
	Islands of 4 Mountains West	52	54.00	N	170	48.00	W	
	Islands of 4 Mountains West	52	54.00	N	170	54.00	W	
	Islands of 4 Mountains West	52	48.00	N	170	54.00	W	
	Islands of 4 Mountains West	52	48.00	N	170	30.00	W	
	Islands of 4 Mountains West	52	54.00	N	170	30.00	W	
	Islands of 4 Mountains West	52	54.00	N	170	24.00	W	
	Islands of 4 Mountains West	53	0.00	N	170	24.00	W	
	Islands of 4 Mountains West	53	0.00	N	170	0.00	W	
3	Yunaska I South	52	24.00	N	170	30.00	W	
	Yunaska I South	52	24.00	N	170	54.00	W	
	Yunaska I South	52	12.00	N	170	54.00	W	
	Yunaska I South	52	12.00	N	170	30.00	W	
4	Amukta I North	52	54.00	N	171	6.00	W	
	Amukta I North	52	54.00	N	171	30.00	W	
	Amukta I North	52	48.00	N	171	30.00	W	
	Amukta I North	52	48.00	N	171	36.00	W	
	Amukta I North	52	42.00	N	171	36.00	W	
	Amukta I North	52	42.00	N	171	12.00	W	
	Amukta I North	52	48.00	N	171	12.00	W	
	Amukta I North	52	48.00	N	171	6.00	W	
5	Amukta Pass North	52	42.00	N	171	42.00	W	
	Amukta Pass North	52	42.00	N	172	6.00	W	
	Amukta Pass North	52	36.00	N	172	6.00	W	
	Amukta Pass North	52	36.00	N	171	42.00	W	
6	Amlia North/Seguam	52	42.00	N	172	12.00	W	
	Amlia North/Seguam	52	42.00	N	172	30.00	W	
	Amlia North/Seguam	52	30.00	N	172	30.00	W	

Area Number	Name	Latitude			Longitude			Footnote
	Amlia North/Seguam	52	30.00	N	172	36.00	W	
	Amlia North/Seguam	52	36.00	N	172	36.00	W	
	Amlia North/Seguam	52	36.00	N	172	42.00	W	
	Amlia North/Seguam	52	39.00	N	172	42.00	W	
	Amlia North/Seguam	52	39.00	N	173	24.00	W	
	Amlia North/Seguam	52	36.00	N	173	30.00	W	
	Amlia North/Seguam	52	36.00	N	173	36.00	W	
	Amlia North/Seguam	52	30.00	N	173	36.00	W	
	Amlia North/Seguam	52	30.00	N	174	0.00	W	
	Amlia North/Seguam	52	27.00	N	174	0.00	W	
	Amlia North/Seguam	52	27.00	N	174	6.00	W	
	Amlia North/Seguam	52	23.93	N	174	6.00	W	1
	Amlia North/Seguam	52	13.71	N	174	6.00	W	
	Amlia North/Seguam	52	12.00	N	174	6.00	W	
	Amlia North/Seguam	52	12.00	N	174	0.00	W	
	Amlia North/Seguam	52	9.00	N	174	0.00	W	
	Amlia North/Seguam	52	9.00	N	173	0.00	W	
	Amlia North/Seguam	52	6.00	N	173	0.00	W	
	Amlia North/Seguam	52	6.00	N	172	45.00	W	
	Amlia North/Seguam	51	54.00	N	172	45.00	W	
	Amlia North/Seguam	51	54.00	N	171	48.00	W	
	Amlia North/Seguam	51	48.00	N	171	48.00	W	
	Amlia North/Seguam	51	48.00	N	171	42.00	W	
	Amlia North/Seguam	51	54.00	N	171	42.00	W	
	Amlia North/Seguam	52	12.00	N	171	42.00	W	
	Amlia North/Seguam	52	12.00	N	171	48.00	W	
	Amlia North/Seguam	52	18.00	N	171	48.00	W	
	Amlia North/Seguam	52	18.00	N	171	42.00	W	
	Amlia North/Seguam	52	30.00	N	171	42.00	W	
	Amlia North/Seguam	52	30.00	N	171	54.00	W	
	Amlia North/Seguam	52	24.00	N	171	54.00	W	
	Amlia North/Seguam	52	24.00	N	172	0.00	W	
	Amlia North/Seguam	52	12.00	N	172	0.00	W	
	Amlia North/Seguam	52	12.00	N	172	42.00	W	
	Amlia North/Seguam	52	18.00	N	172	42.00	W	
	Amlia North/Seguam	52	18.00	N	172	37.13	W	2
	Amlia North/Seguam	52	18.64	N	172	36.00	W	
	Amlia North/Seguam	52	24.00	N	172	36.00	W	
	Amlia North/Seguam	52	24.00	N	172	12.00	W	6

Area Number	Name	Latitude			Longitude			Footnote
	Amlia North/Seguam donut	52	33.00	N	172	42.00	W	5,7
	Amlia North/Seguam donut	52	33.00	N	173	6.00	W	
	Amlia North/Seguam donut	52	30.00	N	173	6.00	W	
	Amlia North/Seguam donut	52	30.00	N	173	18.00	W	
	Amlia North/Seguam donut	52	24.00	N	173	18.00	W	
	Amlia North/Seguam donut	52	24.00	N	172	48.00	W	
	Amlia North/Seguam donut	52	30.00	N	172	48.00	W	
	Amlia North/Seguam donut	52	30.00	N	172	42.00	W	
7	Atka/Amlia South	52	0.00	N	173	18.00	W	
	Atka/Amlia South	52	0.00	N	173	54.00	W	
	Atka/Amlia South	52	3.08	N	173	54.00	W	2
	Atka/Amlia South	52	6.00	N	173	58.00	W	
	Atka/Amlia South	52	6.00	N	174	6.00	W	
	Atka/Amlia South	52	0.00	N	174	18.00	W	
	Atka/Amlia South	52	0.00	N	174	12.00	W	
	Atka/Amlia South	51	54.00	N	174	12.00	W	
	Atka/Amlia South	51	54.00	N	174	18.00	W	
	Atka/Amlia South	52	6.00	N	174	18.00	W	
	Atka/Amlia South	52	6.00	N	174	21.86	W	1
	Atka/Amlia South	52	4.39	N	174	30.00	W	
	Atka/Amlia South	52	3.09	N	174	30.00	W	1
	Atka/Amlia South	52	2.58	N	174	30.00	W	
	Atka/Amlia South	52	0.00	N	174	30.00	W	
	Atka/Amlia South	52	0.00	N	174	36.00	W	
	Atka/Amlia South	51	54.00	N	174	36.00	W	
	Atka/Amlia South	51	54.00	N	174	54.00	W	
	Atka/Amlia South	51	48.00	N	174	54.00	W	
	Atka/Amlia South	51	48.00	N	173	24.00	W	
	Atka/Amlia South	51	54.00	N	173	24.00	W	
	Atka/Amlia South	51	54.00	N	173	18.00	W	
8	Atka I North	52	30.00	N	174	24.00	W	
	Atka I North	52	30.00	N	174	30.00	W	
	Atka I North	52	24.00	N	174	30.00	W	
	Atka I North	52	24.00	N	174	48.00	W	
	Atka I North	52	18.00	N	174	48.00	W	
	Atka I North	52	18.00	N	174	54.00	W	
	Atka I North	52	12.00	N	174	54.00	W	
	Atka I North	52	12.00	N	175	18.00	W	
	Atka I North	52	1.14	N	175	18.00	W	1
	Atka I North	52	2.19	N	175	12.00	W	
	Atka I North	52	6.00	N	175	12.00	W	
	Atka I North	52	6.00	N	174	55.51	W	1
	Atka I North	52	6.00	N	174	54.04	W	
	Atka I North	52	6.00	N	174	48.00	W	

Area Number	Name	Latitude			Longitude			Footnote
	Atka I North	52	12.00	N	174	48.00	W	
	Atka I North	52	12.00	N	174	26.85	W	1
	Atka I North	52	12.94	N	174	18.00	W	
	Atka I North	52	16.80	N	174	18.00	W	1
	Atka I North	52	17.06	N	174	18.00	W	
	Atka I North	52	17.64	N	174	18.00	W	1
	Atka I North	52	18.00	N	174	19.12	W	
	Atka I North	52	18.00	N	174	20.04	W	1
	Atka I North	52	19.37	N	174	24.00	W	
9	Atka I South	52	0.68	N	175	12.00	W	2
	Atka I South	52	0.76	N	175	18.00	W	
	Atka I South	52	0.00	N	175	18.00	W	
	Atka I South	52	0.00	N	175	12.00	W	
10	Adak I East	52	12.00	N	176	36.00	W	
	Adak I East	52	12.00	N	176	0.00	W	
	Adak I East	52	2.59	N	176	0.00	W	1
	Adak I East	52	1.79	N	176	0.00	W	
	Adak I East	52	0.00	N	176	0.00	W	
	Adak I East	52	0.00	N	175	48.00	W	
	Adak I East	51	57.74	N	175	48.00	W	1
	Adak I East	51	55.48	N	175	48.00	W	
	Adak I East	51	54.00	N	175	48.00	W	
	Adak I East	51	54.00	N	176	0.00	W	1
	Adak I East	51	53.09	N	176	6.00	W	
	Adak I East	51	51.40	N	176	6.00	W	1
	Adak I East	51	49.67	N	176	6.00	W	
	Adak I East	51	48.73	N	176	6.00	W	1
	Adak I East	51	48.00	N	176	6.36	W	
	Adak I East	51	48.00	N	176	9.82	W	1
	Adak I East	51	48.00	N	176	9.99	W	
	Adak I East	51	48.00	N	176	16.19	W	1
	Adak I East	51	48.00	N	176	24.71	W	
	Adak I East	51	48.00	N	176	25.71	W	1
	Adak I East	51	45.58	N	176	30.00	W	
	Adak I East	51	42.00	N	176	30.00	W	
	Adak I East	51	42.00	N	176	33.92	W	1
	Adak I East	51	41.22	N	176	42.00	W	
	Adak I East	51	30.00	N	176	42.00	W	
	Adak I East	51	30.00	N	176	36.00	W	
	Adak I East	51	36.00	N	176	36.00	W	
	Adak I East	51	36.00	N	176	0.00	W	
	Adak I East	51	42.00	N	176	0.00	W	
	Adak I East	51	42.00	N	175	36.00	W	
	Adak I East	51	48.00	N	175	36.00	W	
	Adak I East	51	48.00	N	175	18.00	W	

Area Number	Name	Latitude			Longitude			Footnote
	Adak I East	51	51.00	N	175	18.00	W	
	Adak I East	51	51.00	N	175	0.00	W	
	Adak I East	51	57.00	N	175	0.00	W	
	Adak I East	51	57.00	N	175	18.00	W	
	Adak I East	52	0.00	N	175	18.00	W	
	Adak I East	52	0.00	N	175	30.00	W	
	Adak I East	52	3.00	N	175	30.00	W	
	Adak I East	52	3.00	N	175	36.00	W	
11	Cape Adagdak	52	6.00	N	176	12.44	W	
	Cape Adagdak	52	6.00	N	176	30.00	W	
	Cape Adagdak	52	3.00	N	176	30.00	W	
	Cape Adagdak	52	3.00	N	176	42.00	W	
	Cape Adagdak	52	0.00	N	176	42.00	W	
	Cape Adagdak	52	0.00	N	176	46.64	W	
	Cape Adagdak	51	57.92	N	176	46.51	W	1
	Cape Adagdak	51	54.00	N	176	37.07	W	
	Cape Adagdak	51	54.00	N	176	18.00	W	
	Cape Adagdak	52	0.00	N	176	18.00	W	
	Cape Adagdak	52	0.00	N	176	12.00	W	
	Cape Adagdak	52	2.85	N	176	12.00	W	1
	Cape Adagdak	52	4.69	N	176	12.44	W	
12	Cape Kiguga/Round Head	52	0.00	N	176	53.00	W	
	Cape Kiguga/Round Head	52	0.00	N	177	6.00	W	
	Cape Kiguga/Round Head	51	56.06	N	177	6.00	W	1
	Cape Kiguga/Round Head	51	54.00	N	177	2.84	W	
	Cape Kiguga/Round Head	51	54.00	N	176	54.00	W	
	Cape Kiguga/Round Head	51	48.79	N	176	54.00	W	1
	Cape Kiguga/Round Head	51	48.00	N	176	50.35	W	
	Cape Kiguga/Round Head	51	48.00	N	176	43.14	W	1
	Cape Kiguga/Round Head	51	55.69	N	176	48.59	W	
	Cape Kiguga/Round Head	51	55.69	N	176	53.00	W	
13	Adak Strait South	51	42.00	N	176	55.77	W	
	Adak Strait South	51	42.00	N	177	12.00	W	
	Adak Strait South	51	30.00	N	177	12.00	W	
	Adak Strait South	51	36.00	N	177	6.00	W	
	Adak Strait South	51	36.00	N	177	3.00	W	
	Adak Strait South	51	39.00	N	177	3.00	W	
	Adak Strait South	51	39.00	N	177	0.00	W	
	Adak Strait South	51	36.00	N	177	0.00	W	
	Adak Strait South	51	36.00	N	176	57.72	W	3
14	Bay of Waterfalls	51	38.62	N	176	54.00	W	
	Bay of Waterfalls	51	36.00	N	176	54.00	W	
	Bay of Waterfalls	51	36.00	N	176	55.99	W	3
15	Tanaga/Kanaga North	51	54.00	N	177	12.00	W	

Area Number	Name	Latitude			Longitude			Footnote
	Tanaga/Kanaga North	51	54.00	N	177	19.93	W	
	Tanaga/Kanaga North	51	51.71	N	177	19.93	W	
	Tanaga/Kanaga North	51	51.65	N	177	29.11	W	
	Tanaga/Kanaga North	51	54.00	N	177	29.11	W	
	Tanaga/Kanaga North	51	54.00	N	177	30.00	W	
	Tanaga/Kanaga North	51	57.00	N	177	30.00	W	
	Tanaga/Kanaga North	51	57.00	N	177	42.00	W	
	Tanaga/Kanaga North	51	54.00	N	177	42.00	W	
	Tanaga/Kanaga North	51	54.00	N	177	54.00	W	
	Tanaga/Kanaga North	51	50.92	N	177	54.00	W	1
	Tanaga/Kanaga North	51	48.00	N	177	46.44	W	
	Tanaga/Kanaga North	51	48.00	N	177	42.00	W	
	Tanaga/Kanaga North	51	42.59	N	177	42.00	W	1
	Tanaga/Kanaga North	51	45.57	N	177	24.01	W	
	Tanaga/Kanaga North	51	48.00	N	177	24.00	W	
	Tanaga/Kanaga North	51	48.00	N	177	14.08	W	4
16	Tanaga/Kanaga South	51	43.78	N	177	24.04	W	1
	Tanaga/Kanaga South	51	42.37	N	177	42.00	W	
	Tanaga/Kanaga South	51	42.00	N	177	42.00	W	
	Tanaga/Kanaga South	51	42.00	N	177	50.04	W	1
	Tanaga/Kanaga South	51	40.91	N	177	54.00	W	
	Tanaga/Kanaga South	51	36.00	N	177	54.00	W	
	Tanaga/Kanaga South	51	36.00	N	178	0.00	W	
	Tanaga/Kanaga South	51	38.62	N	178	0.00	W	1
	Tanaga/Kanaga South	51	42.52	N	178	6.00	W	
	Tanaga/Kanaga South	51	49.34	N	178	6.00	W	1
	Tanaga/Kanaga South	51	51.35	N	178	12.00	W	
	Tanaga/Kanaga South	51	48.00	N	178	12.00	W	
	Tanaga/Kanaga South	51	48.00	N	178	30.00	W	
	Tanaga/Kanaga South	51	42.00	N	178	30.00	W	
	Tanaga/Kanaga South	51	42.00	N	178	36.00	W	
	Tanaga/Kanaga South	51	36.26	N	178	36.00	W	1
	Tanaga/Kanaga South	51	35.75	N	178	36.00	W	
	Tanaga/Kanaga South	51	27.00	N	178	36.00	W	
	Tanaga/Kanaga South	51	27.00	N	178	42.00	W	
	Tanaga/Kanaga South	51	21.00	N	178	42.00	W	
	Tanaga/Kanaga South	51	21.00	N	178	24.00	W	
	Tanaga/Kanaga South	51	24.00	N	178	24.00	W	
	Tanaga/Kanaga South	51	24.00	N	178	12.00	W	
	Tanaga/Kanaga South	51	30.00	N	178	12.00	W	
	Tanaga/Kanaga South	51	30.00	N	177	24.00	W	
17	Amchitka Pass East	51	42.00	N	178	48.00	W	
	Amchitka Pass East	51	42.00	N	179	18.00	W	
	Amchitka Pass East	51	45.00	N	179	18.00	W	

Area Number	Name	Latitude			Longitude			Footnote
	Amchitka Pass East	51	45.00	N	179	36.00	W	
	Amchitka Pass East	51	42.00	N	179	36.00	W	
	Amchitka Pass East	51	42.00	N	179	39.00	W	
	Amchitka Pass East	51	30.00	N	179	39.00	W	
	Amchitka Pass East	51	30.00	N	179	36.00	W	
	Amchitka Pass East	51	18.00	N	179	36.00	W	
	Amchitka Pass East	51	18.00	N	179	24.00	W	
	Amchitka Pass East	51	30.00	N	179	24.00	W	
	Amchitka Pass East	51	30.00	N	179	0.00	W	
	Amchitka Pass East	51	25.82	N	179	0.00	W	
	Amchitka Pass East	51	25.85	N	178	59.00	W	
	Amchitka Pass East	51	24.00	N	178	58.97	W	
	Amchitka Pass East	51	24.00	N	178	54.00	W	
	Amchitka Pass East	51	30.00	N	178	54.00	W	
	Amchitka Pass East	51	30.00	N	178	48.00	W	
	Amchitka Pass East	51	32.69	N	178	48.00	W	1
	Amchitka Pass East	51	33.95	N	178	48.00	W	
18	Amatignak I	51	18.00	N	178	54.00	W	
	Amatignak I	51	18.00	N	179	5.30	W	1
	Amatignak I	51	18.00	N	179	6.75	W	
	Amatignak I	51	18.00	N	179	12.00	W	
	Amatignak I	51	6.00	N	179	12.00	W	
	Amatignak I	51	6.00	N	179	0.00	W	
	Amatignak I	51	12.00	N	179	0.00	W	
	Amatignak I	51	12.00	N	178	54.00	W	
19	Amchitka Pass Center	51	30.00	N	179	48.00	W	
	Amchitka Pass Center	51	30.00	N	180	0.00	W	
	Amchitka Pass Center	51	24.00	N	180	0.00	W	
	Amchitka Pass Center	51	24.00	N	179	48.00	W	
20	Amchitka Pass West	51	36.00	N	179	54.00	E	
	Amchitka Pass West	51	36.00	N	179	36.00	E	
	Amchitka Pass West	51	30.00	N	179	36.00	E	
	Amchitka Pass West	51	30.00	N	179	45.00	E	
	Amchitka Pass West	51	27.00	N	179	48.00	E	
	Amchitka Pass West	51	24.00	N	179	48.00	E	
	Amchitka Pass West	51	24.00	N	179	54.00	E	
21	Petrel Bank	52	51.00	N	179	12.00	W	
	Petrel Bank	52	51.00	N	179	24.00	W	
	Petrel Bank	52	48.00	N	179	24.00	W	
	Petrel Bank	52	48.00	N	179	30.00	W	
	Petrel Bank	52	42.00	N	179	30.00	W	
	Petrel Bank	52	42.00	N	179	36.00	W	
	Petrel Bank	52	36.00	N	179	36.00	W	
	Petrel Bank	52	36.00	N	179	48.00	W	

Area Number	Name	Latitude			Longitude			Footnote
	Petrel Bank	52	30.00	N	179	48.00	W	
	Petrel Bank	52	30.00	N	179	42.00	E	
	Petrel Bank	52	24.00	N	179	42.00	E	
	Petrel Bank	52	24.00	N	179	36.00	E	
	Petrel Bank	52	12.00	N	179	36.00	E	
	Petrel Bank	52	12.00	N	179	36.00	W	
	Petrel Bank	52	24.00	N	179	36.00	W	
	Petrel Bank	52	24.00	N	179	30.00	W	
	Petrel Bank	52	30.00	N	179	30.00	W	
	Petrel Bank	52	30.00	N	179	24.00	W	
	Petrel Bank	52	36.00	N	179	24.00	W	
	Petrel Bank	52	36.00	N	179	18.00	W	
	Petrel Bank	52	42.00	N	179	18.00	W	
	Petrel Bank	52	42.00	N	179	12.00	W	
22	Rat I/Amchitka I South	51	21.00	N	179	36.00	E	
	Rat I/Amchitka I South	51	21.00	N	179	18.00	E	
	Rat I/Amchitka I South	51	18.00	N	179	18.00	E	
	Rat I/Amchitka I South	51	18.00	N	179	12.00	E	
	Rat I/Amchitka I South	51	23.77	N	179	12.00	E	1
	Rat I/Amchitka I South	51	24.00	N	179	10.20	E	
	Rat I/Amchitka I South	51	24.00	N	179	0.00	E	
	Rat I/Amchitka I South	51	36.00	N	178	36.00	E	
	Rat I/Amchitka I South	51	36.00	N	178	24.00	E	
	Rat I/Amchitka I South	51	42.00	N	178	24.00	E	
	Rat I/Amchitka I South	51	42.00	N	178	6.00	E	
	Rat I/Amchitka I South	51	48.00	N	178	6.00	E	
	Rat I/Amchitka I South	51	48.00	N	177	54.00	E	
	Rat I/Amchitka I South	51	54.00	N	177	54.00	E	
	Rat I/Amchitka I South	51	54.00	N	178	12.00	E	
	Rat I/Amchitka I South	51	48.00	N	178	12.00	E	
	Rat I/Amchitka I South	51	48.00	N	178	17.09	E	1
	Rat I/Amchitka I South	51	48.00	N	178	20.60	E	
	Rat I/Amchitka I South	51	48.00	N	178	24.00	E	
	Rat I/Amchitka I South	52	6.00	N	178	24.00	E	
	Rat I/Amchitka I South	52	6.00	N	178	12.00	E	
	Rat I/Amchitka I South	52	0.00	N	178	12.00	E	
	Rat I/Amchitka I South	52	0.00	N	178	11.01	E	1
	Rat I/Amchitka I South	52	0.00	N	178	5.99	E	
	Rat I/Amchitka I South	52	0.00	N	177	54.00	E	
	Rat I/Amchitka I South	52	9.00	N	177	54.00	E	
	Rat I/Amchitka I South	52	9.00	N	177	42.00	E	
	Rat I/Amchitka I South	52	0.00	N	177	42.00	E	
	Rat I/Amchitka I South	52	0.00	N	177	48.00	E	
	Rat I/Amchitka I South	51	54.00	N	177	48.00	E	

Area Number	Name	Latitude			Longitude			Footnote
	Rat I/Amchitka I South	51	54.00	N	177	30.00	E	
	Rat I/Amchitka I South	51	51.00	N	177	30.00	E	
	Rat I/Amchitka I South	51	51.00	N	177	24.00	E	
	Rat I/Amchitka I South	51	45.00	N	177	24.00	E	
	Rat I/Amchitka I South	51	45.00	N	177	30.00	E	
	Rat I/Amchitka I South	51	48.00	N	177	30.00	E	
	Rat I/Amchitka I South	51	48.00	N	177	42.00	E	
	Rat I/Amchitka I South	51	42.00	N	177	42.00	E	
	Rat I/Amchitka I South	51	42.00	N	178	0.00	E	
	Rat I/Amchitka I South	51	39.00	N	178	0.00	E	
	Rat I/Amchitka I South	51	39.00	N	178	12.00	E	
	Rat I/Amchitka I South	51	36.00	N	178	12.00	E	
	Rat I/Amchitka I South	51	36.00	N	178	18.00	E	
	Rat I/Amchitka I South	51	30.00	N	178	18.00	E	
	Rat I/Amchitka I South	51	30.00	N	178	24.00	E	
	Rat I/Amchitka I South	51	24.00	N	178	24.00	E	
	Rat I/Amchitka I South	51	24.00	N	178	36.00	E	
	Rat I/Amchitka I South	51	30.00	N	178	36.00	E	
	Rat I/Amchitka I South	51	24.00	N	178	48.00	E	
	Rat I/Amchitka I South	51	18.00	N	178	48.00	E	
	Rat I/Amchitka I South	51	18.00	N	178	54.00	E	
	Rat I/Amchitka I South	51	12.00	N	178	54.00	E	
	Rat I/Amchitka I South	51	12.00	N	179	30.00	E	
	Rat I/Amchitka I South	51	18.00	N	179	30.00	E	
	Rat I/Amchitka I South	51	18.00	N	179	36.00	E	
23	Amchitka I North	51	42.00	N	179	12.00	E	
	Amchitka I North	51	42.00	N	178	57.00	E	
	Amchitka I North	51	36.00	N	178	56.99	E	
	Amchitka I North	51	36.00	N	179	0.00	E	
	Amchitka I North	51	33.62	N	179	0.00	E	2
	Amchitka I North	51	30.00	N	179	5.00	E	
	Amchitka I North	51	30.00	N	179	18.00	E	
	Amchitka I North	51	36.00	N	179	18.00	E	
	Amchitka I North	51	36.00	N	179	12.00	E	
24	Pillar Rk	52	9.00	N	177	30.00	E	
	Pillar Rk	52	9.00	N	177	18.00	E	
	Pillar Rk	52	6.00	N	177	18.00	E	
	Pillar Rk	52	6.00	N	177	30.00	E	
25	Murray Canyon	51	48.00	N	177	12.00	E	
	Murray Canyon	51	48.00	N	176	48.00	E	
	Murray Canyon	51	36.00	N	176	48.00	E	
	Murray Canyon	51	36.00	N	177	0.00	E	
	Murray Canyon	51	39.00	N	177	0.00	E	

Area Number	Name	Latitude			Longitude			Footnote
	Murray Canyon	51	39.00	N	177	6.00	E	
	Murray Canyon	51	42.00	N	177	6.00	E	
	Murray Canyon	51	42.00	N	177	12.00	E	
26	Buldir	52	6.00	N	177	12.00	E	
	Buldir	52	6.00	N	177	0.01	E	
	Buldir	52	6.00	N	177	0.00	E	
	Buldir	52	12.00	N	177	0.00	E	
	Buldir	52	12.00	N	176	54.00	E	
	Buldir	52	9.00	N	176	54.00	E	
	Buldir	52	9.00	N	176	48.00	E	
	Buldir	52	0.00	N	176	48.00	E	
	Buldir	52	0.00	N	176	36.00	E	
	Buldir	52	6.00	N	176	36.00	E	
	Buldir	52	6.00	N	176	24.00	E	
	Buldir	52	12.00	N	176	24.00	E	
	Buldir	52	12.00	N	176	12.00	E	
	Buldir	52	18.00	N	176	12.00	E	
	Buldir	52	18.00	N	176	30.00	E	
	Buldir	52	24.00	N	176	30.00	E	
	Buldir	52	24.00	N	176	0.00	E	
	Buldir	52	18.00	N	176	0.00	E	
	Buldir	52	18.00	N	175	54.00	E	
	Buldir	52	20.79	N	175	54.00	E	1
	Buldir	52	22.38	N	175	54.00	E	
	Buldir	52	24.00	N	175	54.00	E	
	Buldir	52	24.00	N	175	48.00	E	
	Buldir	52	30.00	N	175	48.00	E	
	Buldir	52	30.00	N	175	36.00	E	
	Buldir	52	36.00	N	175	36.00	E	
	Buldir	52	36.00	N	175	24.00	E	
	Buldir	52	24.00	N	175	24.00	E	
	Buldir	52	24.00	N	175	30.00	E	
	Buldir	52	18.00	N	175	30.00	E	
	Buldir	52	18.00	N	175	36.00	E	
	Buldir	52	24.00	N	175	36.00	E	
	Buldir	52	24.00	N	175	42.00	E	
	Buldir	52	12.00	N	175	54.00	E	
	Buldir	52	6.00	N	175	54.00	E	
	Buldir	52	6.00	N	175	48.00	E	
	Buldir	52	0.00	N	175	48.00	E	
	Buldir	52	0.00	N	175	54.00	E	
	Buldir	51	54.00	N	175	54.00	E	
	Buldir	51	54.00	N	175	36.00	E	

Area Number	Name	Latitude			Longitude			Footnote
	Buldir	51	42.00	N	175	36.00	E	
	Buldir	51	42.00	N	175	30.00	E	
	Buldir	51	36.00	N	175	30.00	E	
	Buldir	51	36.00	N	175	36.00	E	
	Buldir	51	30.00	N	175	36.00	E	
	Buldir	51	30.00	N	175	42.00	E	
	Buldir	51	36.00	N	175	42.00	E	
	Buldir	51	36.00	N	176	0.00	E	
	Buldir	52	0.00	N	176	0.00	E	
	Buldir	52	0.00	N	176	6.00	E	
	Buldir	52	6.00	N	176	6.00	E	
	Buldir	52	6.00	N	176	12.00	E	
	Buldir	52	0.00	N	176	12.00	E	
	Buldir	52	0.00	N	176	30.00	E	
	Buldir	51	54.00	N	176	30.00	E	
	Buldir	51	54.00	N	177	0.00	E	
	Buldir	52	0.00	N	177	0.00	E	
	Buldir	52	0.00	N	177	0.01	E	
	Buldir	52	0.00	N	177	12.00	E	6
	Buldir donut	51	48.00	N	175	48.00	E	5, 7
	Buldir donut	51	48.00	N	175	42.00	E	
	Buldir donut	51	45.00	N	175	42.00	E	
	Buldir donut	51	45.00	N	175	48.00	E	
27	Buldir Mound	51	54.00	N	176	24.00	E	
	Buldir Mound	51	54.00	N	176	18.00	E	
	Buldir Mound	51	48.00	N	176	18.00	E	
	Buldir Mound	51	48.00	N	176	24.00	E	
28	Tahoma Canyon	52	0.00	N	175	18.00	E	
	Tahoma Canyon	52	0.00	N	175	12.00	E	
	Tahoma Canyon	51	42.00	N	175	12.00	E	
	Tahoma Canyon	51	42.00	N	175	24.00	E	
	Tahoma Canyon	51	54.00	N	175	24.00	E	
	Tahoma Canyon	51	54.00	N	175	18.00	E	
29	Walls Plateau	52	24.00	N	175	24.00	E	
	Walls Plateau	52	24.00	N	175	12.00	E	
	Walls Plateau	52	18.00	N	175	12.00	E	
	Walls Plateau	52	18.00	N	175	0.00	E	
	Walls Plateau	52	12.00	N	175	0.00	E	
	Walls Plateau	52	12.00	N	174	42.00	E	
	Walls Plateau	52	6.00	N	174	42.00	E	
	Walls Plateau	52	6.00	N	174	36.00	E	
	Walls Plateau	52	0.00	N	174	36.00	E	
	Walls Plateau	52	0.00	N	174	42.00	E	

Area Number	Name	Latitude			Longitude			Footnote
	Walls Plateau	51	54.00	N	174	42.00	E	
	Walls Plateau	51	54.00	N	174	48.00	E	
	Walls Plateau	52	0.00	N	174	48.00	E	
	Walls Plateau	52	0.00	N	174	54.00	E	
	Walls Plateau	52	6.00	N	174	54.00	E	
	Walls Plateau	52	6.00	N	175	18.00	E	
	Walls Plateau	52	12.00	N	175	24.00	E	
30	Semichi I	52	30.00	N	175	6.00	E	
	Semichi I	52	30.00	N	175	0.00	E	
	Semichi I	52	36.00	N	175	0.00	E	
	Semichi I	52	36.00	N	174	48.00	E	
	Semichi I	52	42.00	N	174	48.00	E	
	Semichi I	52	42.00	N	174	33.00	E	
	Semichi I	52	36.00	N	174	33.00	E	
	Semichi I	52	36.00	N	174	24.00	E	
	Semichi I	52	39.00	N	174	24.00	E	
	Semichi I	52	39.00	N	174	0.00	E	
	Semichi I	52	42.00	N	173	54.00	E	
	Semichi I	52	45.16	N	173	54.00	E	1
	Semichi I	52	46.35	N	173	54.00	E	
	Semichi I	52	54.00	N	173	54.00	E	
	Semichi I	52	54.00	N	173	30.00	E	
	Semichi I	52	48.00	N	173	30.00	E	
	Semichi I	52	48.00	N	173	36.00	E	
	Semichi I	52	36.00	N	173	36.00	E	
	Semichi I	52	36.00	N	173	54.00	E	
	Semichi I	52	18.00	N	173	54.00	E	
	Semichi I	52	18.00	N	174	30.00	E	
	Semichi I	52	30.00	N	174	30.00	E	
	Semichi I	52	30.00	N	174	48.00	E	
	Semichi I	52	24.00	N	174	48.00	E	
	Semichi I	52	24.00	N	175	6.00	E	
31	Agattu South	52	18.00	N	173	54.00	E	
	Agattu South	52	18.00	N	173	24.00	E	
	Agattu South	52	9.00	N	173	24.00	E	
	Agattu South	52	9.00	N	173	36.00	E	
	Agattu South	52	6.00	N	173	36.00	E	
	Agattu South	52	6.00	N	173	54.00	E	
32	Attu I North	53	3.00	N	173	24.00	E	
	Attu I North	53	3.00	N	173	6.00	E	
	Attu I North	53	0.00	N	173	6.00	E	
	Attu I North	53	0.00	N	173	24.00	E	
33	Attu I West	52	54.00	N	172	12.00	E	

Area Number	Name	Latitude			Longitude			Footnote
	Attu I West	52	54.00	N	172	0.00	E	
	Attu I West	52	48.00	N	172	0.00	E	
	Attu I West	52	48.00	N	172	12.00	E	
34	Stalemate Bank	53	0.00	N	171	6.00	E	
	Stalemate Bank	53	0.00	N	170	42.00	E	
	Stalemate Bank	52	54.00	N	170	42.00	E	
	Stalemate Bank	52	54.00	N	171	6.00	E	

Note: Unless otherwise footnoted, each area is delineated by connecting in order the coordinates listed by straight lines. Except for the Amlia North/Seguam donut and the Buldir donut, each area delineated in the table is open to nonpelagic trawl gear fishing. The remainder of the entire Aleutian Islands subarea and the areas delineated by the coordinates for the Amlia North/Seguam and Buldir donuts are closed to nonpelagic trawl gear fishing, as specified at § 679.22. Unless otherwise noted, the last set of coordinates for each area is connected to the first set of coordinates for the area by a straight line. The projected coordinate system is North American Datum 1983, Albers.

[1]The connection of these coordinates to the next set of coordinates is by a line extending in a clockwise direction from these coordinates along the shoreline at mean lower-low water to the next set of coordinates.
[2]The connection of these coordinates to the next set of coordinates is by a line extending in a counter clockwise direction from these coordinates along the shoreline at mean lower-low water to the next set of coordinates.
[3]The connection of these coordinates to the first set of coordinates for this area is by a line extending in a clockwise direction from these coordinates along the shoreline at mean lower-low water to the first set of coordinates.
[4]The connection of these coordinates to the first set of coordinates for this area is by a line extending in a counter clockwise direction from these coordinates along the shoreline at mean lower-low water to the first set of coordinates.
[5] The area specified by this set of coordinates is closed to fishing with non-pelagic trawl gear.
[6] This set of coordinates is connected to the first set of coordinates listed for the area by a straight line.
[7]The last coordinate for the donut is connected to the first set of coordinates for the donut by a straight line.

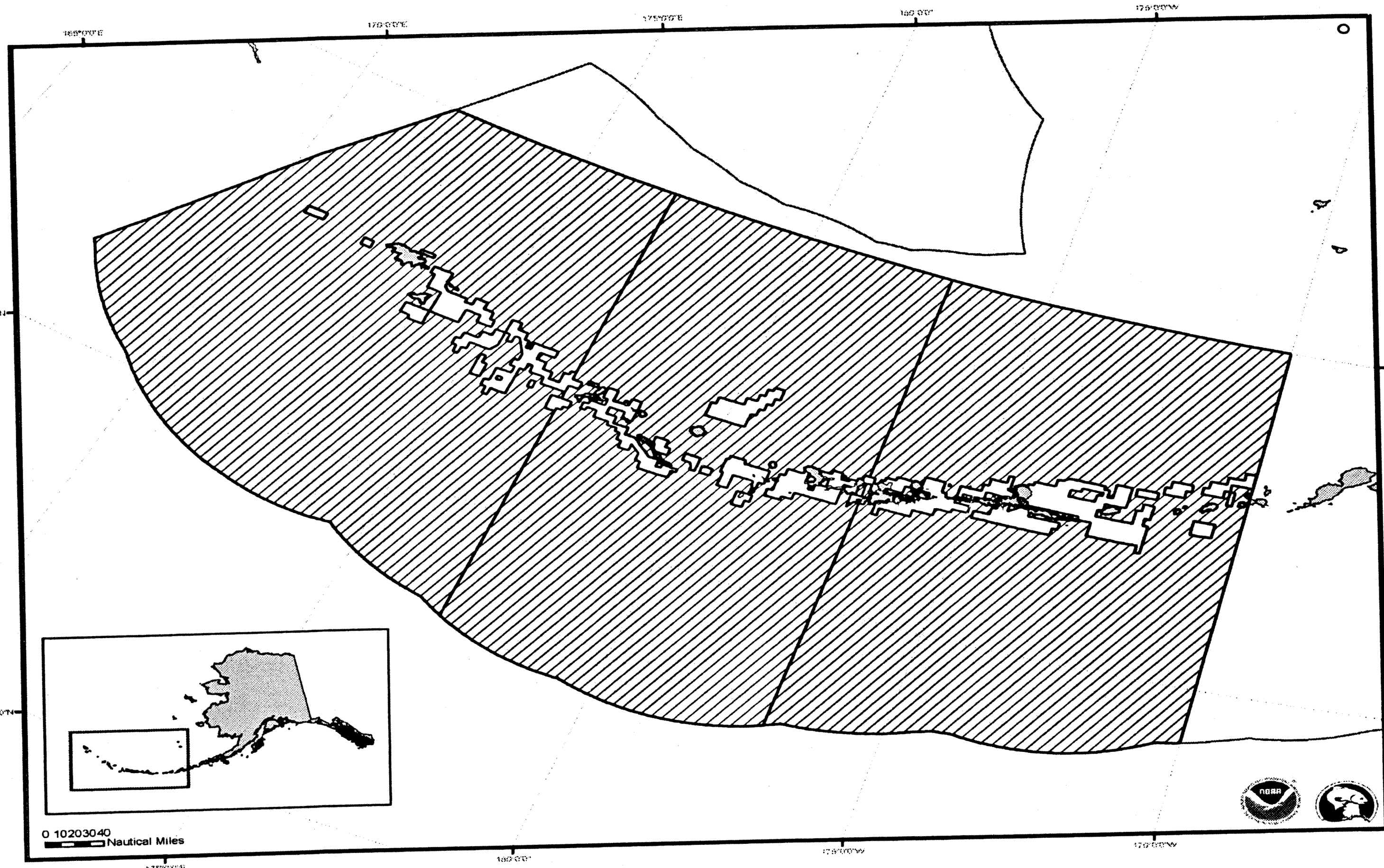


Figure 39 Aleutian Islands Habitat Conservation Area. Polygons are areas open to nonpelagic trawl gear.

3.3.3 GOA Slope Habitat Conservation Areas

Nonpelagic trawl gear fishing is prohibited in the GOA Slope Habitat Conservation Area. Coordinates for the area are listed in the table below. See Figure 40. Note: Each area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates for each area is connected to the first set of coordinates for the area by a straight line. Projected coordinate system is North American Datum 1983, Albers.

Area Number	Name	Latitude			Longitude		
1	Yakutat	58	47.00	N	139	55.00	W
	Yakutat	58	47.00	N	140	32.00	W
	Yakutat	58	37.00	N	140	32.00	W
	Yakutat	58	36.97	N	139	54.99	W
2	Cape Suckling	59	50.00	N	143	20.00	W
	Cape Suckling	59	50.00	N	143	30.00	W
	Cape Suckling	59	40.00	N	143	30.00	W
	Cape Suckling	59	40.00	N	143	20.00	W
3	Kayak Is	59	35.00	N	144	0.00	W
	Kayak Is	59	40.00	N	144	25.00	W
	Kayak Is	59	30.00	N	144	50.00	W
	Kayak Is	59	25.00	N	144	50.00	W
	Kayak Is	59	25.00	N	144	2.00	W
4	Middleton Is east	59	32.31	N	145	29.09	W
	Middleton Is east	59	32.13	N	145	51.14	W
	Middleton Is east	59	20.00	N	145	51.00	W
	Middleton IS east	59	18.85	N	145	29.39	W
5	Middleton Is west	59	14.64	N	146	29.63	W
	Middleton Is west	59	15.00	N	147	0.00	W
	Middleton Is west	59	10.00	N	147	0.00	W
	Middleton Is west	59	8.74	N	146	30.16	W
6	Cable	58	40.00	N	148	0.00	W
	Cable	59	6.28	N	149	0.28	W
	Cable	59	0.00	N	149	0.00	W
	Cable	58	34.91	N	147	59.85	W
7	Albatross Bank	56	16.00	N	152	40.00	W
	Albatross Bank	56	16.00	N	153	20.00	W
	Albatross Bank	56	11.00	N	153	20.00	W
	Albatross Bank	56	10.00	N	152	40.00	W
8	Shumagin Is	54	51.49	N	157	42.52	W
	Shumagin Is	54	40.00	N	158	10.00	W
	Shumagin Is	54	35.00	N	158	10.00	W
	Shumagin Is	54	36.00	N	157	42.00	W
9	Sanak Is	54	12.86	N	162	13.54	W
	Sanak Is	54	0.00	N	163	15.00	W
	Sanak Is	53	53.00	N	163	15.00	W
	Sanak Is	54	5.00	N	162	12.00	W
10	Unalaska Is	53	26.05	N	165	55.55	W
	Unalaska Is	53	6.92	N	167	19.40	W
	Unalaska Is	52	55.71	N	167	18.20	W
	Unalaska Is	53	13.05	N	165	55.55	W

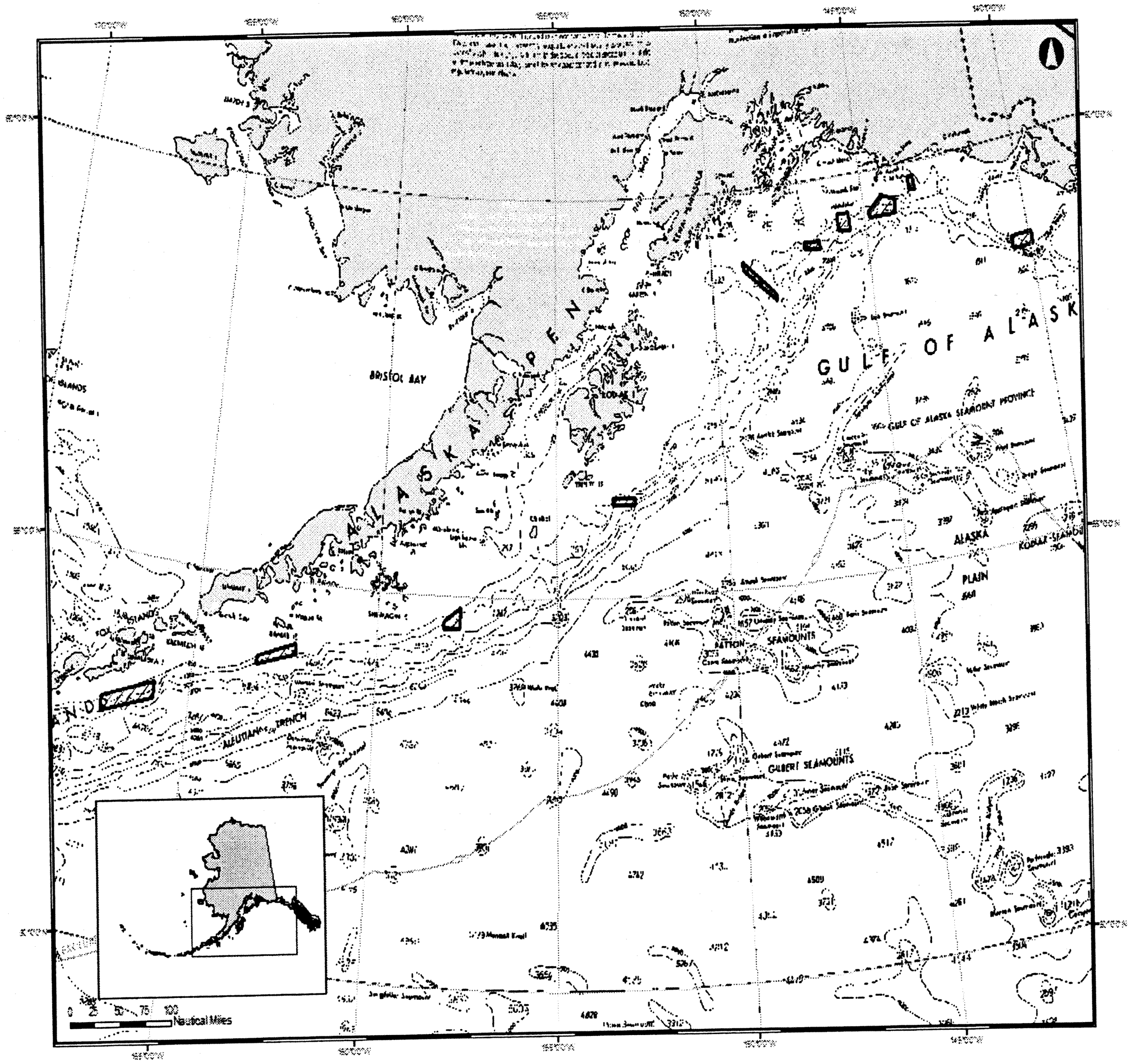


Figure 40 GOA Slope Habitat Conservation Areas are located within the thick line boxes.

3.3.4 Alaska Seamount Habitat Protection Areas

The use of bottom contact gear and anchoring by a federally permitted fishing vessel, as described in 50 CFR part 679, is prohibited year-round in the Alaska Seamount Habitat Protection Areas, see Figure 41. Coordinates for the Alaska Seamount Habitat Protection Areas are listed in the table below.

Area Number	Name	Latitude	Longitude
1	Dickins Seamount	54 39.00 N	136 48.00 W
	Dickins Seamount	54 39.00 N	137 9.00 W
	Dickins Seamount	54 27.00 N	137 9.00 W
	Dickins Seamount	54 27.00 N	136 48.00 W
2	Denson Seamount	54 13.20 N	137 6.00 W
	Denson Seamount	54 13.20 N	137 36.00 W
	Denson Seamount	53 57.00 N	137 36.00 W
	Denson Seamount	53 57.00 N	137 6.00 W
3	Brown Seamount	55 0.00 N	138 24.00 W
	Brown Seamount	55 0.00 N	138 48.00 W
	Brown Seamount	54 48.00 N	138 48.00 W
	Brown Seamount	54 48.00 N	138 24.00 W
4	Welker Seamount	55 13.80 N	140 9.60 W
	Welker Seamount	55 13.80 N	140 33.00 W
	Welker Seamount	55 1.80 N	140 33.00 W
	Welker Seamount	55 1.80 N	140 9.60 W
5	Dall Seamount	58 18.00 N	144 54.00 W
	Dall Seamount	58 18.00 N	145 48.00 W
	Dall Seamount	57 45.00 N	145 48.00 W
	Dall Seamount	57 45.00 N	144 54.00 W
6	Quinn Seamount	56 27.00 N	145 0.00 W
	Quinn Seamount	56 27.00 N	145 24.00 W
	Quinn Seamount	56 12.00 N	145 24.00 W
	Quinn Seamount	56 12.00 N	145 0.00 W
7	Giacomini Seamount	56 37.20 N	146 7.20 W
	Giacomini Seamount	56 37.20 N	146 31.80 W
	Giacomini Seamount	56 25.20 N	146 31.80 W
	Giacomini Seamount	56 25.20 N	146 7.20 W
8	Kodiak Seamount	57 0.00 N	149 6.00 W
	Kodiak Seamount	57 0.00 N	149 30.00 W
	Kodiak Seamount	56 48.00 N	149 30.00 W
	Kodiak Seamount	56 48.00 N	149 6.00 W
9	Odessey Seamount	54 42.00 N	149 30.00 W
	Odessey Seamount	54 42.00 N	150 0.00 W
	Odessey Seamount	54 30.00 N	150 0.00 W
	Odessey Seamount	54 30.00 N	149 30.00 W
10	Patton Seamount	54 43.20 N	150 18.00 W

Area Number	Name	Latitude	Longitude
	Patton Seamount	54 43.20 N	150 36.00 W
	Patton Seamount	54 34.20 N	150 36.00 W
	Patton Seamount	54 34.20 N	150 18.00 W
11	Chirikof & Marchand Seamounts	55 6.00 N	151 0.00 W
	Chirikof & Marchand Seamounts	55 6.00 N	153 42.00 W
	Chirikof & Marchand Seamounts	54 42.00 N	153 42.00 W
	Chirikof & Marchand Seamounts	54 42.00 N	151 0.00 W
12	Sirius Seamount	52 6.00 N	160 36.00 W
	Sirius Seamount	52 6.00 N	161 6.00 W
	Sirius Seamount	51 57.00 N	161 6.00 W
	Sirius Seamount	51 57.00 N	160 36.00 W
13	Derickson Seamount	53 0.00 N	161 0.00 W
	Derickson Seamount	53 0.00 N	161 30.00 W
	Derickson Seamount	52 48.00 N	161 30.00 W
	Derickson Seamount	52 48.00 N	161 0.00 W
14	Unimak Seamount	53 48.00 N	162 18.00 W
	Unimak Seamount	53 48.00 N	162 42.00 W
	Unimak Seamount	53 39.00 N	162 42.00 W
	Unimak Seamount	53 39.00 N	162 18.00 W
15	Bowers Seamount	54 9.00 N	174 52.20 E
	Bowers Seamount	54 9.00 N	174 42.00 E
	Bowers Seamount	54 4.20 N	174 42.00 E
	Bowers Seamount	54 4.20 N	174 52.20 E

Note: The area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates is connected to the first set of coordinates by a straight line. The projected coordinate system is North American Datum 1983, Albers.

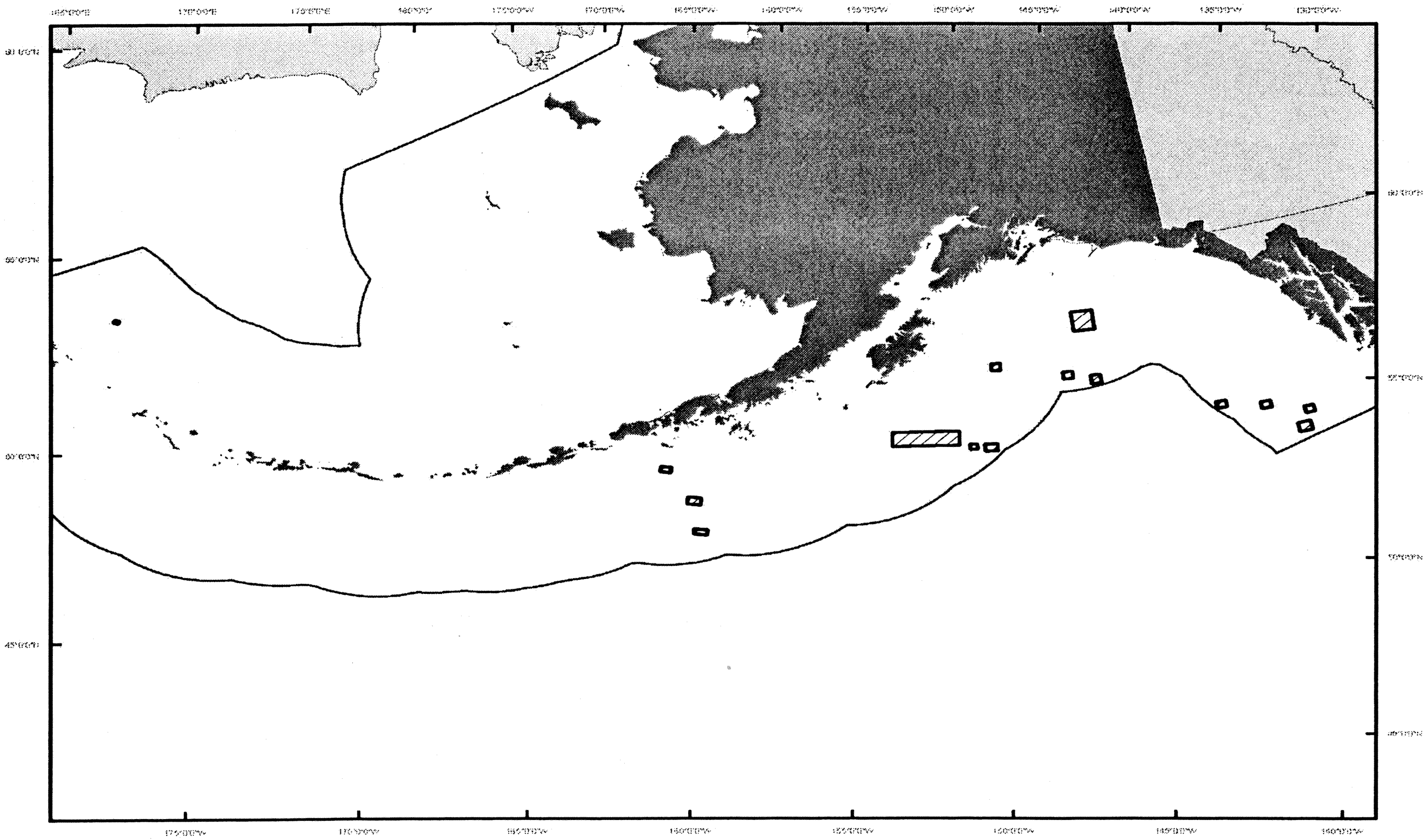


Figure 41 Alaska Seamount Habitat Protection Areas are located within the thick line boxes.

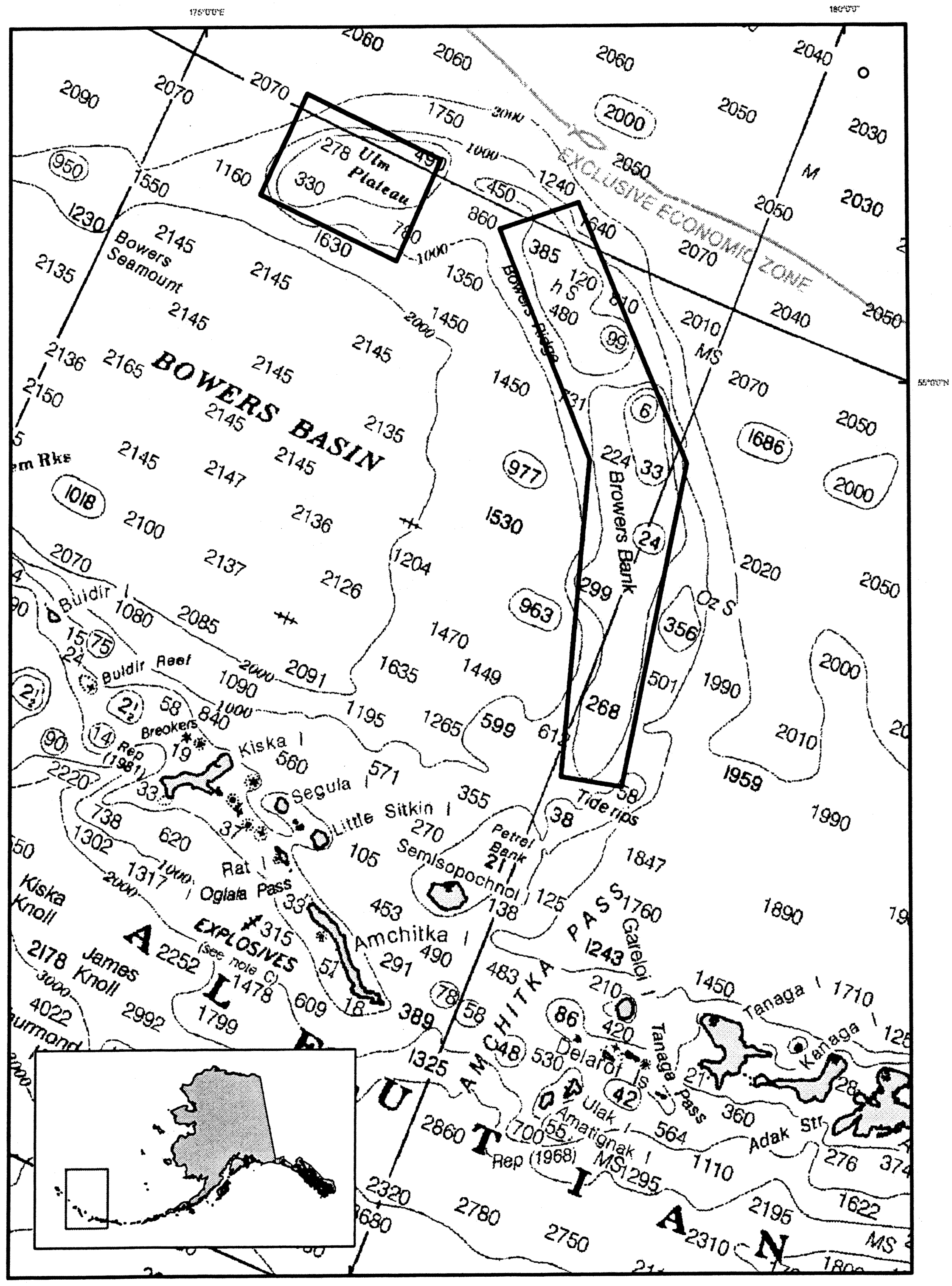
3.3.5 Bowers Ridge Habitat Conservation Zone

The use of mobile bottom contact gear, as described in 50 CFR part 679, is prohibited year-round in the Bowers Ridge Habitat Conservation Zone, see Figure 42. The areas are described in the table below.

Area Number	Name	Latitude			Longitude		
1	Bow ers Ridge	55	10.50	N	178	27.25	E
	Bow ers Ridge	54	54.50	N	177	55.75	E
	Bow ers Ridge	54	5.83	N	179	20.75	E
	Bow ers Ridge	52	40.50	N	179	55.00	W
	Bow ers Ridge	52	44.50	N	179	26.50	W
	Bow ers Ridge	54	15.50	N	179	54.00	W
2	Ulm Plateau	55	5.00	N	177	15.00	E
	Ulm Plateau	55	5.00	N	175	60.00	E
	Ulm Plateau	54	34.00	N	175	60.00	E
	Ulm Plateau	54	34.00	N	177	15.00	E

Note: Each area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates for each area is connected to the first set of coordinates for the area by a straight line. The projected coordinate system is North American Datum 1983, Albers.

Figure 42 Bowers Ridge Habitat Conservation Zone



3.3.6 GOA Coral Habitat Areas of Particular Concern

The coordinates for the GOA Coral Habitat Areas of Particular Concern are listed in the table below. See Figures 43 and 44.

HAPC	Latitude	Longitude
Cape Ommaney	56° 12' 51" N	135° 07' 41" W
	56° 12' 51" N	135° 05' 30" W
	56° 09' 32" N	135° 05' 30" W
	56° 09' 32" N	135° 07' 41" W
Fairweather Ground NW Area	58° 28' 10" N	139° 19' 44" W
	58° 28' 10" N	139° 15' 42" W
	58° 22' 00" N	139° 15' 42" W
	58° 22' 00" N	139° 19' 44" W
Fairweather Ground Southern Area	58° 16' 00" N	139° 09' 45" W
	58° 16' 00" N	138° 51' 34" W
	58° 13' 10" N	138° 51' 34" W
	58° 13' 10" N	139° 09' 45" W

3.3.6.1 GOA Coral Habitat Protection Area

Within the GOA Coral HAPC are GOA Coral Habitat Protection Areas. Bottom contact gear fishing and anchoring are prohibited in the GOA Coral Habitat Protection Area. Coordinates for the area are listed in the table below. See Figures 43 and 44. Note: Each area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates for each area is connected to the first set of coordinates for the area by a straight line. Projected coordinate system is North American Datum 1983, Albers.

Area Number	Name	Latitude			Longitude		
1	Cape Ommaney 1	56	10.85	N	135	5.83	W
	Cape Ommaney 1	56	11.18	N	135	7.17	W
	Cape Ommaney 1	56	9.53	N	135	7.68	W
	Cape Ommaney 1	56	9.52	N	135	7.20	W
2	Fariweather FS2	58	15.00	N	138	52.58	W
	Fariweather FS2	58	15.00	N	138	54.08	W
	Fariweather FS2	58	13.92	N	138	54.08	W
	Fariweather FS2	58	13.92	N	138	52.58	W
3	Fariweather FS1	58	16.00	N	138	59.25	W
	Fariweather FS1	58	16.00	N	139	9.75	W
	Fariweather FS1	58	13.17	N	138	59.25	W
4	Fairweather FN2	58	24.10	N	139	14.58	W
	Fairweather FN2	58	24.10	N	139	18.50	W
	Fairweather FN2	58	22.55	N	139	18.50	W
	Fairweather FN2	58	22.55	N	139	14.58	W
5	Fairweather FN1	58	27.42	N	139	17.75	W
	Fairweather FN1	58	27.42	N	139	19.08	W
	Fairweather FN1	58	26.32	N	139	19.08	W
	Fairweather FN1	58	26.32	N	139	17.75	W

GOA Coral Habitat Protection Area- Fairweather grounds

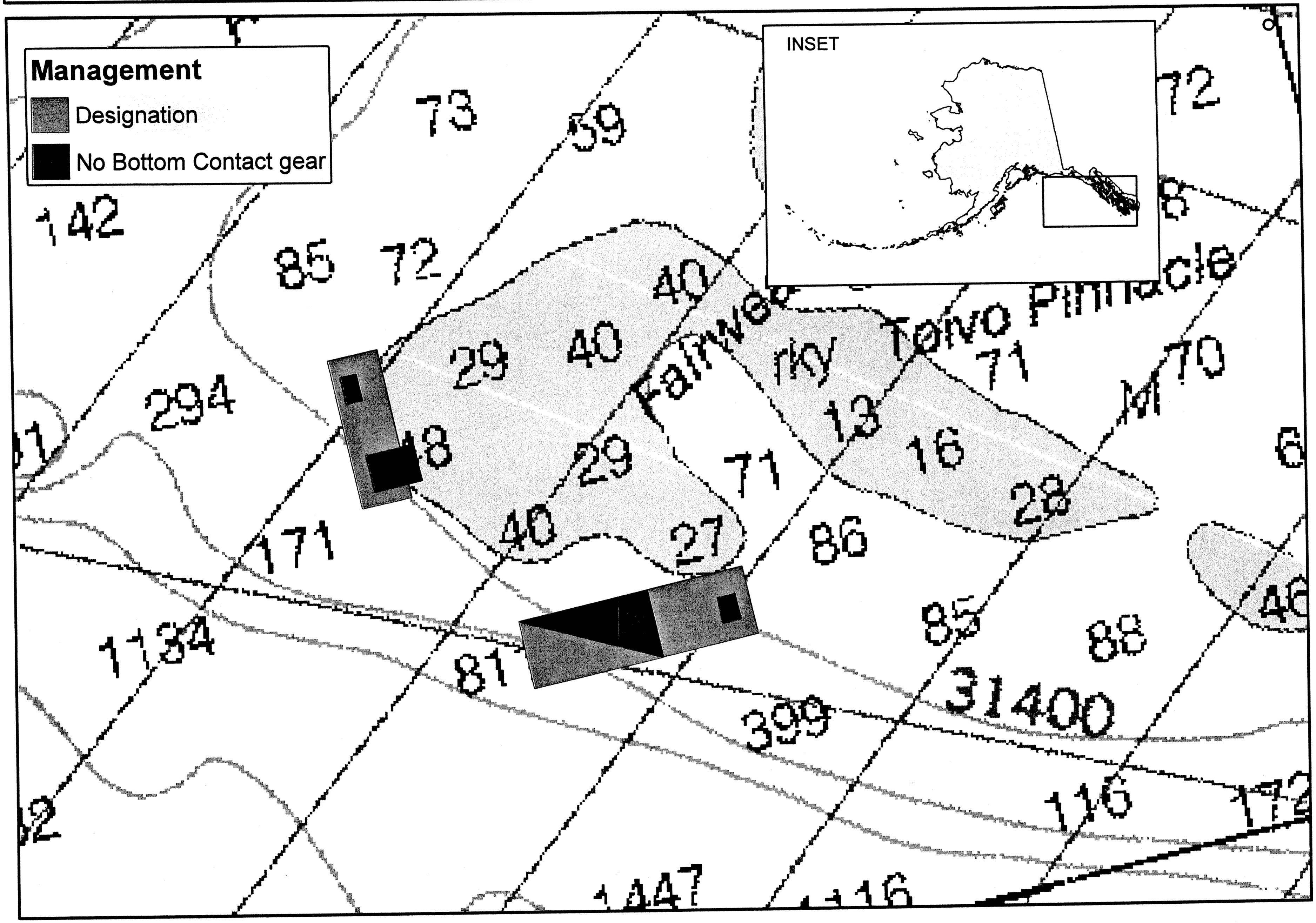


Figure 43 GOA Coral HAPC and GOA Coral Protect Areas in the Fariweather Grounds.

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Figure 44 GOA Coral HAPC and GOA Coral Protect Areas near Cape Ommaney.

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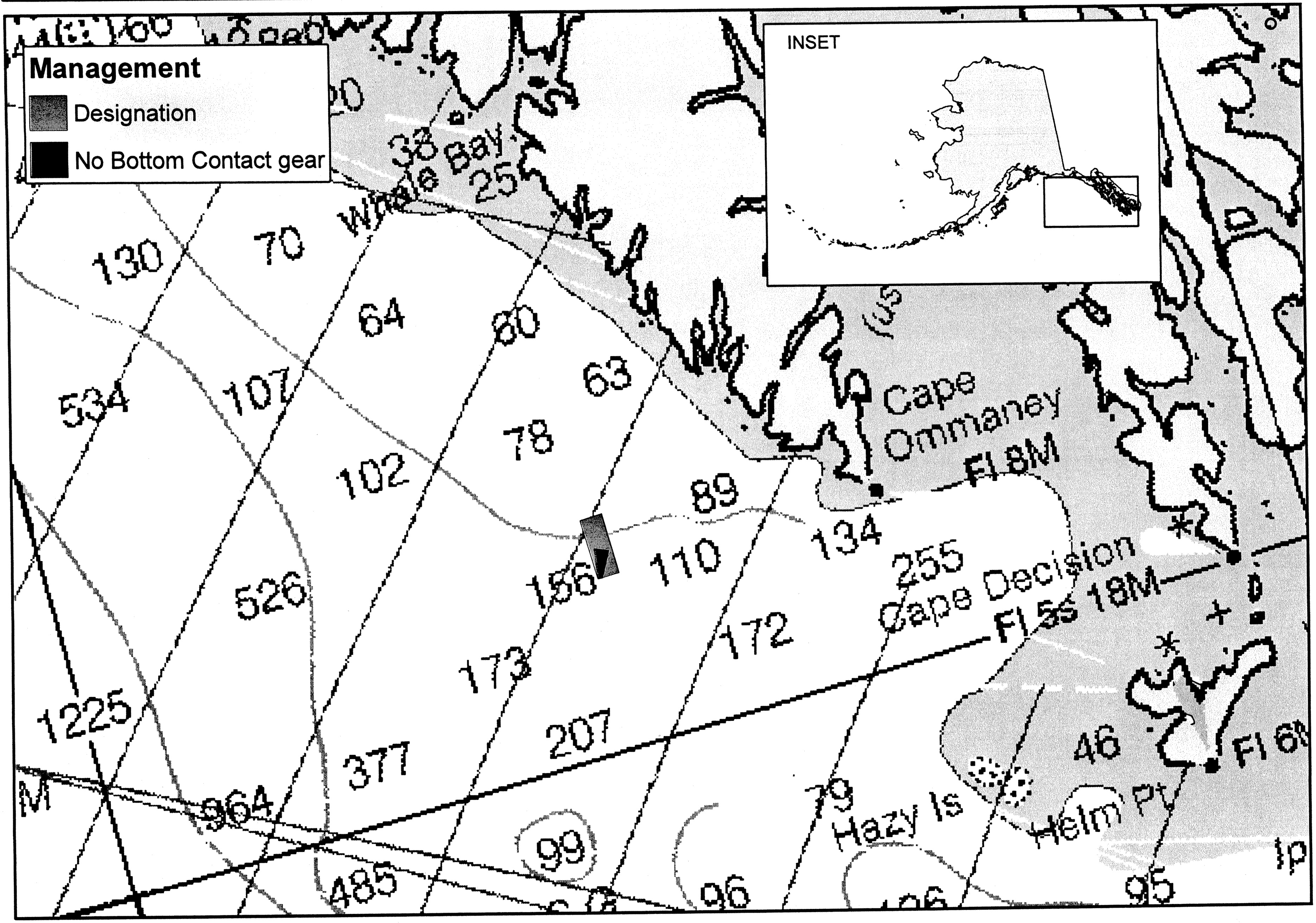
GOA Coral Habitat Protection Area- Cape Ommaney



3.3.7 HAPC Process

The Council may designate specific sites as HAPCs and may develop management measures to protect habitat features within HAPCs.

50 CFR 600.815(a)(8) provides guidance to the Councils in identifying HAPCs. FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern based on one or more of the following considerations:

(i) The importance of the ecological function provided by the habitat.
(ii) The extent to which the habitat is sensitive to human-induced environmental degradation.
(iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type.
(iv) The rarity of the habitat type.

Proposed HAPCs, identified on a map, must meet at least two of the four considerations established in 50 CFR 600.815(a)(8), and rarity of the habitat is a mandatory criterion. HAPCs may be developed to address identified problems for FMP species, and they must meet clear, specific, adaptive management objectives.

The Council will initiate the HAPC process by setting priorities and issuing a request for HAPC proposals. Any member of the public may submit a HAPC proposal. HAPC proposals may be solicited every 3 years or on a schedule established by the Council. The Council may periodically review existing HAPCs for efficacy and considerations based on new scientific research.

Criteria to evaluate the HAPC proposals will be reviewed by the Council and the Scientific and Statistical Committee prior to the request for proposals. The Council will establish a process to review the proposals and may establish HAPCs and conservation measures (NPFMC 2005).

4.0 Effects of Fishing on Essential Fish Habitat

This section addresses the requirement in EFH regulations (50 CFR 600.815(a)(2)(i)) that each FMP must contain an evaluation of the potential adverse effects of all regulated fishing activities on EFH. This evaluation must 1) describe each fishing activity, 2) review and discuss all available relevant information, and 3) provide conclusions regarding whether and how each fishing activity adversely affects EFH. Relevant information includes the intensity, extent, and frequency of any adverse effect on EFH; the type of habitat within EFH that may be affected adversely; and the habitat functions that may be disturbed.

In addition, the evaluation should 1) consider the cumulative effects of multiple fishing activities on EFH, 2) list and describe the benefits of any past management actions that minimize potential adverse effects on EFH, 3) give special attention to adverse effects on HAPCs and identify any EFH that is particularly vulnerable to fishing activities for possible designation as HAPCs, 4) consider the establishment of research closure areas or other measures to evaluate the impacts of fishing activities on EFH, 5) and use the best scientific information available, as well as other appropriate information sources.

This evaluation assesses whether fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature (50 CFR 600.815(a)(2)(ii)). This standard determines whether Councils are required to act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable.

Much of the material supporting this evaluation is located in the following sections of the EFH EIS (NMFS 2005). These include:

- Descriptions of fishing activities (including gear, intensity, extent and frequency of effort) - Sections 3.4.1 and 3.4.2.
- Effects of fishing activities on fish habitat - Section 3.4.3.
- Past management actions that minimize potential adverse effects on EFH - Sections 2.2 and 4.3.
- Habitat requirements of managed species - Sections 3.2.1, 3.2.2, and Appendices D and F.
- Features of the habitat - Sections 3.1, 3.2.4 and 3.3.
- HAPCs - 2.2.2.7, 2.2.2.8, 2.3.2, and 4.2
- Cumulative effects of multiple fishing activities on EFH - Section 4.4.

Appendix B of the EFH EIS also contains a comprehensive, peer-reviewed analysis of fishing effects on EFH and detailed results for each managed species. This FMP incorporates by reference the complete analysis in Appendix B of the EFH EIS and summarizes below the results for salmon species and the salmon fisheries.

An initial analysis, prepared by the Council indicated that groundfish fisheries represent all but a small fraction of the potential fishing effects on habitat and that salmon fisheries have a negligible effect on EFH (Witherell 2002). For the salmon fisheries, the analysis found that the effects of EFH are almost non-existent because troll and purse seine gear, which are predominant in the fisheries, generally never touches benthic habitat. Thus, the effects on EFH of the Alaska salmon fisheries are considered minimal and temporary in nature, and the salmon fisheries were not analyzed in detail in Appendix B of the EFH EIS (NMFS 2005).

The remainder of Appendix B of the EFH EIS evaluates whether the fisheries, as they are currently conducted off of Alaska, affect habitat that is essential to the welfare of salmon in a way that is more than minimal and not temporary. The previous statement describes the standard set in the EFH regulations which, if met, requires Councils to act to minimize such effects. The analysis in Appendix B of the EFH EIS identified changes to habitat features that are not expected to be temporary. The habitat features were selected as those which a) can be affected by fishing and b) may be important to fish in spawning, breeding, feeding, and growth to maturity. This section evaluates the extent that these changes relate to the EFH of salmon species and whether they constitute an effect to EFH that is more than minimal.

Two conclusions are necessary for this evaluation: (1) the definition of EFH draws a distinction between the amount of habitat necessary for a species to "support a sustainable fishery and the managed species' contribution to a healthy ecosystem" (50 CFR 600.10) and all habitat features used by any individuals of a species; (2) this distinction applies to both the designation of EFH and the evaluation of fishing effects on EFH. If these conclusions are valid, the "more than minimal" standard relates to impacts that potentially affect the ability of the species to fulfill its fishery and ecosystem roles, not just impacts on a local scale. The analysis indicated substantial effects to some habitat features in some locations, many of which are within the spatial boundaries of the EFH for salmon. These habitat changes may or may not affect the welfare of salmon species (a term used to represent "the ability of a species to support a sustainable fishery and its role in a healthy ecosystem").

The evaluation method is detailed in Section B.3.1 of Appendix B of the EFH EIS (NMFS 2005).

Habitat Connections

Five species of Pacific salmon (chinook, chum, pink, coho, and sockeye) are managed under the Alaska salmon FMP. Because all of these species use similar types of habitat, including habitats where fishing activities may occur, fishing effects on EFH were evaluated for all species together.

Spawning/Breeding—Salmon spawn and deposit their eggs in gravel areas of freshwater rivers and streams. Successful spawning depends upon the numbers of spawners, available habitat for spawning and nursery areas, and environmental conditions. Impacts to spawning and breeding of salmon occur when these habitat areas are disturbed, spawning biomass is reduced, or spawners are unable to reach suitable spawning areas.

Feeding—Once salmon smolts begin to enter the ocean, they feed on copepods. As they get larger, they add squid, juvenile herring, smelt, and other forage fish and invertebrate species to their diets. Salmon smolts use the nearshore area after entering the ocean, moving offshore as they get older, using pelagic habitats when at sea.

Growth to Maturity—Salmon feed throughout the open ocean of the North Pacific for up to 6 years (depending upon species) before maturing and returning to their natal rivers to spawn. Growth and mortality of juveniles depend on food availability, predation, bycatch in fisheries, and environmental conditions.

Evaluation of Effects

Issue	**Evaluation**
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)
Growth to maturity	MT (Minimal, temporary, or no effect)

Summary of Effects—No commercial fisheries in Alaska are thought to adversely affect salmon spawning habitat given almost no effort (except recreational and subsistence fisheries) in freshwater spawning and rearing areas. Thus, the effects of the fisheries on spawning of salmon are considered minimal and temporary in nature.

Fisheries are considered not to have any impact on freshwater or pelagic habitats used by juvenile salmon. However, fisheries do catch some species eaten by piscivorus species of salmon in the ocean, including squid, capelin, and juvenile herring. Currently, the catch of these prey species is very small relative to overall population size of these species, so fishing activities are considered to have minimal and temporary effects on feeding of all salmon species.

As stated above, fisheries are considered to have minimal effects on prey availability of salmon, including juveniles. Fisheries impacts on juvenile salmon at sea are due to incidental catches in groundfish fisheries. Bycatch in groundfish fisheries is almost nonexistent for pink salmon, coho salmon, and sockeye salmon, but does occur in measurable numbers for chum salmon and chinook salmon taken in trawl fisheries, particularly the pollock trawl fisheries (Witherell et al. 2002). The bycatch amounts are considered to be a small proportion of the stocks and do not cause a substantial impact on salmon populations (Witherell et al. 2002). Thus, fishing activities are considered to have minimal and temporary effects on growth to maturity of salmon.

Fishing activities are considered to have overall minimal and temporary effects on the EFH for all salmon species. Fishing activities only interact with salmon habitat to any degree in the ocean habitats, and the concerns about these interactions center on effects on prey availability and bycatch. Prey of salmon (from copepods up to squid and forage fish) are not subject to directed fisheries removals, and bycatch is not a significant factor in total mortality. Professional judgement led to the conclusion that fisheries do not adversely affect the EFH of salmon species.

5.0 Non-fishing Impacts

The diversity, widespread distribution, and ecological linkages with other aquatic and terrestrial environments make the waters and substrates that comprise EFH susceptible to a wide array of human activities unrelated to fishing.

Non-fishing activities have the potential to adversely affect the quantity or quality of EFH in riverine, estuarine, and marine systems. Broad categories of such activities include, but are not limited to, mining, dredging, fill, impoundment, discharge, water diversions, thermal additions, actions that contribute to nonpoint source pollution and sedimentation, introduction of potentially hazardous materials, introduction of exotic species, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH. For each activity, known and potential adverse impacts to EFH are described in the EFH EIS, Appendix G (NMFS 2005). The descriptions explain the mechanisms or processes that may cause the adverse effects and how these may affect habitat function. This FMP incorporates by reference the complete analysis of non-fishing impacts in Appendix G of the EFH EIS and summarizes the results for each type of non-fishing activity (NMFS 2005).

Non-fishing activities discussed in this document are subject to a variety of regulations and restrictions designed to limit environmental impacts under federal, state, and local laws. Many current requirements help to avoid or minimize adverse effects to aquatic habitats, including EFH. The conservation recommendations contained in this document are rather general and may overlap with certain existing standards for specific development activities. Nevertheless, the recommendations highlight practices that can help to avoid and minimize adverse effects to EFH. During EFH consultations between NMFS and other agencies, NMFS strives to provide reasonable and scientifically based recommendations that account for restrictions imposed under various state and federal laws by agencies with appropriate regulatory jurisdiction. Moreover, the coordination and consultation required by Section 305(b) of the Magnuson-Stevens Act do not supersede the regulations, rights, interests, or jurisdictions of other federal or state agencies. NMFS will not recommend that state or federal agencies take actions beyond their statutory authority, and NMFS' EFH conservation recommendations are not binding.

The conservation measures discussed in this document should be viewed as options to avoid, minimize, or compensate for adverse impacts and promote the conservation and enhancement of EFH. Ideally, non-water-dependent actions should not be located in EFH if such actions may have adverse impacts on EFH. Activities that may result in significant adverse effects on EFH should be avoided where less environmentally harmful alternatives are available. If there are no alternatives, the impacts of these actions should be minimized. Environmentally sound engineering and management practices should be employed for all actions that may adversely affect EFH. If avoidance or minimization is not practicable, or will not adequately protect EFH, compensatory mitigation (as defined for Section 404 of the Clean Water Act – the restoration, creation, enhancement, or in exceptional circumstances, preservation of wetlands and/or other aquatic resources for the purpose of compensating for unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved) should be considered to conserve and enhance EFH.

Section 303(a)(7) of the Magnuson-Stevens Act requires FMPs to identify activities other than fishing that may adversely affect EFH and define actions to encourage the conservation and enhancement of EFH, including recommended options to avoid, minimize, or compensate for the adverse effects identified. During consultation, agencies strive to consider all potential non-fishing impacts to EFH so that the appropriate recommendations can be made. Because impacts that may adversely affect EFH can be direct, indirect, and cumulative, the biologist must consider and analyze these interrelated impacts.

The conservation recommendations included with each activity present a series of site-specific measures the action agency can undertake to avoid, offset, or mitigate impacts to EFH. Not all of these suggested measures are necessarily applicable to any one project or activity that may adversely affect EFH. More specific or different measures based on the best and most current scientific information may be developed before or during EFH consultations and communicated to the appropriate agency. The conservation recommendations provided herein represent a short menu of actions that can contribute to the conservation, enhancement, and proper functioning of EFH.

While it is necessary to distinguish between activities to identify possible adverse impacts, it is equally important to consider and analyze these activities as they interrelate within habitats. This document is organized by activities that may potentially impact EFH occurring in four discrete ecosystems. The separation of these ecosystems is artificial, and many of the impacts and their related activities are not exclusive to one system.

The format for presenting the information in this document provides an introductory description of each activity, identification of potential adverse impacts, and suggested general conservation measures that would help minimize and avoid adverse effects of non-fishing activities on EFH. Table 3.4-36 in the EFH EIS identifies the categories from Appendix G and correlates them with possible changes in physical, chemical, and biological parameters, and Table 3.4-37 in the EFH EIS takes the same categories from Appendix G and broadly interprets whether the effects from the activities in Alaska have been positive, insignificant, negative, or unknown.

5.1 UPLAND ACTIVITIES

5.1.1 Nonpoint Source Pollution

Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, seepage, or hydrologic modification. Technically, the term nonpoint source means anything that does not meet the legal definition of point source in Section 502(14) of the Clean Water Act (CWA), which refers to discernable, confined, and discrete conveyance from which pollutants are or may be discharged. The major categories of nonpoint pollution are as follows:

- Agricultural runoff
- Urban runoff, including developed and developing areas (Section G.2.2 of the EFH EIS)
- Silvicultural (forestry) runoff (Section G.2.1.1 of the EFH EIS)
- Marinas and recreational boating
- Road construction
- Channel and streambank modifications, including channelization (Section G.4.7 of the EFH EIS)
- Streambank and shoreline erosion

Nonpoint source pollution is usually lower in intensity than an acute point source event, but it may be more damaging to fish habitat in the long term. Nonpoint source pollution is often difficult to detect. It may affect sensitive life stages and processes, and the impacts may go unnoticed for a long time. When severe pollution impacts are finally noticed, they may not be tied to any one event; hence, it may be difficult to correct, clean up, or mediate.

5.1.2 Silviculture/Timber Harvest

Recent revisions of Alaska's federal and state timber harvest regulations and best management practices (BMPs) have resulted in increased protection of EFH on federal, state, and private timber lands. Current forest management practices, when fully implemented and effective, avoid or minimize adverse effects to EFH that can result from the harvest and cultivation of timber and other forestry products. However, timber harvest can have both short- and long-term impacts throughout many coastal watersheds and estuaries if management practices are not fully implemented or effective. Past timber harvest in Alaska was not conducted under the current protective standards, and some effects from past harvesting continue to affect EFH.

If appropriate environmental standards are not followed, forest conditions after harvest may result in altered or impaired instream habitat structure and watershed function. In general, timber harvest can have a variety of effects such as removing the dominant vegetation; converting mature and old-growth upland and riparian forests to tree stands or forests of early seral stage; reducing permeability of soils and increasing the area of impervious surfaces; increasing sedimentation from surface runoff and mass wasting processes; altering hydrologic regimes; and impairing fish passage through inadequate design, construction, and/or maintenance of stream crossings (Northcote and Hartman 2004). Timber harvest may result in inadequate or excessive surface and stream flows, increased streambank and streambed erosion, loss of complex instream habitats, sedimentation of riparian habitat, and increased surface runoff with associated contaminants (e.g., herbicides, fertilizers, and fine sediments). Hydrologic characteristics (e.g., water temperature), annual hydrograph change, and greater variation in stream discharge can be associated with timber harvest. Alterations in the supply of large woody debris (LWD) and sediment can have negative effects on the formation and persistence of instream habitat features. Excess debris in the form of small pieces of wood and silt can cover benthic habitat and reduce dissolved oxygen levels.

Potential Adverse Impacts

There are many complex and important interactions, in both small and large watersheds, between fish and forests (Northcote and Hartman, 2004). Five major categories of activities can adversely affect EFH: 1) construction of logging roads, 2) creation of fish migration barriers, 3) removal of streamside vegetation, 4) hydrologic changes and sedimentation and 5) disturbance associated with log transfer facilities (LTFs) (Section G.4.9 of the EFH EIS). Potential impacts to EFH have been greatly reduced by the adoption of best management practices (BMPs) designed to protect fish habitat.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. For timber operations near streams with EFH, adhere to modern forest management practices and BMPs, including the maintenance of vegetated buffers to reduce sedimentation and supply LWD.

2. Avoid timber operations to the extent practicable in wetlands contiguous with anadromous fish streams.
3. For timber operations near estuaries or beaches, maintain vegetated buffers as needed to protect EFH.
4. Maintain riparian buffers along all streams to the extent practicable. In Alaska, buffer width is site-specific and dependent on use by anadromous and resident fish and stream process type.
5. Incorporate watershed analysis into timber and silviculture projects whenever possible or practicable. Particular attention should be given to the cumulative effects of past, present, and future timber sales within the watershed.
6. For forest roads, see Section G.2.3 in the EFH EIS, Road Building and Maintenance.

5.1.3 Pesticide Application (includes insecticides, herbicides, fungicides)

Pesticides are frequently detected in freshwater and estuarine systems that provide EFH. Pesticides are substances intended to prevent, destroy, control, repel, or mitigate any pest. They include the following: insecticides, herbicides, fungicides, rodenticides, repellents, bactericides, sanitizers, disinfectants, and growth regulators. More than 800 different pesticides are currently registered for use in the U.S. Legal mandates covering pesticides are the CWA and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Water quality criteria for the protection of aquatic life have only been developed for a few of the currently used chemicals (EPA, Office of Pesticide Programs). The most common pesticides are insecticides, herbicides, and fungicides. These are used for pest control on forested lands, agricultural crops, tree farms and nurseries, highways and utility rights of way, parks and golf courses, and residences. Pesticides can enter the aquatic environment as single chemicals or as complex mixtures. Direct applications, surface runoff, spray drift, agricultural return flows, and groundwater intrusions are all examples of transport processes that deliver pesticides to aquatic ecosystems.

Habitat alteration from pesticides is different from more conventional water quality parameters, such as temperature, suspended solids, or dissolved oxygen, because, unlike temperature or dissolved oxygen, the presence of pesticides can be difficult to detect due to limitations in proven methodologies. This monitoring may also be expensive. As analytical methodologies have improved in recent years, however, the number of pesticides documented in fish and their habitats has increased.

Potential Adverse Impacts

There are three basic ways that pesticides can adversely affect EFH. These are (1) a direct toxicological impact on the health or performance of exposed fish, (2) an indirect impairment of the productivity of aquatic ecosystems, and (3) a loss of aquatic vegetation that provides physical shelter for fish.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Incorporate integrated pest management and BMPs as part of the authorization or permitting process to ensure the reduction of pesticide contamination in EFH (Scott et al. 1999).
2. Carefully review labels and ensure that application is consistent. Follow local, supplemental instructions such as state-use bulletins where they are available.
3. Avoid the use of pesticides in and near EFH.
4. Refrain from aerial spraying of pesticides on windy days.

5.1.4 Urban/Suburban Development

Urban development is most likely the greatest non-fishing threat to EFH. Urban growth and development in the U.S. continue to expand in coastal areas at a rate approximately four times greater than in other areas. Urban and suburban development and the corresponding infrastructure result in four broad categories of impacts to aquatic ecosystems: hydrological, physical, water quality, and biological indicators (Center for Watershed Protection [CWP] 2003). Runoff from impervious surfaces is the most widespread source of pollution into the nation's waterways (EPA 1995). When a watershed's impervious cover exceeds 10 percent, impacts to stream quality can be expected (CWP 2003).

Potential Adverse Impacts

Development activities within watersheds and in coastal marine areas often impact the EFH of managed species on both long- and short-term scales. The CWP made a comprehensive review of the impacts associated with impervious cover and urban development and found a negative relationship between watershed development and about 26 stream quality indicators (CWP 2003). Many of the impacts listed here are discussed in greater detail in other sections of this document. The primary impacts include (1) the loss of riparian and shoreline habitat and vegetation and (2) runoff. Upland and shoreline vegetation removal can increase stream water temperatures, reduce supplies of LWD, and reduce sources of prey and nutrients to the water system. An increase in impervious surfaces, such as the addition of new roads (see Section G.2.3 of the EFH EIS), roofs, bridges, and parking facilities, results in a decreased infiltration to groundwater and increased runoff volumes. This also has the potential to adversely affect water quality and water quantity/timing in downstream water bodies (i.e., estuaries and coastal waters).

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Implement BMPs (EPA 1993) for sediment control during construction and maintenance operations.
2. Avoid using hard engineering structures for shoreline stabilization and channelization when possible.
3. Encourage comprehensive planning for watershed protection to avoid filling and building in floodplain areas affecting EFH.
4. Where feasible, remove impervious surfaces such as abandoned parking lots and buildings from riparian and shoreline areas, and reestablish wetlands and native vegetation.
5. Protect and restore vegetated buffer zones of appropriate width along all streams, lakes, and wetlands that include or influence EFH.
6. Manage stormwater to duplicate the natural hydrologic cycle, maintaining natural infiltration and runoff rates to the maximum extent practicable.
7. Where in-stream flows are insufficient to maintain water quality and quantity needed for EFH, establish conservation guidelines for water use permits and encourage the purchase or lease of water rights and the use of water to conserve or augment instream flows in accordance with state and federal water laws.
8. Encourage municipalities to use the best available technologies in upgrading their wastewater systems to avoid combined sewer overflow problems and chlorinated sewage discharges into rivers, estuaries, and the ocean.
9. Design and install proper on-site disposal systems.

5.1.5 Road Building and Maintenance

The building and maintenance of roads can affect aquatic habitats by increasing rates of natural processes such as debris slides or landslides and sedimentation, introducing exotic species, degrading water quality, and introducing chemical contamination (e.g., petroleum-based contaminants; Section G.2.2 of the EFH EIS). Paved and dirt roads introduce an impervious or semipervious surface into the landscape. This surface intercepts rain and creates runoff, carrying soil, sand and other sediments, and oil-based materials quickly downslope. If roads are built near streams, wetlands, or other sensitive areas, they may experience increased sedimentation that occurs from maintenance and use, as well as during storm and snowmelt events. Even carefully designed and constructed roads can become sources of sediment and pollutants if they are not properly maintained.

Potential Adverse Impacts

The effects of roads on aquatic habitat can be profound. They include (1) increased deposition of fine sediments, (2) changes in water temperature, (3) elimination or introduction of migration barriers such as culverts, (4) changes in streamflow, (5) introduction of non-native plant species, and (6) changes in channel configuration (see Section G.2.1.1 and the standards referenced in the EFH EIS).

Recommended Conservation Measures

The following conservation measures for road building and maintenance should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. To the extent practicable, avoid locating roads near fish-bearing streams.
2. Incorporate appropriate erosion control and stabilization measures into road construction plans to reduce erosion potential.
3. Build bridges when possible.
4. Locate stream crossings in stable stream reaches.
5. Design bridge abutments to minimize disturbances to streambanks and place abutments outside of the floodplain whenever possible.
6. To the extent practicable, avoid road construction across alluvial floodplains, mass wastage areas, or braided stream bottom lands unless site-specific protection can be implemented to ensure protection of soils, water, and associated resources.
7. Avoid side-casting of road construction and maintenance materials on native surfaces and into streams.
8. To the extent practicable, use native vegetation in stabilization plantings.
9. Ensure that maintenance operations avoid adverse affects to EFH.

5.2 RIVERINE ACTIVITIES

5.2.1 Mining

Mining and mineral extraction activities take many forms, such as commercial dredging and recreational suction dredging, placer, area surface removal, and contour operations (Section G.5.6 of EIS EFH). Activities include gravel mining (NMFS 2004), exploration, site preparation, mining, milling, waste management, decommissioning or reclamation, and mine abandonment (American Fisheries Society [AFS] 2000). Mining and its associated activities have the potential to cause environmental impacts from exploration through post-closure. These impacts may include adverse effects to EFH. The operation of metal, coal, rock quarries, and gravel pit mining has caused varying degrees of environmental damage in urban, suburban, and rural areas. Some of the most severe damage, however, occurs in remote areas, where some of the most productive fish habitat is often located (Sengupta 1993). In Alaska, existing regulations, promulgated and enforced by other federal and state agencies, have been designed to control and manage these changes to the landscape to avoid and minimize impacts. These regulations are regularly updated as new technologies are developed to improve mineral extraction, reclaim mined lands, and limit environmental impacts. However, while environmental regulations may avoid, limit, control, or offset many of these potential impacts, mining will, to some degree, always alter landscapes and environmental resources (National Research Council [NRC] 1999).

Mineral Mining

Potential Adverse Impacts

The effects of mineral mining on EFH depend on the type, extent, and location of the activities. Potential impacts from mining include (1) adverse modification of hydrologic conditions so as to cause erosion of desirable habitats, (2) removal of substrates that serve as habitat for fish and invertebrates, (3) conversion of habitats,(4) release of harmful or toxic materials, and (5) creation of harmful turbidity levels.

Recommended Conservation Measures

The following conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. To the extent practicable, avoid mineral mining in waters, riparian areas, and floodplains containing EFH.
2. Schedule necessary in-water activities when the fewest species/least vulnerable life stages of federally managed species will be present.
3. Use an integrated environmental assessment, management, and monitoring package in accordance with state and federal law and regulations.
4. Minimize spillage of dirt, fuel, oil, toxic materials, and other contaminants into EFH.
5. Treat and test wastewater (acid neutralization, sulfide precipitation, reverse osmosis, electrochemical, or biological treatments) and recycle on site to minimize discharge to streams.
6. Minimize opportunities for sediments to enter or affect EFH.
7. If possible, reclaim, rather than bury, mine waste that contains heavy metals, acid materials, or other toxic compounds if leachate can enter EFH through groundwater.
8. Restore natural contours and plant native vegetation on site after use to restore habitat function to the extent practicable.
9. Minimize the aerial extent of ground disturbance (e.g., through phasing of operations), and stabilize disturbed lands to reduce erosion.

Sand and Gravel Mining

Potential Adverse Impacts

Sand and gravel mining is extensive and occurs by several methods. These include wet-pit mining (i.e., removal of material from below the water table), dry-pit mining on beaches, exposed bars, and ephemeral streambeds, and subtidal mining. Sand and gravel mining in riverine, estuarine, and coastal environments can create EFH impacts, including (1) turbidity plumes and resuspension effects, (2) removal of spawning habitat, and (3) alteration of channel morphology.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. To the extent practicable, avoid sand/gravel mining in waters containing EFH.
2. Identify upland or off-channel (where the channel will not be captured) gravel extraction sites as alternatives to gravel mining in or adjacent to EFH, if possible.
3. Design, manage, and monitor sand and gravel mining operations to minimize potential direct and indirect impacts to EFH, if operations in EFH cannot be avoided.
4. Minimize the areal extent and depth of extraction.
5. Include restoration, mitigation, and monitoring plans, as appropriate in sand/gravel extraction plans.

5.2.2 Organic and Inorganic Debris

Natural occurring flotsam, such as LWD and macrophyte wrack (i.e., kelp), plays an important role in aquatic ecosystems, including EFH. LWD and wrack promote habitat complexity and provide structure to various aquatic and shoreline habitats. The natural deposition of LWD creates habitat complexity by altering local hydrologic conditions, nutrient availability, sediment deposition, turbidity, and other structural habitat conditions. Conversely, inorganic flotsam and jetsam debris can negatively impact EFH. Inorganic marine debris is a problem along much of the coastal U.S., where it litters shorelines, fouls estuaries, entangles fish and wildlife, and creates hazards in the open ocean. Marine debris consists of a wide variety of man-made materials, including general litter, plastics, hazardous wastes, and discarded or lost fishing gear. The debris enters waterbodies indirectly through rivers and storm drains, as well as directly via ocean dumping and accidental release. Although laws and regulatory programs exist to prevent or control the problem, marine debris continues to affect aquatic resources.

Organic Debris Removal

Natural occurring flotsam, such as LWD and macrophyte wrack (i.e., kelp), is sometimes intentionally removed from streams, estuaries, and coastal shores. This debris is removed for a variety of reasons, including dam operations, aesthetic concerns, and commercial and recreational uses. However, the presence of organic debris is important for maintaining aquatic habitat structure and function. Removal can alter the ecological conditions of riverine, estuarine, and coastal ecosystems and habitats.

Potential Adverse Impacts

The removal of organic debris from natural systems can reduce habitat function, adversely impacting habitat quality. Reductions in woody debris inputs to estuaries may also affect the ecological balance of estuarine systems by altering rates and patterns of nutrient transport, sediment deposition, and availability of in-water cover for larval and juvenile fish. Beach grooming and wrack removal can substantially alter the macrofaunal community structure of exposed sand beaches by reducing species richness, abundance, and biomass of macrofauna associated with beach wrack (e.g., sand crabs, isopods, amphipods, and polychaetes).

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Leave LWD whenever possible, removing it only when it presents a threat to life or property.
2. Encourage appropriate federal, state, and local agencies to prohibit or minimize commercial removal of LWD from rivers, estuaries, and beaches.
3. Encourage appropriate federal, state, and local agencies to aid in the downstream movement of LWD around dams, culverts, and bridges wherever possible, rather than removing it from the system.
4. Educate landowners and recreationalists about the benefits of maintaining LWD.
5. Localize beach grooming practices, and minimize them whenever possible.

Inorganic Debris

Numerous national and international laws are intended to prevent the disposal of marine debris in ocean waters, including ocean dumping and land-based sources. Nationally, land-based sources of marine debris account for about 80 percent of the marine debris on beaches and in U.S. waters. Debris can originate from combined sewer overflows and storm drains, stormwater runoff, landfills, solid waste disposal, poorly maintained garbage bins, floating structures, and general littering of beaches, rivers, and open waters. Typical debris from these land-based sources includes raw or partially treated sewage, litter, hazardous materials, and discarded trash.

Potential Adverse Impacts

Land and ocean based marine debris is a very diverse problem, and adverse effects to EFH are likewise varied. Floating or suspended trash can directly affect fish that consume or are entangled in it. Toxic substances in plastics can kill or impair fish and invertebrates that use habitat polluted by these materials. The chemicals leach from plastics, persist in the environment, and can bioaccumulate through the food web.
Once floatable debris settles to the bottom of estuaries, coastal, and open ocean areas it may cover and suffocate immobile animals and plants, creating large spaces devoid of life. Currents can carry suspended debris to underwater reef habitats where the debris can become snagged, damaging these sensitive habitats. The typical floatable debris from combined sewer overflows includes street litter, sewage containing viral and bacterial pathogens, pharmaceutical by-products from human excretion, and pet wastes. Pathogens can also contaminate shellfish beds and reefs.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Encourage proper trash disposal in coastal and ocean settings.
2. Advocate and participate in coastal cleanup activities.
3. Encourage enforcement of regulations addressing marine debris pollution and proper disposal.
4. Provide resources and technical guidance for development of studies and solutions addressing the problem of marine debris.

5. Provide resources to the public explaining the impact of marine debris and giving guidance on how to reduce or eliminate the problem.

5.2.3 Dam Operation

Dams are constructed and operated to provide sources for hydropower, water storage, and flood control. Their operation, however, can affect water quality and quantity in riverine systems.

Potential Adverse Impacts

The effects of dam construction and operation on EFH can include (1) migratory impediments, (2) water flow and current pattern shifts, (3) thermal impacts, and (4) limits on sediment and woody debris transport.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Operate facilities to create flow conditions that provide for passage, water quality, proper timing of life history stages, and properly functioning channel conditions to avoid strandings and redd dewatering.
2. Develop water and energy conservation guidelines for integration into dam operation plans and into regional and watershed-based water resource plans.
3. Provide mitigation (including monitoring and evaluation) for nonavoidable adverse effects on EFH.

5.2.4 Commercial and Domestic Water Use

Commercial and domestic water use demands to support the needs of homes, farms, and industries require a constant supply of water. Freshwater is diverted directly from lakes, streams, and rivers by means of pumping facilities, or is stored in impoundments. Because human populations are expected to continue increasing in Alaska, it is reasonable to assume that water uses, including water impoundments and diversion, will similarly increase (Gregory and Bisson 1997).

Potential Adverse Impacts

Water diversions can involve either withdrawals (reducing flow) or discharges (increasing flow). The withdrawal of water can affect EFH by (1) altering natural flows and the process associated with flow rates, (2) affecting shoreline riparian habitats, (3) affecting prey bases, (4) affecting water quality, and (5) entrapping fishes. Problems associated with return flows include increased water temperature, increased salinity, introduction of pathogens, decreased dissolved oxygen, increased toxic contaminants from pesticides and fertilizers, and increased sedimentation (Northwest Power Planning Council [NPPC] 1986). Diversions can also physically divert or entrap EFH-managed species (Section G.5.3 of the EFH EIS).

Recommended Conservation Measures

The recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Design projects to create flow conditions that provide for adequate passage, water quality, proper timing of life history stages, and properly functioning channels to avoid juvenile stranding and redd dewatering, as well as to maintain and restore proper channel, floodplain, riparian, and estuarine conditions.
2. Establish adequate instream flow conditions for anadromous fish.
3. Screen water diversions on fish-bearing streams, as needed.
4. Incorporate juvenile and adult fish passage facilities on all water diversion projects (e.g., fish bypass systems).
5. Where practicable, ensure that mitigation is provided for nonavoidable impacts.

5.3 ESTUARINE ACTIVITIES

5.3.1 Dredging

Dredging navigable waters creates a continuous impact primarily affecting benthic and water-column habitats in the course of constructing and operating marinas, harbors, and ports. Routine dredging (i.e., the excavation of soft-bottom substrates) is used to create deepwater navigable channels or to maintain existing channels that periodically fill with sediments. In addition, port expansion has become an almost continuous process due to economic growth, competition between ports, and significant increases in vessel size (Section G.4.3 of the EFH EIS). Elimination or degradation of aquatic and upland habitats is commonplace because port expansion almost always affects open water, submerged bottoms, and, possibly, riparian zones.

Potential Adverse Impacts

The environmental effects of dredging on EFH can include (1) direct removal/burial of organisms; (2) turbidity/siltation effects, including light attenuation from turbidity; (3) contaminant release and uptake, including nutrients, metals, and organics; (4) release of oxygen consuming substances; (5) entrainment; (6) noise disturbances; and (6) alteration to hydrodynamic regimes and physical habitat.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Avoid new dredging to the maximum extent practicable.
2. Where possible, minimize dredging by using natural and existing channels.
3. Site activities that would likely require dredging (such as placement of piers, docks, marinas, etc.) in deep-water areas or design such structures to alleviate the need for maintenance dredging.
4. Incorporate adequate control measures by using BMPs to minimize turbidity and dispersal of dredged material in areas where the dredging equipment would cause such effects.
5. For new dredging projects, undertake multi-season, pre-, and post-dredging biological surveys to assess the cumulative impacts to EFH and allow for implementation of adaptive management techniques.
6. Provide appropriate compensation for significant impacts (short-term, long-term, and cumulative) to benthic environments resulting from dredging.
7. Perform dredging at times when impacts to federally managed species or their prey are least likely. Avoid dredging in areas with submerged aquatic vegetation.
8. Reference all dredging latitude-longitude coordinates at the site so that information can be incorporated into a geographical information system format.

9. Test sediments for contaminants as per EPA and USACE requirements.
10. Identify excess sedimentation in the watershed that prompts excessive maintenance dredging activities, and implement appropriate management actions, if possible, to ensure that actions are taken to curtail those causes.
11. Ensure that bankward slopes of the dredged area are slanted to acceptable side slopes (e.g., 3:1) to prevent sloughing.
12. Avoid placing pipelines and accessory equipment used in conjunction with dredging operations to the maximum extent possible close to kelp beds, eelgrass beds, estuarine/salt marshes, and other high value habitat areas.

5.3.2 Material Disposal/Fill Material

The discharge of dredged materials subsequent to dredging operations or the use of fill material in aquatic habitats can result in sediments (e.g., dirt, sand, mud) covering or smothering existing submerged substrates, loss of habitat function, and adverse effects on benthic communities.

Disposal of Dredged Material

Potential Adverse Impacts

The disposal of dredged material can adversely affect EFH by (1) altering or destroying benthic communities, (2) altering adjacent habitats, and (3) creating turbidity plumes and introducing contaminants and/or nutrients.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Study all options for disposal of dredged materials, including upland disposal sites, and select disposal sites that minimize adverse effects to EFH.
2. Where long-term maintenance dredging is anticipated, acquire and maintain disposal sites for the entire project life.
3. Encourage beneficial uses of dredged materials.
4. State and federal agencies should identify the direct and indirect impacts open-water disposal permits for dredged material may have on EFH during proposed project reviews.
5. Minimize the areal extent of any disposal site in EFH, or avoid the site entirely. Mitigate all non-avoidable adverse impacts as appropriate.

Fill Material

Potential Adverse Impacts

Adverse impacts to EFH from the introduction of fill material include (1) loss of habitat function and (2) changes in hydrologic patterns.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH:

1. Federal, state, and local resource management and permitting agencies should address the cumulative impacts of past and current fill operations on EFH and consider them in the permitting process for individual projects.
2. Minimize the areal extent of any fill in EFH, or avoid it entirely. Mitigate all non-avoidable adverse impacts as appropriate.
3. Consider alternatives to the placement of fill into areas that support EFH.

5.3.3 Vessel Operations/Transportation/Navigation

The growth in Alaska coastal communities is putting demands on port districts to increase infrastructure capacity to accommodate additional vessel operations for cargo handling activities and marine transportation. Port expansion has become an almost continuous process due to economic growth, competition between ports, and significant increases in vessel size (Council 1999). In addition, increasing boat sales have put more pressure on improving and building new commercial fishing and small boat harbors.

Potential Adverse Impacts

Port facilities, vessel/ferry operations, and recreational marinas can impact to EFH, especially by filling productive shallow water habitats. Potential adverse impacts to EFH can occur during both the construction and operation phases. These include direct, indirect, and cumulative impacts on shallow subtidal, deep subtidal, eelgrass beds, mudflats, sand shoals, rock reefs, and salt marsh habitats. There is considerable evidence that docks and piers block sunlight penetration, alter water flow, introduce chemicals, and restrict access and navigation (Section G.4.6 of the EFH EIS). The increase in hard surfaces close to the marine environment increases nonpoint surface discharges (Section G.2.2 of the EFH EIS), adds debris sources, and reduces buffers between land use and the aquatic ecosystem. Additional impacts include vessel groundings, modification of water circulation (breakwaters, channels, and fill), vessel wake generation, pier lighting, anchor and prop scour, discharge of contaminants and debris, and changing natural patterns of fish movement.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Locate marinas in areas of low biological abundance and diversity; if possible, for example, avoid the disturbance of eelgrass or other submerged aquatic vegetation including macroalgae, mudflats, and wetlands as part of the project design.
2. If practicable, excavate uplands to create marina basins rather than converting intertidal or shallow subtidal areas to deeper subtidal areas for basin creation.
3. Leave riparian buffers in place to help maintain water quality and nutrient input.
4. Should mitigation be required, include a monitoring plan to gauge the success of mitigation efforts.
5. Include low-wake vessel technology, appropriate routes, and BMPs for wave attenuation structures as part of the design and permit process.
6. Incorporate BMPs to prevent or minimize contamination from ship bilge waters, antifouling paints, shipboard accidents, shipyard work, maintenance dredging and disposal, and nonpoint source contaminants

from upland facilities related to vessel operations and navigation.
7. Locate mooring buoys in water deep enough to avoid grounding and to minimize the effects of prop wash.
8. Use catchment basins for collecting and storing surface runoff from upland repair facilities.
9. Locate facilities in areas with enough water velocity to maintain water quality levels within acceptable ranges.
10. Locate marinas where they do not interfere with drift sectors determining the structure and function of adjacent habitats.
11. To facilitate the movement of fish around breakwaters, provide a shallow shelf or "fish bench" on the outside of the breakwater.
12. Harbor facilities should be designed to include practical measures for reducing, containing, and cleaning up petroleum spills.
13. Use appropriate timing windows for construction and dredging activities to avoid potential impacts on EFH.

5.3.4 Introduction of Exotic Species

Introductions of exotic species into estuarine, riverine, and marine habitats have been well documented and can be intentional (e.g., for the purpose of stock or pest control) or unintentional (e.g., fouling organisms). Exotic fish, shellfish, pathogens, and plants can enter the environment from industrial shipping (e.g., as ballast), recreational boating, aquaculture (Section G.4.10 of the EFH EIS), biotechnology, and aquariums. The transportation of nonindigenous organisms to new environments can have many severe impacts on habitat (Omori et al. 1994).

Potential Adverse Impacts

Long-term impacts from the introduction of nonindigenous and reared species can change the natural community structure and dynamics, lower the overall fitness and genetic diversity of natural stocks, and pass and/or introduce exotic lethal disease. Overall, exotic species introductions create five types of negative effects: (1) habitat alteration, (2) trophic alteration, (3) gene pool alteration, (4) spatial alteration, and (5) introduction of diseases.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Uphold fish and game regulations of the Alaska Board of Fisheries (AS 16.05.251) and Board of Game (AS 16.05.255), which prohibit and regulate the live capture, possession, transport, or release of native or exotic fish or their eggs.
2. Adhere to regulations and use best management practices outlined in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002).
3. Encourage vessels to perform a ballast water exchange in marine waters (in accordance with the U.S. Coast Guard's voluntary regulations) to minimize the possibility of introducing exotic estuarine species into similar habitats.
4. Discourage vessels that have not performed a ballast water exchange from discharging their ballast water into estuarine receiving waters.
5. Require vessels brought from other areas over land via trailer to clean any surfaces that may harbor non-

native plant or animal species (propellers, hulls, anchors, fenders, etc.).

6. Treat effluent from public aquaria displays and laboratories and educational institutes using exotic species before discharge to prevent the introduction of viable animals, plants, reproductive material, pathogens, or parasites into the environment.
7. Prevent introduction of non-native plant species into aquatic and riparian ecosystems by avoiding use of non-native seed mixes or invasive, non-native landscaping materials near waterways and shorelines.
8. Encourage proper disposal of seaweeds and other plant materials used for packing purposes when shipping fish or other animals.

5.3.5 Pile Installation and Removal

Pilings are an integral component of many overwater and in-water structures. They provide support for the decking of piers and docks, function as fenders and dolphins to protect structures, support navigation markers, and help in the construction of breakwaters and bulkheads. Materials used in pilings include steel, concrete, wood (both treated and untreated), plastic, or a combination thereof. Piles are usually driven into the substrate by using either impact hammers or vibratory hammers. Impact hammers consist of a heavy weight that is repeatedly dropped onto the top of the pile, driving it into the substrate. Vibratory hammers use a combination of a stationary, heavy weight and vibration, in the plane perpendicular to the long axis of the pile, to force the pile into the substrate. Impact hammers are able to drive piles into most substrates (including hardpan, glacial till, etc.), vibratory hammers are limited to softer, unconsolidated substrates (e.g., sand, mud, and gravel).

Piles can be removed using a variety of methods, including vibratory hammer, direct pull, clam shell grab, or cutting/breaking the pile below the mudline, leaving the buried section in place.

Pile Driving

Potential Adverse Impacts

Pile driving can generate intense underwater sound pressure waves that may adversely affect EFH. These pressure waves have been shown to injure and kill fish (CalTrans 2001, Longmuir and Lively 2001, Stotz and Colby 2001, Stadler, pers. obs. 2002). Injuries associated directly with pile driving are poorly studied, but include rupture of the swimbladder and internal hemorrhaging (CalTrans 2001; Abbott and Bing-Sawyer 2002; Stadler, pers. obs. 2002). The type and intensity of the sounds produced during pile driving depend on a variety of factors, including, but not limited to, the type and size of the pile, the firmness of the substrate into which the pile is being driven, the depth of water, and the type and size of the pile-driving hammer. Driving large hollow-steel piles with impact hammers produces intense, sharp spikes of sound that can easily reach levels injurious to fish. Vibratory hammers, on the other hand, produce sounds of lower intensity, with a rapid repetition rate.

Systems successfully designed to reduce the adverse effects of underwater sounds on fish have included the use of air bubbles. Both confined (i.e., metal or fabric sleeve) and unconfined air bubble systems have been shown to attenuate underwater sound pressures (Longmuir and Lively 2001, Christopherson and Wilson 2002, Reyff and Donovan 2003).

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Install hollow-steel piles with an impact hammer at a time of year when larval and juvenile stages of fish species with designated EFH are not present.
2. Drive piles during low tide when they are located in intertidal and shallow subtidal areas.
3. Use a vibratory hammer when driving hollow-steel piles.
4. Implement measures to attenuate the sound should it exceed threshold levels. If sound pressure levels are anticipated to exceed acceptable limits, implement appropriate mitigation measures when practicable. Methods to reduce the sound pressure levels include, but are not limited to, the following:
   a) Surround the pile with an air bubble curtain system or air-filled coffer dam.
   b) Because the sound produced has a direct relationship to the force used to drive the pile, use a smaller hammer to reduce the sound pressures.
   c) Use a hydraulic hammer if impact driving cannot be avoided. The force of the hammer blow can be controlled with hydraulic hammers; reducing the impact force will reduce the intensity of the resulting sound.
5. Drive piles when the current is reduced (i.e., centered around slack current) in areas of strong current to minimize the number of fish exposed to adverse levels of underwater sound.

Pile Removal

Potential Adverse Impacts

The primary adverse effect of removing piles is the suspension of sediments, which may result in harmful levels of turbidity and release of contaminants contained in those sediments. Vibratory pile removal tends to cause the sediments to slough off at the mudline, resulting in relatively low levels of suspended sediments and contaminants. Breaking or cutting the pile below the mudline may suspend only small amounts of sediment, providing that the stub is left in place, and little digging is required to access the pile. Direct pull or use of a clamshell to remove broken piles may, however, suspend large amounts of sediment and contaminants. When the piling is pulled from the substrate using these two methods, sediments clinging to the piling will slough off as it is raised through the water column, producing a potentially harmful plume of turbidity and/or contaminants. The use of a clamshell may suspend additional sediment if it penetrates the substrate while grabbing the piling.

While there is a potential to adversely affect EFH during the removal of piles, many of the piles removed are old creosote-treated timber piles. In some cases, the long-term benefits to EFH obtained by removing a chronic source of contamination may outweigh the temporary adverse effects of turbidity.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Remove piles completely rather than cutting or breaking them off, if they are structurally sound.
2. Minimize the suspension of sediments and disturbance of the substrate when removing piles. Measures to help accomplish this include, but are not limited to, the following:
   a) When practicable, remove piles with a vibratory hammer, rather than using the direct pull or clamshell

method.

b) Remove the pile slowly to allow sediment to slough off at, or near, the mudline.
c) The operator should first hit or vibrate the pile to break the bond between the sediment and the pile to minimize the potential for the pile to break, as well as to reduce the amount of sediment sloughing off the pile during removal.
d) Encircle the pile, or piles, with a silt curtain that extends from the surface of the water to the substrate.

3. Complete each pass of the clamshell to minimize suspension of sediment if pile stubs are removed with a clamshell.
4. Place piles on a barge equipped with a basin to contain all attached sediment and runoff water after removal.
5. Using a pile driver, drive broken/cut stubs far enough below the mudline to prevent release of contaminants into the water column as an alternative to their removal.

5.3.6 Overwater Structures

Overwater structures include commercial and residential piers and docks, floating breakwaters, barges, rafts, booms, and mooring buoys. These structures typically are located in intertidal areas out to about 49 feet (15 meters) below the area exposed by the mean lower low tide (i.e., the shallow subtidal zone). Light, wave energy, substrate type, depth, and water quality are the primary factors controlling the plant and animal assemblages found at a particular site. Overwater structures and associated activities can alter these factors and interfere with key ecological functions such as spawning, rearing, and refugia. Site-specific factors (e.g., water clarity, current, depth, etc.) and the type and use of a given overwater structure determine the occurrence and magnitude of these impacts.

Potential Adverse Impacts

Overwater structures and associated developments may adversely affect EFH in a variety of ways, primarily by (1) changes in ambient light conditions, (2) alteration of the wave and current energy regime, and (3) activities associated with the use and operation of the facilities (Nightingale and Simenstad 2001).

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Use upland boat storage whenever possible to minimize need for overwater structures.
2. Locate overwater structures in deep enough waters to avoid intertidal and shade impacts, minimize or preclude dredging, minimize groundings, and avoid displacement of submerged aquatic vegetation, as determined by a preconstruction survey.
3. Design piers, docks, and floats to be multiuse facilities to reduce the overall number of such structures and to limit impacted nearshore habitat.
4. Incorporate measures that increase the ambient light transmission under piers and docks. These measures include, but are not limited to, the following:
   a) Maximize the height of the structure, and minimize the width of the structure to decrease the shade footprint and using grated decking material.
   b) Use reflective materials (e.g., concrete or steel instead of materials that absorb light such as wood) on the underside of the dock to reflect ambient light.

c) Use the fewest number of pilings necessary to support the structures to allow light into under-pier areas and minimize impacts to the substrate.
d) Align piers, docks, and floats in a north-south orientation to allow the arc of the sun to cross perpendicular to the structure and to reduce the duration of light limitation.

5. Use floating rather than fixed breakwaters whenever possible, and remove them during periods of low dock use. Encourage seasonal use of docks and off-season haul-out.
6. Locate floats in deep water to avoid light limitation and grounding impacts to the intertidal or shallow subtidal zone.
7. Maintain at least 1 foot (0.30 meter) of water between the substrate and the bottom of the float at extreme low tide.
8. Conduct in-water work when managed species and prey species are least likely to be impacted.
9. To the extent practicable, avoid the use of treated wood timbers or pilings and use alternative materials such as untreated wood, concrete, or steel.
10. Mitigate for unavoidable impacts to benthic habitats. Mitigation should be adequate, monitored, and adaptively managed.

5.3.7 Flood Control/Shoreline Protection

Protecting riverine and estuarine communities from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitat. The use of dikes and berms can also have long-term adverse effects on tidal marsh and estuarine habitats. Tidal marshes are highly variable, but typically have freshwater vegetation at the landward side, saltwater vegetation at the seaward side, and gradients of species inbetween that are in equilibrium with the prevailing climatic, hydrographic, geological, and biological features of the coast. These systems normally drain through highly dendritic tidal creeks that empty into the bay or estuary. Freshwater entering along the upper edges of the marsh drains across the surface and enters the tidal creeks. Structures placed for coastal shoreline protection include, but are not limited to, concrete or wood seawalls, rip-rap revetments (sloping piles of rock placed against the toe of the dune or bluff in danger of erosion from wave action), dynamic cobble revetments (natural cobble placed on an eroding beach to dissipate wave energy and prevent sand loss), vegetative plantings, and sandbags.

Potential Adverse Impacts

Dikes, levees, ditches, or other water controls at the upper end of a tidal marsh can cut off all tributaries feeding the marsh, preventing freshwater flushing and annual flushing, annual renewal of sediments and nutrients, and the formation of new marshes. Water controls within the marsh proper intercept and carry away freshwater drainage, block freshwater from flowing across seaward portions of the marsh, increase the speed of runoff of freshwater to the bay or estuary, lower the water table, permit saltwater intrusion into the marsh proper, and create migration barriers for aquatic species. In deeper channels where reducing conditions prevail, large quantities of hydrogen sulfide are produced. These quantities are toxic to marsh grasses and other aquatic life. Acid conditions of these channels can also result in release of heavy metals from the sediments.

Long-term effects on the tidal marsh include land subsidence (sometimes even submergence), soil compaction, conversion to terrestrial vegetation, greatly reduced invertebrate populations, and general loss of productive wetland characteristics. Loss of these low-salinity environments reduces estuarine fertility, restricts suitable habitat for aquatic species, and creates abnormally high salinity during drought years. Low-salinity environments form a barrier that prevents the entrance of many marine species, including competitors, predators, parasites, and pathogens.

Armoring of shorelines to prevent erosion and to maintain or create shoreline real estate simplifies habitats, reduces the amount of intertidal habitat, and affects nearshore processes and the ecology of numerous species (Williams and Thom 2001). Hydraulic effects on the shoreline include increased energy seaward of the armoring, reflected wave energy, dry beach narrowing, substrate coarsening, beach steepening, changes in sediment storage capacity, loss of organic debris, and downdrift sediment starvation (Williams and Thom 2001). Installation of breakwaters and jetties can result in community changes from burial or removal of resident biota, changes in cover and preferred prey species, and predator attraction (Williams and Thom 2001). As with armoring, breakwaters and jetties modify hydrology and nearshore sediment transport, as well as movement of larval forms of many species (Williams and Thom 2001).

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Minimize the loss of riparian habitats as much as possible.
2 Do not undertake diking and draining of tidal marshlands and estuaries.
3. Wherever possible, use soft approaches (such as beach nourishment, vegetative plantings, and placement of LWD) to shoreline modifications.
4. Include efforts to preserve and enhance EFH by providing new gravel for spawning areas, removing barriers to natural fish passage, and using weirs, grade control structures, and low-flow channels to provide the proper depth and velocity for fish.
5. Construct a low-flow channel to facilitate fish passage and help maintain water temperature in reaches where water velocities require armoring of the riverbed.
6. Offset unavoidable impacts to in-stream fish habitat by providing rootwads, deflector logs, boulders, and rock weirs and by planting shaded riverine aquatic cover vegetation.
7. Use an adaptive management plan with ecological indicators to oversee monitoring and to ensure that mitigation objectives are met. Take corrective action as needed.

5.3.8 Log Transfer Facilities/In-water Log Storage

Rivers, estuaries, and bays were historically the primary ways to transport and store logs in the Pacific Northwest. Log storage within the bays and estuaries remains an issue in several Pacific Northwest bays. Using estuaries and bays and nearby uplands for storage of logs is common in Alaska, with most LTFs found in Southeast Alaska and a few located in Prince William Sound.

Potential Adverse Impacts

Log handling and storage in the estuary and intertidal zones of rivers can result in modification of benthic habitat and water quality degradation within the area of bark deposition (Levings and Northcote 2004). EFH may also be physically impacted by activities associated with facilities, constructed in the water, that are used to transfer commercially harvested logs to or from a vessel or log raft, including log rafts. Bark and wood debris may accumulate as a result of the abrasion of log surfaces from transfer equipment and impact EFH. After the logs have entered the water, they usually are bundled into rafts and hooked to a tug for shipment. In the process, bark and other wood debris can pile up on the ocean floor. The piles can smother clams, mussels, some seaweed, kelp, and grasses, with the bark sometimes remaining for decades. Accumulation of bark debris in shallow and deep-water environments has resulted in locally decreased epifaunal macrobenthos richness and abundance (Kirkpatrick et al. 1998, Jackson 1986). Log storage may also result in a release of soluble organic compounds within the bark pile. The physical, chemical, and biological impacts of log operations can be substantially reduced by adherence to appropriate siting and operational constraints. Adherence operational and siting guidelines will reduce (1) the amount of bark and wood debris that enters the marine and coastal environment, (2) the potential for displacement or harm to aquatic species, and (3) the accumulation of bark and wood debris on the ocean floor.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Restrict or eliminate storage and handling of logs from waters where state and federal water quality standards cannot be met at all times outside of the authorized zone of deposition.
2. Minimize potential impacts of log storage by employing effective bark and wood debris control, collection, and disposal methods at log dumps, raft building areas, and mill-side handling zones; avoiding free-fall dumping of logs; using easy let-down devices for placing logs in the water; and bundling logs before water storage (bundles should not be broken except on land and at millside).
3. Do not store logs in the water if they will ground at any time or shade sensitive aquatic vegetation such as eelgrass.
4. Avoid siting log-storage areas and LTFs in sensitive habitat and areas important for specified species, as required by the ATTF guidelines.
5. Site log storage areas and LTFs in areas with good currents and tidal exchanges.
6. Use land-based storage sites where possible, with the goal of eliminating in-water storage of logs.

5.3.9 Utility Line/Cables/Pipeline Installation

With the continued development of coastal regions comes greater demand for the installation of cables, utility lines for power and other services, and pipelines for water, sewage, etc. The installation of pipelines, utility lines, and cables can have direct and indirect impacts on the offshore, nearshore, estuarine, wetland, beach, and rocky shore coastal zone habitats. Many of the primary and direct impacts occur during the construction phase of installation, such as ground disturbance in the clearing of the right-of-way, access roads, and equipment staging areas. Indirect impacts can include increased turbidity, saltwater intrusion, accelerated erosion, and introduction of urban and industrial pollutants.

Potential Adverse Impacts

Adverse effects on EFH from the installation of pipelines, utility lines, and cables can occur through (1) destruction of organisms and habitat, (2) turbidity impacts, (3) resuspension of contaminants, and (4) changes in hydrology.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Align crossings along the least environmentally damaging route. Avoid sensitive habitats such as hard-bottom (e.g., rocky reefs), cold-water corals, submerged aquatic vegetation, oyster reefs, emergent marsh, and mud flats.
2. Use horizontal directional drilling where cables or pipelines would cross anadromous fish streams, salt marsh, vegetated inter-tidal zones, or steep erodible bluff areas adjacent to the inter-tidal zone to avoid surface disturbances.
3. Avoid construction of permanent access channels since they disrupt natural drainage patterns and destroy wetlands through excavation, filling, and bank erosion.
4. Store and contain excavated material on uplands.
5. Backfill excavated wetlands with either the same or comparable material capable of supporting similar wetland vegetation and at original marsh elevations.
6. Use existing rights-of-way whenever possible to lessen overall encroachment and disturbance of wetlands.
7. Bury pipelines and submerged cables where possible.
8. Remove inactive pipelines and submerged cables unless they are located in sensitive areas (e.g., marsh, reefs, sea grass, etc.) or in areas that present no safety hazard.
9. Use silt curtains or other type barriers to reduce turbidity and sedimentation whenever possible near the project site.
10. Limit access for equipment to the immediate project area.
11. Limit construction equipment to the minimum size necessary to complete the work.
12. Conduct construction during the time of year when it will have the least impact on sensitive habitats and species.
13. Suspend transmission lines beneath existing bridges or conduct directional boring under streams to reduce the environmental impact.
14. For activities on the Continental Shelf, shunt drill cuttings through a conduit and either discharge the cuttings near the sea floor, or transport them ashore.
15. For activities on the Continental Shelf, and to the extent practicable, locate drilling and production structures, including pipelines, at least 1 mile (1.6 kilometers) from the base of a hard-bottom habitat.
16. For activities on the Continental Shelf, and to avoid and minimize adverse impacts to managed species, implement the following to the extent practicable:
    a) Bury pipelines at least 3 feet (0.9 meter) beneath the sea floor, whenever possible. Particular considerations (i.e., currents, ice scour) may require deeper burial or weighting to maintain adequate cover. Buried pipeline and cables should be examined periodically for maintenance of adequate earthen cover.
    b) Where burial is not possible, such as in hard-bottomed areas, attach pipelines and cables to substrate to minimize conflicts with fishing gear.
    c) Locate alignments along routes that will minimize damage to marine and estuarine habitat.
    d) Where user conflicts are likely, consult and coordinate with fishing stakeholder groups during the route-planning process to minimize conflict.

5.3.10 Commercial Utilization of Habitat

Productive embayments are often used for commercial culturing and harvesting operations. These locations provide protected waters which serve as sites for oyster and mussel culturing. These operations may occur in areas of productive eelgrass beds. In 1988, Alaska passed the Alaska Aquatic Farming Act which is designed to encourage establishment and growth of an aquatic farming industry in the state. The Act establishes four criteria for issuance of an aquatic farm permit, including the requirement that the farm may not significantly affect fisheries, wildlife, or other habitats in an adverse manner.

Potential Adverse Impacts

Adverse impacts to EFH by operations that directly or indirectly use habitat include (1) discharge of organic waste, (2) shading and direct impacts to the seafloor, (3) risk of introducing undesirable species, and (4) impacts on estuarine food webs.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Site mariculture operations away from exisiting kelp or eelgrass beds. If mariculture operations are to be located adjacent to existing kelp or eelgrass beds, monitor these beds on an annual basis and resite the mariculture facility if monitoring reveals adverse effects.
2. Do not enclose or impound tidally influenced wetlands for mariculture. Take into account the size of the facility, migratory patterns, competing uses, hydrographic conditions, and upstream uses when siting facilities.
3. Undertake a thorough scientific review and risk assessment before any non-native species are introduced.
4. Encourage development of harvesting methods to minimize impacts on plant communities and the loss of food and/or habitat to fish populations during harvesting operations.
5. Provide appropriate mitigation for the unavoidable, extensive, or permanent loss of plant communities.

5.4 COASTAL/MARINE ACTIVITIES

5.4.1 Point-source Discharges

Point-source discharges from municipal sewage treatment facilities or storm water discharges are controlled through EPA's regulations under the CWA and by state water regulations. The primary concerns associated with municipal point-source discharges involve treatment levels needed to attain acceptable nutrient inputs and overloading of treatment systems due to rapid development of the coastal zone. Storm drains are contaminated from communities using settling and storage ponds, street runoff, harbor activities, and honey buckets. Annually, wastewater facilities introduce large volumes of untreated excrement and chlorine through sewage outfall lines, as well as releasing treated freshwater into the nation's waters. This can significantly alter pH levels of marine waters (Council 1999).

Potential Adverse Impacts

There are many potential impacts from point-source discharge, but point-source discharges and resulting altered water quality in aquatic environments do not necessarily result in adverse impacts, either to marine resources or EFH. Because most point-source discharges are regulated by the state or EPA, effects to receiving waters are generally considered on a case-by-case basis. Point-source discharges can adversely affect EFH by (1) reducing habitat functions necessary for growth to maturity, (2) modifying community structure, (3) bioaccumulation, and (4) modifying habitat.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Locate discharge points in coastal waters well away from shellfish beds, sea grass beds, coral reefs, and other similar fragile and productive habitats.
2. Reduce potentially high velocities by diffusing effluent to acceptable velocities.
3. Determine benthic productivity by sampling before any construction activity related to installation of new or modified facilities. Develop outfall design (e.g., modeling concentrations within the predicted plume or likely extent of deposition along a productive nearshore) with input from appropriate resource and Tribal agencies.
4. Provide for mitigation when degradation or loss of habitat occurs from placement and operation of the outfall structure and pipeline.
5. Institute source-control programs that effectively reduce noxious materials to avoid introducing these materials into the waste stream.
6. Ensure compliance with pollutant discharges regulated through discharge permits which set effluent discharge limitations and/or specify operation procedures, performance standards, or BMPs. These efforts rely on the implementation of BMPs to control polluted runoff (EPA 1993).
7. Treat discharges to the maximum extent practicable, including implementation of up-to-date methodologies for reducing discharges of biocides (e.g., chlorine) and other toxic substances.
8. Use land-treatment and upland disposal/storage techniques where possible. Limit the use of vegetated wetlands as natural filters and pollutant assimilators for large-scale discharges to those instances where other less damaging alternatives are not available, and the overall environmental and ecological suitability of such actions has been demonstrated.
9. Avoid siting pipelines and treatment facilities in wetlands and streams. Since pipelines and treatment facilities are not water-dependent with regard to positioning, it is not essential that they be placed in wetlands or other fragile coastal habitats. Avoiding placement of pipelines within streambeds and wetlands will also reduce inadvertent infiltration into conveyance systems and retain natural hydrology of local streams and wetlands.

5.4.2 Fish Processing Waste—Shoreside and Vessel Operation

Seafood processing facilities are either shore-based facilities discharging through stationary outfalls or mobile vessels engaged in the processing of fresh or frozen seafood (Science Applications International Corporation 2001). Discharge of fish waste from shoreside and vessel processing has occurred in marine waters since the 1800s (Council 1999). With the exception of fresh market fish, some form of processing involving butchering, evisceration, precooking, or cooking is necessary to bring the catch to market. Precooking or blanching facilitates the removal of skin, bone, shell, gills, and other materials. Depending on the species, the cleaning operation may be manual, mechanical, or a combination of both (EPA 1974). Seafood processing facilities generally consist of mechanisms to offload the harvest from fishing boats; tanks to hold the seafood until the processing lines are ready to accept them; processing lines, process water, and waste collection systems; treatment and discharge facilities; processed seafood storage areas; and necessary support facilities such as electrical generators, boilers, retorts, water desalinators, offices, and living quarters. In addition, marinas that cater to patrons who fish a large amount can produce an equally large quantity of fish waste at the marina from fish cleaning.

Potential Adverse Impacts

Generally, seafood processing wastes consist of biodegradable materials that contain high concentrations of soluble organic material. Seafood processing operations have the potential to adversely affect EFH through (1) direct and/or nonpoint source discharge, (2) particle suspension, and (3) increased turbidity and surface plumes.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. To the maximum extent practicable, base effluent limitations on site-specific water quality concerns.
2. To the maximum extent practicable, avoid the practice of discharging untreated solid and liquid waste directly into the environment.
3. Do not allow designation of new ZODs. Explore options to eliminate or reduce ZODs at existing facilities.
4. Control stickwater by physical or chemical methods.
5. Promote sound fish waste management through a combination of fish-cleaning restrictions, public education, and proper disposal of fish waste.
6. Encourage the alternative use of fish processing wastes (e.g., fertilizer for agriculture and animal feed).
7. Explore options for additional research.
8. Locate new plants outside rearing and nursery habitat. Monitor both biological and chemical changes to the site.

5.4.3 Water Intake Structures/Discharge Plumes

The withdrawal of riverine, estuarine, and marine waters by water intake structures is a common aquatic activity. Water may be withdrawn and used, for example, to cool power-generating stations and create temporary ice roads and ice ponds. In the case of power plants, the subsequent discharge of heated and/or chemically treated discharge water can also occur.

Potential Adverse Impacts

Water intake structures and effluent discharges can interfere with or disrupt EFH functions in the source or receiving waters by (1) entrainment, (2) impingement, (3) discharge, (4) operation and maintenance, and (5) construction-related impacts.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Locate facilities that rely on surface waters for cooling in areas other than estuaries, inlets, heads of submarine canyons, rock reefs, or small coastal embayments where managed species or their prey concentrate.
2. Design intake structures to minimize entrainment or impingement.
3. Design power plant cooling structures to meet the best technology available requirements as developed pursuant to Section 316(b) of the CWA.
4. Regulate discharge temperatures (both heated and cooled effluent) so they do not appreciably alter the temperature to an extent that could cause a change in species assemblages and ecosystem function in the receiving waters.
5. Avoid the use of biocides (e.g., chlorine) to prevent fouling where possible. Implement the least damaging antifouling alternatives.
6. Mitigate for impacts related to power plants and other industries requiring cooling water.
7. Treat all discharge water from outfall structures to meet state water quality standards at the terminus of the pipe.

5.4.4 Oil/Gas Exploration/Development/Production

Offshore exploration, development, and production of natural gas and oil reserves have been, and continue to be, an important aspect of the U.S. economy. As demand for energy resources grows, the debate over trying to balance the development of oil and gas resources and the protection of the environment will also continue. Projections indicate that U.S. demand for oil will increase by 1.3 percent per year between 1995 and 2020. Gas consumption is projected to increase by an average of 1.6 percent during the same time frame (Waisley 1998). Much of the 1.9 billion acres within the offshore jurisdiction of the U.S. remains unexplored (Oil and Gas Technologies for the Arctic and Deepwater 1985). Some of the older oil and gas platforms in operation will probably reach the end of their productive life in the near future, and decommissioning them is also an issue.

Potential Adverse Impacts

Offshore oil and gas operations can be classified into exploration, development, and production activities (which includes transportation). These activities occur at different depths in a variety of habitats. Not all of the potential disturbances in this list apply to every type of activity. These areas are subject to an assortment of physical, chemical, and biological disturbances, including the following (Council 1999, Helvey 2002):

- Noise from seismic surveys, vessel traffic, and construction of drilling platforms or islands
- Physical alterations to habitat from the construction, presence, and eventual decommissioning and removal of facilities such as islands or platforms, storage and production facilities, and pipelines to onshore common carrier pipelines, storage facilities, or refineries
- Waste discharges, including well drilling fluids, produced waters, surface runoff and deck drainage, domestic waste waters generated from the offshore facility, solid waste from wells (drilling muds and cuttings), and other trash and debris from human activities associated with the facility
- Oil spills
- Platform storage and pipeline decommissioning

The potential disturbances and associated adverse impacts on the marine environment have been reduced through operating procedures required by regulatory agencies and, in many cases, self-imposed by facilities operators. Most of the activities associated with oil and gas operations are conducted under permits and regulations that require companies to minimize impacts or avoid construction in sensitive marine habitats. New technological advances in operating procedures also reduce the potential for impacts.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH:

1. As part of pre-project planning, identify all species of concern regulated under federal or state fishery management plans that inhabit, spawn, or migrate through areas slated for exploration, development, or production.
2. Avoid the discharge of produced waters into marine waters and estuaries. Reinject produced waters into the oil formation whenever possible.
3. Avoid discharge of muds and cuttings into the marine and estuarine environment.
4. To the extent practicable, avoid the placement of fill to support construction of causeways or structures in the nearshore marine environment.
5. As required by federal and state regulatory agencies, encourage the use of geographic response strategies that identify EFH and environmentally sensitive areas.
6. To the extent practicable, use methods to transport oil and gas that limit the need for handling in environmentally sensitive areas, including EFH.
7. Ensure that appropriate safeguards have been considered before drilling the first development well into the targeted hydrocarbon formations whenever critical life history stages of federally managed species are present.
8. Ensure that appropriate safeguards have been considered before drilling exploration wells into untested formations whenever critical life stages of federally managed species are present.
9. Oil and gas transportation and production facilities should be designed, constructed, and operated in accordance with applicable regulatory and engineering standards.
10. Evaluate and minimize impacts to EFH during the decommissioning phase of oil and gas facilities, including possible impacts during the demolition phase.

5.4.5 Habitat Restoration/Enhancement

Habitat loss and degradation are major, long-term threats to the sustainability of fishery resources (NMFS 2002). Viable coastal and estuarine habitats are important to maintaining healthy fish stocks. Good water quality and quantity, appropriate substrate, ample food sources, and substantial hiding places are needed to sustain fisheries. Restoration and/or enhancement of coastal and riverine habitat that supports managed fisheries and their prey will assist in sustaining and rebuilding fisheries stocks and recovering certain threatened or endangered species by increasing or improving ecological structure and functions. Habitat restoration/enhancement may include, but is not limited to, improvement of coastal wetland tidal exchange or reestablishment of historic hydrology, dam or berm removal, fish passage barrier removal/ modification, road-related sediment source reduction, natural or artificial reef/substrate/habitat creation, establishment or repair of riparian buffer zones, improvement of freshwater habitats that support anadromous fishes, planting of native coastal wetland and submerged aquatic vegetation, creation of oyster reefs, and improvements to feeding, shade or refuge, spawning, and rearing areas that are essential to fisheries.

Potential Adverse Impacts

The implementation of restoration/enhancement activities may have localized and temporary adverse impacts on EFH. Possible impacts can include (1) localized nonpoint source pollution such as influx of sediment or nutrients, (2) interference with spawning and migration periods, (3) temporary or permanent removal feeding opportunities, and (4) indirect effects from actual construction portions of the activity.

Recommended Conservation Measures

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. Use BMPs to minimize and avoid potential impacts to EFH during restoration activities. BMPs should include, but are not limited to, the following:
   a) Use turbidity curtains, haybales, and erosion mats to protect the water column.
   b) Plan staging areas in advance, and keep them to a minimum size.
   c) Establish buffer areas around sensitive resources; flag and avoid rare plants, archeological sites, etc.
   d) Remove invasive plant and animal species from the proposed action area before starting work. Plant only native plant species. Identify and implement measures to ensure native vegetation or revegetation success (Section G.4.4 of the EFH EIS).
   e) Establish temporary access pathways before restoration activities to minimize adverse impacts from project implementation.
2. Avoid restoration work during critical life stages for fish such as spawning, nursery, and migration. Determine these periods before project implementation to reduce or avoid any potential impacts.
3. Provide adequate training and education for volunteers and project contractors to ensure minimal impact to the restoration site. Train volunteers in the use of low-impact techniques for planting, equipment handling, and any other activities associated with the restoration.
4. Conduct monitoring before, during, and after project implementation to ensure compliance with project design and restoration criteria. If immediate post-construction monitoring reveals that unavoidable impacts to EFH have occurred, ensure that appropriate coordination with NMFS occurs to determine appropriate response measures, possibly including mitigation.
5. To the extent practicable, mitigate any unavoidable damage to EFH within a reasonable time after the impacts occur.
6. Remove and, if necessary, restore any temporary access pathways and staging areas used in the restoration effort.
7. Determine benthic productivity by sampling before any construction activity in the case of subtidal enhancement (e.g., artificial reefs). Avoid areas of high productivity to the maximum extent possible. Develop a sampling design with input from state and federal resource agencies. Before construction, evaluate of the impact resulting from the change in habitat (sand bottom to rocky reef, etc.). During post-construction monitoring, examine the effectiveness of the structures for increasing habitat productivity.

5.4.6 Marine Mining

Mining activity, which is also described in Sections G.3.1.1 and G.3.1.2 of the EFH EIS, can lead to the direct loss of EFH for certain species. Offshore mining, such as the extraction of gravel and gold in the Bering Sea and the mining of gravel from beaches, can increase turbidity of water. Thus, the resuspension of organic materials could affect less motile organisms (i.e., eggs and recently hatched larvae) in the area. Benthic habitats could be damaged or destroyed by these actions. Mining large quantities of beach gravel may significantly affect the removal, transport, and deposition of sand and gravel along the shore, both at the mining site and down-current (Council 1999). Neither the future extent of this activity nor the effects of such mortality on the abundance of marine species is known.

Potential Adverse Impacts

Mining practices that can affect EFH include physical impacts from intertidal dredging and chemical impacts from the use of additives such as flocculates (Council 1999). Impacts may include the removal of substrates that serve as habitat for fish and invertebrates; habitat creation or conversion in less productive or uninhabitable sites, such as anoxic holes or silt bottom; burial of productive habitats, such as in near-shore disposal sites (as in beach nourishment); release of harmful or toxic materials either in association with actual mining, or in connection with machinery and materials used for mining; creation of harmful turbidity levels; and adverse modification of hydrologic conditions so as to cause erosion of desirable habitats. Submarine disposal of mine tailings can also alter the behavior of marine organisms. Submarine mine tailings may not provide suitable habitat for some benthic organisms. In laboratory experiments, benthic dwelling flatfishes (Johnson et al. 1998a) and crabs (Johnson et al. 1998b) strongly avoided mine tailings.

During beach gravel mining, water turbidity increases and the resuspension of organic materials can affect less motile organisms (i.e., eggs and recently hatched larvae) in the area. Benthic habitats can be damaged or destroyed by these actions. Changes in bathymetry and bottom type may also alter population and migrations patterns (Hurme and Pullen 1988).

Recommended Conservation Measures

The following recommended conservation measures for marine mining should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

1. To the extent practicable, avoid mining in waters containing sensitive marine benthic habitat including EFH (e.g., spawning, migrating, and feeding sites).
2. Minimize the areal extent and depth of extraction to reduce recolonization times.
3. Monitor turbidity during operations, and cease operations if turbidity exceeds predetermined threshold levels. Use sediment or turbidity curtains to limit the spread of suspended sediments and minimize the area affected.
4. Monitor individual mining operations to avoid and minimize cumulative impacts. For instance, three mining operations in an intertidal area could impact EFH, whereas one may not. Disturbance of previously contaminated mining areas may cause additional loss of EFH.
5. Use seasonal restrictions, as appropriate, to avoid and minimize impacts to EFH during critical life history stages of managed species (e.g., migration and spawning).

5.4.7 Persistent Organic Pollutants

The single biggest pollution threat to marine waters in Alaska is the deposition of persistent pollutants from remote sources. A large variety of contaminants can be found in Alaska's marine environment, including persistent organic pollutants (POPs) and heavy metals. North Pacific and Alaska marine waters are perceived as pristine because most of Alaska's 6,640 miles (10,686 kilometers) of coastline are devoid of point-source pollution, unlike much of North America. Effluents from pulp mills, marinas and boat harbors, municipal outfalls, and other industrial activities are generally considered to be the primary sources of contamination in Alaska waters, so most efforts at monitoring and mitigation have been focused on the local level. However, there is an increasing body of evidence suggesting that the greatest contaminant threat in Alaska comes from atmospheric and marine transport of contaminants from areas quite distant from Alaska.

The geography of Alaska makes it particularly vulnerable to contaminants volatilized from Asia. Pesticides applied to crops in Southeast Asia can be volatilized into the air, bound to suspended particulates, transported in the atmosphere to Alaska, and deposited in snow or rain directly into marine ecosystems or indirectly from freshwater flow to nearshore waters. Revolatilization of these compounds is inhibited by the cold temperatures associated with Alaska latitudes, resulting in a net accumulation of these compounds in northern habitats. This same distillation process also transfers volatilized contaminants from the atmosphere to the Pacific at lower latitudes, and ocean currents also deliver the contaminants to Alaska. Concentrations will be very low, but there will extensive geographical marine or land areas to act as cold deposit zones. The effect of these transport mechanisms has been the appearance of persistent organic contaminants in northern latitudes, despite the absence of local sources.

With over 100,000 chemicals on the market and an additional 1,000 to 2,000 new ones introduced annually, there are likely other toxic compounds in the environment whose concentrations are increasing. In addition, combustion and industrial processes result in the inadvertent production of unregulated chemicals (Arctic Monitoring and Assessment Programme [AMAP] 2002).

Potential Adverse Impacts

It is not clear if the levels of contaminants in Alaska waters are causing deleterious effects to populations, because research in this area is still in its infancy. Relatively small and spotty contaminant surveys have established that POPs are present in Alaska waters, forage, and predators. No comprehensive geographical and temporal studies have been done to date to examine trends or sources of variation. The potential for the problem has been exposed; the extent and significance remain to be determined.

The existence of organic contaminants in biological tissues means these contaminants are being transported within the food webs in Alaska fish habitats. The trophic structure of Alaska marine food webs, coupled with the tendency of contaminants to accumulate in Alaska habitats, causes apex predators to concentrate significant amounts of POPs in their tissues. Contamination is probably widespread among forage species at low levels, but apex predators are likely be the most affected as a result of their longevity, lipid storage, and the relatively high concentrations they bear. Contamination can cause immunological and reproductive impairment, acute toxic effects, and population declines. This issue is particularly relevant when the contaminant loads experienced by Alaska natives subsisting on foods derived from marine habitats are considered. Impacts may also occur at lower trophic levels, but there has been even less research in this area.

The impacts of persistent contaminants on populations in Alaska waters are not likely to be acute. The impacts are more likely be expressed as sublethal impacts in apparently healthy animals. These sublethal impacts ultimately lead to reduced reproductive fitness or decreased survival to maturity; therefore, they manifest themselves indirectly. Science is certain that the physical properties of these compounds couple with global climate patterns to ensure that they will be deposited in Alaska habitats, while maintaining their toxicity and perfusing through Alaska food webs, which include some of the most valuable fisheries on the planet. What is uncertain is how these compounds impact the health of organisms deriving sustenance from those food webs and how those impacts might feed back into the food web.

Recommended Conservation Measures

No mitigation strategies are proposed at this time relative to contaminants. There are too many unknowns. POP contaminants are present in Alaska waters and forage species and in predators up through apex predators, but the significance of the present loads is not known. Also, the relative concentrations in forage species (pollock for example) from the EBS, near Russia, or the northern GOA are not known. Comprehensive studies on a geographical, temporal, or widespread species scale to determine any relationship between contaminant loads and population changes have not been conducted. POP contaminants may contribute to poor recovery in some species, but mitigation strategies, whether they would be changes in fishing regulations or international regulation to curb contaminant releases, will likely need a better research foundation to support changes.

6.0 Cumulative Effects of Fishing and Non-fishing Activities on EFH

This section discusses the cumulative effects of fishing and non-fishing activities on EFH. As identified in Section 4.0, historical fishing practices may have had effects on EFH that have led to declining trends in some of the criteria examined. As described in earlier sections, the effects of current fishing activities on EFH are classified as minimal and temporary or unknown. Additional information and analysis is provided in Appendix B of the EFH EIS (NMFS 2005).

A review of the effects of non-fishing activities on EFH is found in Section 5.0. Additional information and analysis is provided in Appendix G of the EFH EIS. Section 5.0 identifies 29 non-fishing activities for which potential effects. However, the magnitude of these effects cannot currently be quantified with available information. Of the 29 activities, most are described as likely having less than substantial potential effects on EFH. Some of these activities such as urban/suburban development, road building and maintenance (including the placement of fill material), vessel operations/transportation/navigation, silviculture (including LTFs), and point source discharge may have potential cumulative impacts due to the additive and chronic nature of these activities. NMFS does not have regulatory authority over non-fishing activities, but frequently provides recommendations to other agencies to avoid, minimize, or otherwise mitigate the effects of these activities.

Fishing and each activity identified in the analysis of non-fishing activities may not significantly affect the function of EFH. However, the synergistic effect of the combination of all of these activities may be a cause for concern. Unfortunately, available information is not sufficient to assess how the cumulative effects of fishing and non-fishing activities influence the function of EFH on an ecosystem or watershed scale. The magnitude of the combined effect of all of these activities cannot be quantified, so the level of concern is not known at this point.

7.0 Research Approach for EFH

The EFH EIS (NMFS 2005) identified the following research approach for EFH regarding minimizing fishing impacts.

Objectives

Reduce impacts. (1) Limit bottom trawling in the AI to areas historically fished and prevent expansion into new areas. (2) Limit bottom contact gear in specified coral garden habitat areas. (3) Restrict higher impact trawl fisheries from a portion of the GOA slope. (4) Increase monitoring for enforcement. (5) Establish a scientific research program.

Benthic habitat recovery. Allow recovery of habitat in a large area with relatively low historic effort.

Research Questions

Reduce impacts. Does the closure effectively restrict higher-impact trawl fisheries from a portion of the GOA slope? Is there increased use of alternative gears in the GOA closed areas? Does total bottom trawl effort in adjacent open areas increase as a result of effort displaced from closed areas? Do bottom trawls affect these benthic habitats more than the alternative gear types? What are the research priorities? Are fragile habitats in the AI affected by any fisheries that are not covered by the new EFH closures? Are sponge and coral essential components of the habitat supporting FMP species?

Benthic habitat recovery. Did the habitat within closed areas recover or remain unfished because of these closures? Do recovered habitats support more abundant and healthier FMP species? If FMP species are more abundant in the EFH protection areas, is there any benefit in yield for areas that are still fished without EFH protection?

Research Activities

Reduce impacts. Fishing effort data from observers and remote sensing would be used to study changes in bottom trawl and other fishing gear activity in the closed (and open) areas. First, the recent gear-specific fishing pattern must be characterized to establish a baseline for comparison with observed changes in effort after closures occur. An effective analysis of change requires comprehensive effort data with high spatial resolution, including accurate information about the tow path or setting location, as well as complete gear specifications. Effects of displaced fishing effort would have to be considered. The relative effects of bottom trawl and alternative gear/footrope designs and, thus, the efficacy of the measure should be investigated experimentally in a relatively undisturbed area that is representative of the closed areas. The basis of comparison would be changes in the structure and function of benthic communities and populations, as well as important physical features of the seabed, after comparable harvests of target species are taken with each gear type. Ultimately, there should be detectable increases in FMP species that are directly attributable to the reduced impacts on sponge and coral habitat.

Benthic habitat recovery. Monitor the structure and function of benthic communities and populations in the newly closed areas, as well as important physical features of the seabed, for changes that may indicate recovery of benthic habitat. Whether these changes constitute recovery from fishing or just natural variability/shifts requires comparison with an area that is undisturbed by fishing and otherwise comparable. A reference site would have to remain undisturbed by fishing during the entire course of the recovery experiment. Such a reference site may or may not exist, and the essential elements of comparability for identifying this area are presently unknown. Without proper reference sites, it may still be possible to deduce recovery dynamics based on changes observed in comparable newly closed areas with different histories of fishing disturbance.

Research Time Frame

Changes in fishing effort and gear types should be readily detectable. Biological recovery monitoring may require an extended period if undisturbed habitats of this type typically include large or long-lived organisms and/or high species diversity. Recovery of smaller, shorter-lived components should be apparent much sooner.

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