EFH 5-year Review for 2010: Summary Report

Appendix 2 GOA Groundfish FMP species reviews

Pollock 1
Pacific cod 16
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Worksheet **GOA Pollock**

Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? Y or N If yes, explain.
N

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2*)?
N

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.

N

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

None that I am aware of.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

Additional research is needed on impacts of trawling using midwater nets.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions.
No.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list.
N

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain.

No.

* EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table 4-9.

Table 4-9 Levels of essential fish habitat information currently available for GOA groundfish, by life history stage.

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Pollock	1	1	x	1	1

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves

Note: "1" indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Walleye Pollock

Eggs: EFH for walleye pollock eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the GOA, as depicted in Figure E-1.

Larvae: EFH for larval walleye pollock is the general distribution area for this life stage, located in epipelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the GOA, as depicted in Figure E-2.

Early Juveniles: No EFH description determined. Information is insufficient due to these ages (primarily age 2) being unavailable to bottom-trawl survey gear and partially available to echo-integrated mid-water trawl surveys.

Late Juveniles: EFH for late juvenile walleye pollock is the general distribution area for this life stage, located in the lower and middle portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA, as depicted in Figure E-3. Substrate preferences, if they exist, are unknown.

Adults: EFH for adult walleye pollock is the general distribution area for this life stage, located in the lower and middle portion of the water column along the entire shelf (~10 to 200 m) and slope (200 to 1,000 m) throughout the GOA, as depicted in Figure E-3. Substrate preferences, if they exist, are unknown.

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[Pulled from Appendix D GOA Groundfish, Tables D.1-D.3] GOA Pollock

Table Error! No text of specified style in document.**.1 Summary of habitat associations for GOA groundfish.**

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Walleye Pollock	M						x	x	x	x				x		x	x	x	x	x	x		x	x	x	x	x	
	J					x	x	x								x	x	x	x	x	x		x	x	x	x		
	L						x	x								x	x	x	x	x	x		x	x	x	x		
	E						x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x		x		

GOA Groundfish		Physical Oceanography					Substrate													Structure									
Species	Life Stage	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	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made
Walleye Pollock	M	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x											
	J	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x											
	L	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x											
	E	x	x	x	x																								

EFH 5-year report - Appendix 2

[Pulled from Appendix D GOA Groundfish, Tables D.1-D.3] **GOA Pollock**

GOA Groundfish		Community Associations												Oceanographic Properties			
Species	Life Stage	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Walleye Pollock	M													**2-10**			M
	J													**2-10**			J
	L																L
	E																E

Table Error! No text of specified style in document.**.2 Summary of biological associations for GOA groundfish.**

GOA Groundfish		Reproductive Traits																										
		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
Walleye Pollock	M	4-5		4-5		x						x						x	x	x	x							

[Pulled from Appendix D GOA Groundfish, Tables D.1-D.3] GOA Pollock

Table Error! No text of specified style in document.**.3 Summary of predator and prey associations for GOA groundfish**

		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Walleye Pollock	M				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
	EJ				X			X			X									X	X	X									
	L				X			X			X																				
	E																														

		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Walleye Pollock	M								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		
	L							X	X						X	X								X		X	X	X		
	E																													

1.2 Walleye pollock (*Theragra calcogramma*)

The Gulf of Alaska (GOA) pollock stocks are managed under the GOA Groundfish Fisheries Management Plan, and the Eastern Bering Sea (EBS) and Aleutian Islands pollock stocks are managed under the BSAI groundfish fisheries management plan. Pollock occur throughout the area covered by the FMP and straddle into the Canadian and Russian EEZ, international waters of the central Bering Sea, and into the Chukchi Sea.

1.2.1 Life History and General Distribution

Pollock is the most abundant species within the eastern Bering Sea comprising 75-80% of the catch and 60% of the biomass. In the Gulf of Alaska, pollock is the second most abundant groundfish stock comprising 25-50% of the catch and 20% of the biomass.

Four stocks of pollock are recognized for management purposes: Gulf of Alaska, eastern Bering Sea, Aleutian Islands, and Aleutian Basin. For the contiguous sub-regions (i.e., areas adjacent to their management delineation), there appears to be some relationship among the eastern Bering Sea, Aleutian Islands, and Aleutian Basin stocks. Some strong year classes appear in all three places suggesting that pollock may expand from one area into the others or that discrete spawning areas benefit (in terms of recruitment) from similar environmental conditions. There appears to be stock separation between the Gulf of Alaska stocks and stocks to the north.

The most abundant stock of pollock is the eastern Bering Sea stock which is primarily distributed over the eastern Bering Sea outer continental shelf between approximately 70-200 m. Information on pollock distribution in the eastern Bering Sea comes from commercial fishing locations, annual bottom trawl surveys and regular (every two or three years) echo-integration mid-water trawl surveys.

The Aleutian Islands stock extends through the Aleutian Islands from 170° W to the end of the Aleutian Islands (Attu Island), with the greatest abundance in the eastern Aleutians (170° W to Seguam Pass). Most of the information on pollock distribution in the Aleutian Islands comes from regular (every two or three years) bottom trawl surveys. These surveys indicate that pollock are primarily located on the Bering Sea side of the Aleutian Islands, and have a spotty distribution throughout the Aleutian Islands chain, particularly during the summer months when the survey is conducted. Thus, the bottom trawl data may be a poor indicator of pollock distribution because a significant portion of the pollock biomass is likely to be unavailable to bottom trawls. Also, many areas of the Aleutian Islands shelf are untrawlable due to rough bottom.

The third stock, Aleutian Basin, appears to be distributed throughout the Aleutian Basin which encompasses the U.S. EEZ, Russian EEZ, and international waters in the central Bering Sea. This stock has appeared throughout the Basin apparently for feeding, but then concentrates near the continental shelf for spawning. The principal spawning location is thought to be near Bogoslof Island in the eastern Aleutian Islands, but data from pollock fisheries in the first quarter of the year indicate that there are other concentrations of deepwater spawning concentrations in the central and western Aleutian Islands. The Aleutian Basin spawning stock appears to be derived from migrants from the eastern Bering Sea shelf stock, and possibly some western Bering Sea pollock. Recruitment to the stock occurs generally around age 5 with younger fish being rare in the Aleutian Basin. Most of the pollock in the Aleutian Basin appear to originate from strong year classes also observed in the Aleutian Islands and EBS shelf region.

The Gulf of Alaska stock extends from southeast Alaska to the Aleutian Islands (170° W), with the greatest abundance in the western and central regulatory areas (147° W to 170° W). Most of the information on pollock distribution in the Gulf of Alaska comes from annual winter echo-intregration mid-water trawl surveys and regular (every two or three years) bottom trawl surveys. These surveys indicate that pollock are distributed throughout the shelf regions of the Gulf of Alaska at depths less than 300 m. The bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass may be pelagic and unavailable to bottom trawls. The principal

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spawning location is in Shelikof Strait, but other spawning concentrations in the Shumagin Islands, the east side of Kodiak Island, and near Prince William Sound also contribute to the stock.

Peak pollock spawning occurs on the southeastern Bering Sea and eastern Aleutian Islands along the outer continental shelf around mid-March. North of the Pribilof Islands spawning occurs later (April-May) in smaller spawning aggregations. The deep spawning pollock of the Aleutian Basin appear to spawn slightly earlier, late February-early March. In the Gulf of Alaska, peak spawning occurs in late March in Shelikof Strait. Peak spawning in the Shumagin area appears to 2-3 weeks earlier than in Shelikof Strait.

Spawning occurs in the pelagic zone and eggs develop throughout the water column (70-80 m in the Bering Sea shelf, 150-200 m in Shelikof Strait). Development is dependent on water temperature. In the Bering Sea, eggs take about 17-20 days to develop at 4 degrees in the Bogoslof area and 25.5 days at 2 degrees on the shelf. In the Gulf of Alaska, development takes approximately 2 weeks at ambient temperature (5 degrees C). Larvae are also distributed in the upper water column. In the Bering Sea the larval period lasts approximately 60 days. The larvae eat progressively larger naupliar stages of copepods as they grow and then small euphausiids as they approach transformation to juveniles (~25 mm standard length). In the Gulf of Alaska, larvae are distributed in the upper 40 m of the water column and the diet is similar to Bering Sea larvae. FOCI survey data indicate larval pollock may utilize the stratified warmer upper waters of the mid-shelf to avoid predation by adult pollock which reside in the colder bottom water.

At age 1 pollock are found throughout the eastern Bering Sea both in the water column and on bottom depending on temperature. Age 1 pollock from strong year-classes appear to be found in great numbers on the inner shelf, and further north on the shelf than weak year classes which appear to be more concentrated on the outer continental shelf. From age 2-3 pollock are primarily pelagic and then to be most abundant on the outer and mid-shelf northwest of the Pribilof Islands. As pollock reach maturity (age 4) in the Bering Sea, they appear to move from the northwest to the southeast shelf to recruit to the adult spawning population. Strong year-classes of pollock persist in the population in significant numbers until about age 12, and very few pollock survive beyond age 16. The oldest recorded pollock was age 31.

Growth varies by area with the largest pollock occurring on the southeastern shelf. On the northwest shelf the growth rate is slower. A newly maturing pollock is around 40 cm.

The upper size limit for juvenile pollock in the eastern Bering Sea and Gulf of Alaska is about 38-42 cm. This is the size of 50% maturity. There is some evidence that this has changed over time.

1.2.2 Fishery

The eastern Bering Sea pollock fishery has, since 1990 been divided into two fishing periods; an "A season" occurring from January-March, and a "B season" occurring from June-October. The A season concentrates fishing effort on prespawning pollock in the southeastern Bering Sea. During the B season fishing is more dispersed with concentrations in the southeastern Bering Sea and extending north generally along the 200m isobaths. During the B season the offshore fleet (catcher processors and motherships) are required to fish north of 56° N latitude while the area to the south is reserved for catcher vessels delivering to shoreside processing plants on Unalaska and Akutan.

Since 1992, the Gulf of Alaska pollock TAC has been apportioned spatially and temporally to reduce impacts on Steller sea lions. Although the details of the apportionment scheme have evolved over time, the general objective is to allocate the TAC to management areas based on the distribution of surveyed biomass, and to establish three or four seasons between mid-January and autumn during which some fraction of the TAC can be taken. The Steller Sea Lion Protection Measures implemented in 2001 establish four seasons in the Central and Western GOA beginning January 20, March 10, August 25, and October 1, with 25% of the total TAC allocated to each season. Allocations to management areas 610, 620 and 630 are based on the seasonal biomass distribution as estimated by groundfish surveys. In addition, a new harvest control rule was implemented that requires a cessation of fishing when spawning biomass declines below 20% of the unfished stock biomass estimate.

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In the Gulf of Alaska approximately 90% of the pollock catch is taken using pelagic trawls. During winter, fishing effort usually targeted primarily on pre-spawning aggregations in Shelikof Strait and near the Shumagin Islands. The pollock fishery has a very low bycatch rate with discards averaging about 2% since 1998 (with the 1991-1997 average around 9%). Most of the discards in the pollock fishery are juvenile pollock, or pollock too large to fit filleting machines. In the pelagic trawl fishery the catch is almost exclusively pollock.

The eastern Bering Sea pollock fishery primarily harvests mature pollock. The age where fish are selected by the fishery roughly corresponds to the age at maturity (management guidelines are oriented towards conserving spawning biomass). Fishery selectivity increases to a maximum around age 6-8 and declines slightly. The reduced selectivity for older ages is due to pollock becoming increasingly demersal with age. Younger pollock form large schools and are semi-demersal, thereby being easier to locate by fishing vessels. Immature fish (ages 2 and 3) are usually caught in low numbers. Generally the catch of immature pollock increases when strong year-classes occur and the abundance of juveniles increase sharply. This occurred with the 1989 year-class, the second largest year-class on record. Juvenile bycatch increased sharply in 1991 and 1992 when this year-class was age 2 and 3. Under the 1999 American Fisheries Act (AFA) the pollock fishery became rationalized and effectively ended the "race for fish." This generally slowed the pace of the fishery and also reduced the tendency to catch smaller pollock. A secondary problem is that strong to moderate year-classes may reside in the Russian EEZ adjacent to the U. S. EEZ as juveniles. Russian catch-age data and anecdotal information suggest that juveniles may comprise a major portion of the catch. There is a potential for the Russian fishery to reduce subsequent abundance in the U. S. fishery.

The Gulf of Alaska pollock fishery also targets mature pollock. Fishery selectivity increases to a maximum around age 5-7 and then declines. In both the EBS and GOA, the selectivity pattern varies between years due to shifts in fishing strategy and changes in the availability of different age groups over time.

In response to continuing concerns over the possible impacts groundfish fisheries may have on rebuilding populations of Steller sea lions, NMFS and the NPFMC have made changes to the Atka mackerel (mackerel) and pollock fisheries in the Bering Sea/Aleutian Islands and Gulf of Alaska. These have been designed to reduce the possibility of competitive interactions with Steller sea lions. For the pollock fisheries, comparisons of seasonal fishery catch and pollock biomass distributions (from surveys) by area in the eastern Bering Sea led to the conclusion that the pollock fishery had disproportionately high seasonal harvest rates within critical habitat which *could* lead to reduced sea lion prey densities. Consequently, the management measures were designed to redistribute the fishery both temporally and spatially according to pollock biomass distributions. The underlying assumption in this approach was that the independently derived area-wide and annual exploitation rate for pollock would not reduce local prey densities for sea lions. Here we examine the temporal and spatial dispersion of the fishery to evaluate the potential effectiveness of the measures.

Three types of measures were implemented in the pollock fisheries:

- Additional pollock fishery exclusion zones around sea lion rookery or haulout sites,
- Phased-in reductions in the seasonal proportions of TAC that can be taken from critical habitat, and
- Additional seasonal TAC releases to disperse the fishery in time.

Prior to the management measures, the pollock fishery occurred in each of the three major fishery management regions of the north Pacific ocean managed by the NPFMC: the Aleutian Islands (1,001,780 km^2 inside the EEZ), the eastern Bering Sea (968,600 km^2), and the Gulf of Alaska (1,156,100 km^2). The marine portion of Steller sea lion critical habitat in Alaska west of 150°W encompasses 386,770 km^2 of ocean surface, or 12% of the fishery management regions.

Prior to 1999, a total of 84,100 km^2, or 22% of critical habitat, was closed to the pollock fishery. Most of this closure consisted of the 10 and 20 nm radius all-trawl fishery exclusion zones around sea lion rookeries (48,920 km^2 or 13% of critical habitat). The remainder was largely management area 518

(35,180 km^2, or 9% of critical habitat) which was closed pursuant to an international agreement to protect spawning stocks of central Bering Sea pollock.

In 1999, an additional 83,080 km^2 (21%) of critical habitat in the Aleutian Islands was closed to pollock fishing along with 43,170 km^2 (11%) around sea lion haulouts in the GOA and eastern Bering Sea. Consequently, a total of 210,350 km^2 (54%) of critical habitat was closed to the pollock fishery. The portion of critical habitat that remained open to the pollock fishery consisted primarily of the area between 10 and 20 nm from rookeries and haulouts in the GOA and parts of the eastern Bering Sea foraging area.

The Bering Sea/Aleutian Islands pollock fishery was also subject to changes in total catch and catch distribution. Disentangling the specific changes in the temporal and spatial dispersion of the EBS pollock fishery resulting from the sea lion management measures from those resulting from implementation of the 1999 American Fisheries Act (AFA) is difficult. The AFA reduced the capacity of the catcher/processor fleet and permitted the formation of cooperatives in each industry sector by 2000. Both of these changes would be expected to reduce the rate at which the catcher/processor sector (allocated 36% of the EBS pollock TAC) caught pollock beginning in 1999, and the fleet as a whole in 2000. Because of some of its provisions, the AFA gave the industry the ability to respond efficiently to changes mandated for sea lion conservation that otherwise could have been more disruptive to the industry.

In 2000, further reductions in seasonal pollock catches from BSAI sea lion critical habitat were realized by closing the entire Aleutian Islands region to pollock fishing and by phased-in reductions in the proportions of seasonal TAC that could be caught from the Sea Lion Conservation Area, an area which overlaps considerably with sea lion critical habitat. In 1998, over 22,000 t of pollock were caught in the Aleutian Island regions, with over 17,000 t caught in AI critical habitat. Since 1998 directed fishery removals of pollock have been prohibited.

1.2.3 Relevant Trophic Information

Juvenile pollock through newly maturing pollock primarily utilize copepods and euphausiids for food. At maturation and older ages pollock become increasingly piscivorous, with pollock (cannibalism) a major food item in the Bering Sea. Most of the pollock consumed by pollock are age 0 and 1 pollock, and recent research suggests that cannibalism can regulate year-class size. Weak year-classes appear to be those located within the range of adults, while strong year-classes are those that are transported to areas outside the range of adult abundance.

Being the dominant species in the eastern Bering Sea, pollock is an important food source for other fish, marine mammals, and birds. On the Pribilof Islands hatching success and fledgling survival of marine birds has been tied to the availability of age 0 pollock to nesting birds.

1.2.4 Habitat and Biological Associations

Egg-Spawning: Pelagic on outer continental shelf generally over 100-200 m depth in Bering Sea. Pelagic on continental shelf over 100-200 m depth in Gulf of Alaska.

Larvae: Pelagic outer to mid-shelf region in Bering Sea. Pelagic throughout the continental shelf within the top 40 m in the Gulf of Alaska.

Juveniles: Age 0 appears to be pelagic, as is age 2 and 3. Age 1 pelagic and demersal with a widespread distribution and no known benthic habitat preference.

Adults: Adults occur both pelagically and demersally on the outer and mid-continental shelf of the Gulf of Alaska, eastern Bering Sea and Aleutian Islands. In the eastern Bering Sea few adult pollock occur in waters shallower than 70 m. Adult pollock also occur pelagically in the Aleutian Basin. Adult pollock range throughout the Bering Sea in both the U.S. and Russian waters, however, the maps provided for this document detail distributions for pollock in the U.S. Exclusive Economic Zone and the basin.

Habitat and Biological Associations: Walleye Pollock

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	14 d. at 5 C	None	Feb-Apr	OCS, UCS	P	N/A	G?	
Larvae	60 days	copepod naupli and small euphausiids	Mar-Jul	MCS, OCS	P	N/A	G? F	pollock larvae with jellyfish
Juveniles	0.4 to 4.5 years	Pelagic crustaceans, copepods and euphausiids	Aug. +	OCS, MCS, ICS	P, SD	N/A	CL, F	
Adults	4.5 - 16 years	Pelagic crustaceans and fish	Spawning Feb-Apr	OCS, BSN	P, SD	UNK	F UP	Increasingly demersal with age.

1.2.5 Additional sources of information

Eggs and Larvae:

Jeff Napp, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA, 206-526-4148.

Shallow water concentrations:

Bill Bechtol, Alaska Department of Fish and Game, 3298 Douglas Place, Homer, Alaska 99603-8027.

1.2.6 Literature

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Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-1 to E-3 Walleye pollock (eggs, larvae, late juveniles/adults)

Figure E-1
GOA Walleye Pollock Egg Presence

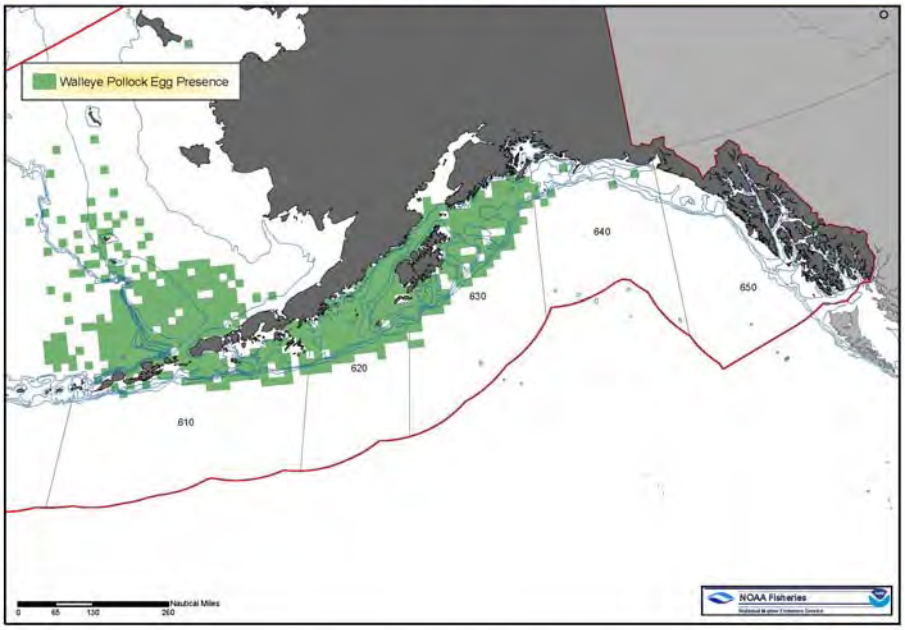


Figure E-2
GOA Walleye Pollock Larval Presence

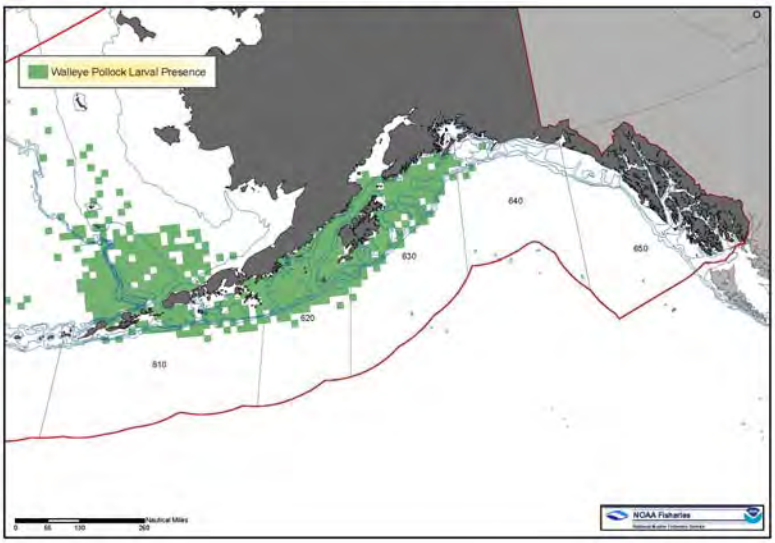
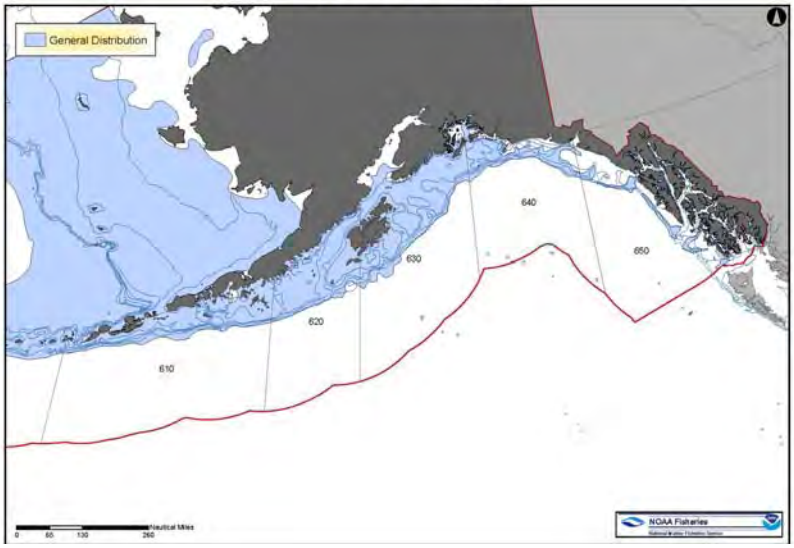


Figure E-3
GOA Walleye Pollock Late Juveniles/Adults



1.2.7 Evaluation of Effects on EFH of Groundfish Species

1.2.7.1 Walleye Pollock (BSAI and GOA)

Issue	Evaluation
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—Pollock is a generalist species that occupies a broad geographic niche and can use a wide variety of different habitats (Bailey et al. 1999). The ability of pollock to invade and adapt to marginal habitats has been suggested as a possible reason for the rapid increases in abundance during the environmental changes that occurred in the North Pacific in the 1970s (Bailey 2000). Pollock's ecological plasticity may allow adaption to habitats that have been modified by fishing impacts. Fishing impacts might even be beneficial, particularly if there are significant adverse impacts on predators or competitors more dependent on seafloor habitat features.

The overall evaluation of fishing impacts on pollock EFH is based primarily on extensive life history information that shows that pollock eggs, larvae, juveniles, and adults are not associated with seafloor habitat features affected by fishing. Some pollock life history stages are more demersal (i.e., age-1 juveniles), but even here the association is more likely related to temperature tolerances and avoidance of predators higher up in the water column than any characteristic of the bottom that can be impacted by trawling. The rating for fishing impacts on spawning/breeding for BSAI/GOA pollock is MT because pollock are pelagic spawners, as are their eggs and larvae. The rating for fishing impacts on feeding for BSAI/GOA pollock is MT because adults feed mainly on pelagic euphausiids followed by calanoid copepods.

The primary concern for pollock is the reduction in living structure in areas that support high pollock densities and its potential importance to juvenile pollock in providing refuge from predation. Changes in predation (or cannibalism) on juveniles have been proposed as a mechanism for population control in both the BSAI (Hunt et al. 2002) and the GOA (Bailey 2000). An increase in juvenile mortality will reduce spawning output per individual and, if large enough, could impair the ability of the stock to produce MSY over the long term (Dorn 2004). In the GOA, there is evidence of an increase in pollock mortality due to increases in the abundance of the dominant piscivores (Bailey 2000, Hollowed et al. 2000). However, evidence is weak that living structure plays a significant role in mediating mortality risk for juvenile pollock in the BSAI and the GOA, and it appears more likely that juveniles avoid predation risk through behavioral mechanisms such as shoaling and position in the water column. In addition, the overall reduction in living substrate for pollock EFH is relatively small (7 percent). Therefore, the rating for fishing impacts on growth to maturity for BSAI/GOA pollock is MT.

GOA Pacific Cod Worksheet

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? **Y** or N If yes, explain. Several items required clarification or updating. For example, several recent publications were added to the Literature section.

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2)? **No.**

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here. **No.**

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

EFH 2008-02 (Laurel et al.): This project is studying productivity, habitat utilization, and recruitment dynamics of Pacific cod.

NPRB #R0605 (Laurel et al.): This project is studying climate change and the match-mismatch hypothesis in terms of Pacific cod larval survival.

NPRB #618 (Logerwell and Neidetcher): This project is studying spatio-temporal spawning patterns of Pacific cod.

NPRB #815 (Munro and Conners): This project is studying spawning and migration through a mark-recapture experiment.

3. Research and Information Needs

Is research needed or do data gaps exist? **Yes.** Briefly explain and list in order of priority. **The early life history stages of Pacific cod are poorly understood, as noted in several recent articles. Most of the recent work has focused on the Gulf of Alaska stock of Pacific cod.**

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? **No.** Explain. **The current text seems to be satisfactory.** See item #4 in section B of instructions.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list**. No (other than those already identified).**

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? **No.** Explain. **The Council is already doing a good job with respect to conservation of EFH.**

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Pacific cod	1	1	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Pacific Cod

Eggs: EFH for Pacific cod eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper (200 to 500 m) slope throughout the GOA wherever there are soft substrates consisting of mud and sand, as depicted in Figure E-4.

Larvae: EFH for larval Pacific cod is the general distribution area for this life stage, located in pelagic waters along the inner (0 to 50 m) and middle (50 to 100 m) shelf throughout the GOA wherever there are soft substrates consisting of mud and sand, as depicted in Figure E-5.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile Pacific cod is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are soft substrates consisting of sand, mud, sandy mud, and muddy sand, as depicted in Figure E-6.

Adults: EFH for adult Pacific cod is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are soft substrates consisting of sand, mud, sandy mud, muddy sand, and gravel, as depicted in Figure E-6.

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Pcod**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Pacific Cod	M					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			
	L					x	x	x																		x		
	E					x	x	x																	x			

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Pacific Cod	M							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
	EJ							x	x	x	x	x	x	x	x	x	x		
	L																		
	E							x	x	x	x	x	x	x	x	x	x	x	x

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Pcod**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Pacific Cod	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							
	L																									
	E																							3-6	13-23	2-3

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																										
		Age at Maturity (unless otherwise noted)				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
Pacific Cod	M	5		5		x						x					x	x	x	x	x							

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Pcod**

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Pacific Cod	M							X		X			X							X										X	
	LJ							X		X			X							X										X	
	EJ							X		X			X							X											
	L			X	X						X																				
	E																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Pacific Cod	M															X	X	X		X		X	X	X						
	LJ															X	X	X		X		X	X	X						
	EJ															X	X	X				X	X	X			X			
	L																													
	E																													

1.2 Pacific cod (Gadus macrocephalus)

1.2.1 Life History and General Distribution

Pacific cod is a transoceanic species, occurring at depths from shoreline to 500 m. The southern limit of the species' distribution is about lat. 34° N, with a northern limit of about lat. 63° N. Adults are largely demersal and form aggregations during the peak spawning season, which extends approximately from January through May. Pacific cod eggs are demersal and adhesive. Eggs hatch in about 15 to 20 days. Little is known about the distribution of Pacific cod larvae, which undergo metamorphosis at about 25 to 35 mm. Juvenile Pacific cod start appearing in trawl surveys at a fairly small size, as small as 10 cm in the EBS. Pacific cod can grow to be more than 1 m in length, with weights in excess of 10 kilogram (kg). Natural mortality is currently estimated to be 0.34 in the Bering Sea and Aleutian Islands (BSAI) and 0.38 in the Gulf of Alaska (GOA). Approximately 50 percent of Pacific cod are mature by age 5 in the BSAI and age 4 in the GOA. The maximum recorded age of a Pacific cod is 17 years in the BSAI and 14 years in the GOA.

The estimated size at 50 percent maturity is 58 cm in the BSAI and 50 cm in the GOA.

1.2.2 Fishery

The fishery is conducted with bottom trawl, longline, pot, and jig gear. More than 100 vessels participate in each of the three largest fisheries (trawl, longline, pot). The trawl fishery is typically concentrated during the first few months of the year, whereas fixed-gear fisheries may sometimes run, intermittently, at least, throughout the year. Historically, bycatch of crab and halibut has sometimes caused the Pacific cod fisheries to close prior to reaching the TAC. In the BSAI, trawl fishing is concentrated immediately north of Unimak Island, whereas the longline fishery is distributed along the shelf edge to the north and west of the Pribilof Islands. In the GOA, the trawl fishery has centers of activity around the Shumagin Islands and south of Kodiak Island, while the longline fishery is located primarily in the vicinity of the Shumagins.

1.2.3 Relevant Trophic Information

Pacific cod are omnivorous. In terms of percent occurrence, the most important items in the diet of Pacific cod in the BSAI and GOA are polychaetes, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, the most important dietary items are euphausiids, miscellaneous fishes, and amphipods. In terms of weight of organisms consumed, the most important dietary items are walleye pollock, fishery discards, and yellowfin sole. Small Pacific cod feed mostly on invertebrates, while large Pacific cod are mainly piscivorous. Predators of Pacific cod include halibut, salmon shark, northern fur seals, sea lions, harbor porpoises, various whale species, and tufted puffin.

1.2.4 Habitat and Biological Associations

Egg/Spawning: Spawning takes place in the sublittoral-bathyal zone (40 to 290 m) near bottom. Eggs sink to the bottom after fertilization and are somewhat adhesive. Optimal temperature for incubation is 3 to 6°C, optimal salinity is 13 to 23 parts per thousand (ppt), and optimal oxygen concentration is from 2 to 3 ppm to saturation. Little is known about the optimal substrate type for egg incubation.

Larvae: Larvae are epipelagic, occurring primarily in the upper 45 m of the water column shortly after hatching, moving downward in the water column as they grow.

Juveniles: Juveniles occur mostly over the inner continental shelf at depths of 60 to 150 m.

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Deleted: The age at 50 percent recruitment varies between gear types and regions. In the BSAI, the age at 50 percent recruitment is 6 years for trawl gear, 4 years for longline, and 5 years for pot gear. In the GOA, the age at 50 percent recruitment is 5 years for trawl gear and 6 years for longline and pot gear.

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Adults: Adults occur in depths from the shoreline to 500 m. Average depth of occurrence tends to vary directly with age for at least the first few years of life, with mature fish concentrated on the outer continental shelf. Preferred substrate is soft sediment, from mud and clay to sand.

Habitat and Biological Associations: Pacific cod

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	15 to 20 days	NA	winter-spring	ICS, MCS, OCS	D	M, SM, MS, S	U	optimum 3-6°C optimum salinity 13-23 ppt
Larvae	U	copepods (?)	winter-spring	U	P (?), N (?)	U	U	
Early Juveniles	to 2 years	Small invertebrates (mysids, euphausiids, shrimp)	all year	ICS, MCS	D	M, SM, MS, S	U	
Late Juveniles	to 5 years	pollock, flatfish, fishery discards, crab	all year	ICS, MCS, OCS	D	M, SM, MS, S	U	
Adults	5+ yr	pollock, flatfish, fishery discards, crab	Spawning (Jan-May) Non-spawning (Jun-Dec)	ICS, MCS, OCS ICS, MCS, OCS	D	M, SM, MS, S,G	U	

1.2.5 Additional Information Sources

NMFS, Alaska Fisheries Science Center, FOCI Program, Ann Matarese.

1.2.6 Literature

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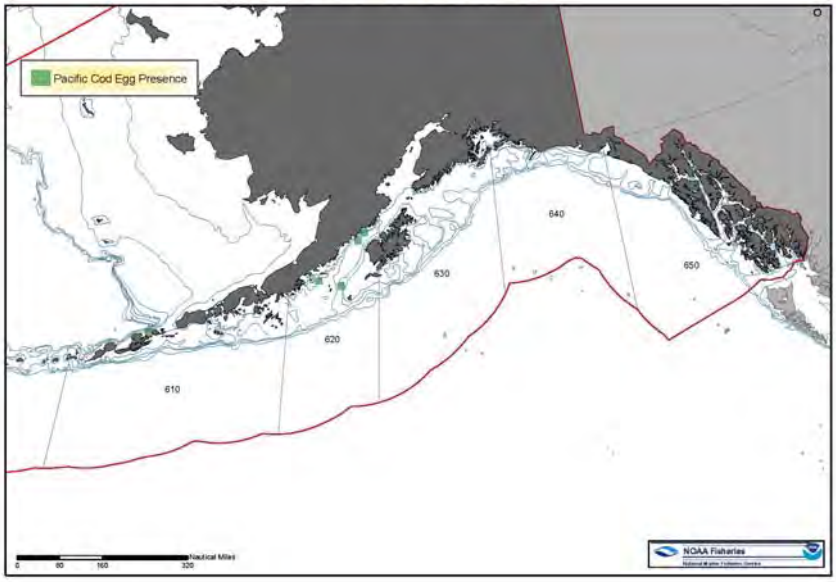
Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-4 to E-6 Pacific cod (eggs, larvae, late juveniles/adults)

Figure E-4
GOA Pacific Cod Egg Presence



[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] **GOA Pcod**

Figure E-5
GOA Pacific Cod Larval Presence

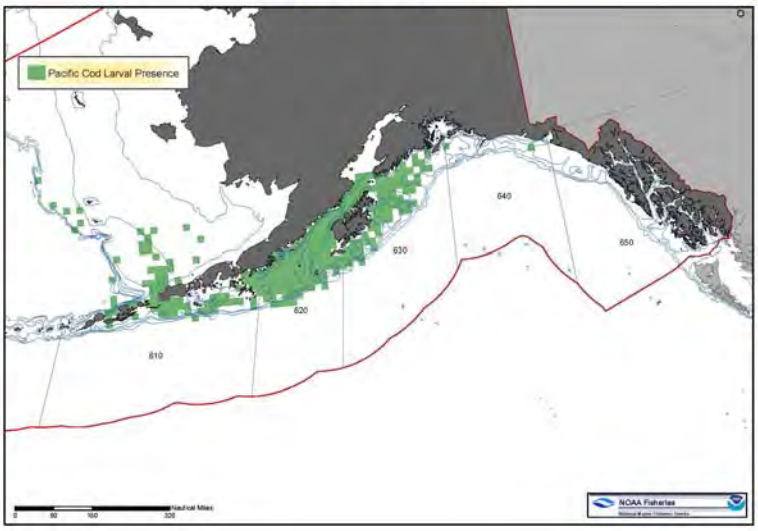
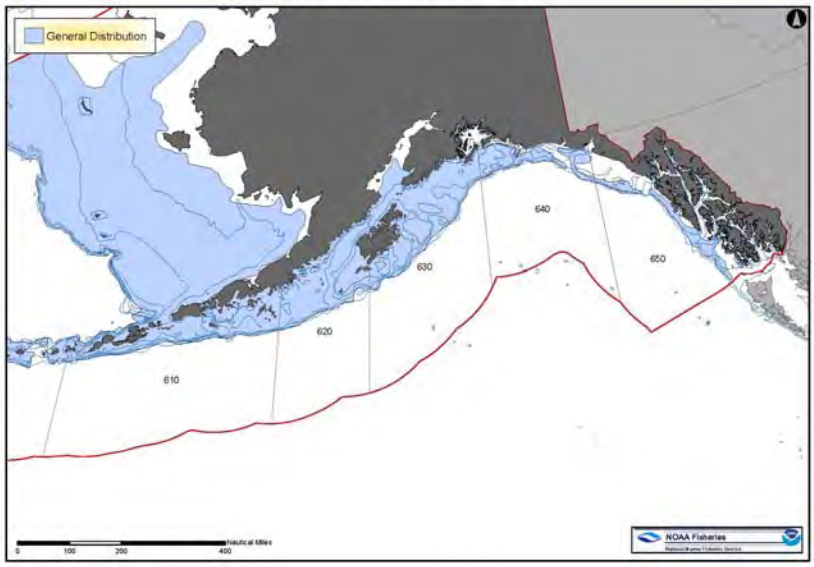


Figure E-6
GOA Pacific Cod Late Juveniles/Adults



1.2.7 Evaluation of Effects on EFH of Groundfish Species

The fishing effects analysis is performed to evaluate whether the fisheries, as they are currently conducted off Alaska, will affect habitat that is essential to the welfare of the managed fish populations 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 above analysis has 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 each managed 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 forgoing analysis has indicated substantial effects to some habitat features in some locations, many of which are within the spatial boundaries of the EFH of a species that may use them in a life-history function. These habitat changes may or may not affect the welfare of that 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.

The Effects of Fishing on EFH analysis in the EFH EIS was designed to answer the question: "Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature?" The following text summarizes the results of the analysis for each managed species. The details of the analysis for each species, including the habitat connections and the evaluation of effects, are contained in Section B.3.3 of Appendix B of the EFH EIS (NMFS 2005) and are incorporated by reference.

1.2.7.1 Pacific Cod (BSAI and GOA)

Issue	Evaluation
Spawning/Breeding	MT (Minimal or temporary effect)
Growth to Maturity	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)

Summary of Effects—Fishing's effects on the habitat of Pacific cod in the BSAI and GOA do not appear to have impaired either stocks' ability to sustain itself at or near the MSY level. When weighted by the proportions of habitat types used by Pacific cod, the long-term effect indices are low, particularly those of the habitat features most likely to be important to Pacific cod (infaunal and epifaunal prey). The fishery appears to have had minimal effects on the distribution of adult Pacific cod. Effects of fishing on weight at length, while statistically significant in some cases, are uniformly small and sometimes positive. While the fishery may impose some habitat-mediated effects on recruitment, these fall below the standard necessary to justify a rating of anything other than minimal or temporary.

Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? Y or N If yes, explain.
No, but some text was added to early juveniles to give better idea of what little is known. Also text was added to the BSAI sablefish description to make it similar to the GOA text. Since the GOA, BS, and AI are all the same stock, anything relevant in either description would be relevant in the other. Also some minor typos were fixed.

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2*)?
No

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.
There is a more recent report of groundfish food habits that was added to the list of references.

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future. ***Tagging juvenile sablefish in southeast Alaska with time/depth recording tags to track movements from shallow inshore waters to deeper areas on the slope. Revisited lightly trawled shelf habitat in SE AK to estimate recovery rates of benthic habitat organisms. Mounted substrate nearby corals and spongesto examine recolonization of benthic organisms in SE AK. Examining the distribution of juvenile sablefish in AFSC trawl surveys (1977-present).***

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority. ***Little is known about the early juvenile stage distribution, habitat requirements, and interaction with other components of the ecosystem. They have been known to reside in habitat subject to potentially adverse fishing effects as indicated by high LEI values for living structure (table B.3-3 of Final EFH EIS). Research is needed on the effect of fishing on the habitat in this area, the role of habitat features on prey, predator, and competitor species in the area, and the role of these species on the growth and survival of sablefish.***

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions.
Table B.3-3 of Final EFH EIS indicated reductions of living structure in habitat of early juvenile sablefish that are more than minimal and not temporary. Estimated changes in fishing intensity provided for this review do not indicate there would be any substantial change in this result. Yes, fishing activity has a more than minimal and not temporary effect on the EFH of juvenile sablefish.

* EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

No substantial research has been accomplished or initiated on effect of fishing on habitat features since the last EIS. Little research has been done on role of habitat features in the success of sablefish prey, predators, or competitors. Therefore it cannot yet be determined whether effects of fishing does not have an adverse effect on ability of early juvenile sablefish to grow and survive. It is Unknown whether fishing has an adverse effect on EFH.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list.

Areas of extensive and intensive bottom trawling should be of concern. Small unobtrusive research closures would be a responsible step for NMFS in determining whether EFH is adversely effected.

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain.

Given the intense fishing in areas of sensitive habitat features as indicated in Figure B.2-3a,b more research should be done to evaluate the recovery rates of these features and their role in the survival and growth of the early juvenile life stage of sablefish and other species that inhabit those areas.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Sablefish	1	1	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Sablefish

Eggs: EFH for sablefish eggs is the general distribution area for this life stage, located in deeper waters along the slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-26.

Larvae: EFH for larval sablefish is the general distribution area for this life stage, located in epipelagic waters along the middle shelf (50 to 100 m), outer shelf (100 to 200 m), and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-27.

Early Juveniles: No EFH Description Determined. Generally, have been observed in inshore waters, bays and passes, and on shallow shelf pelagic and demersal habitat. Information is limited

Insufficient information is available.

Late Juveniles: EFH for late juvenile sablefish is the general distribution area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) throughout the GOA, as depicted in Figure E-28.

Adults: EFH for adult sablefish is the general distribution area for this life stage, located in the lower portion of the water column, varied habitats, generally softer substrates, and deep shelf gulleys along the slope (200 to 1,000 m) throughout the GOA, as depicted in Figure E-28.

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Comment [CR1]: I know BASIS finds them in surface trawls in the EBS, and looks like they have been found out there on your map below too.

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA sablefish**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Sablefish	M								x	x	x	x	x				x				x				x			
	LJ							x	x	x	x						x				x				x			
	EJ					x	x	x							x		x						x	x	x	x	x	
	L						x	x	x	x	x	x	x	x								x	x					
	E								x	x	x	x	x	x												x	x	

GOA Groundfish	Physical Oceanography					Substrate												
Species	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
Sablefish	x						x	x	x								x	x
	x						x	x	x								x	x
	x																	
	x																	
	x																	

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA sablefish**

GOA Groundfish	Structure										Community Associations												Oceanographic Properties			
Species	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Sablefish							x																			M
																										LJ
																										EJ
																										L
																										E

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Sablefish	M	65cm		67cm		x						x					x	x	x									

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EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA sablefish**

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Sablefish	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	X		X	X	X	
	EJ							X		X	X		X	X	X			X		X			X					X			
	L				X						X																				
	E																														

GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Sperm whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrestrial Mammals
Sablefish	M																													
	LJ						X									X								X						
	EJ																													
	L																													
	E																													

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1.2 Sablefish (Anoplopoma fimbria)

1.2.1 Life History and General Distribution

Sablefish are distributed from Mexico through the GOA to the Aleutian Chain, BS, along the Asian coast from Sagami Bay, and along the Pacific sides of Honshu and Hokkaido Islands and the Kamchatkan Peninsula. Adult sablefish occur along the continental slope, shelf gullies, and in deep fjords such as Prince William Sound and southeast Alaska, at depths generally greater than 200 m. Adults are assumed to be demersal. Spawning or very ripe sablefish are observed in late winter or early spring along the continental slope. Eggs are apparently released near the bottom where they incubate. After hatching and yolk adsorption, the larvae rise to the surface, where they have been collected with neuston nets. Larvae are oceanic through the spring and by late summer, small pelagic juveniles (10 to 15 cm) have been observed along the outer coasts of Southeast Alaska, where they apparently move into shallow waters to spend their first winter. During most years, there are only a few places where juveniles have been found during their first winter and second summer. It is not clear if the juvenile distribution is highly specific or appears so because sampling is highly inefficient and sparse. During the occasional times of large year-classes, the juveniles are easily found in many inshore areas during their second summer. They are typically 30 to 40 cm long during their second summer, after which they apparently leave the nearshore bays. One or two years later, they begin appearing on the continental shelf and move to their adult distribution as they mature.

Pelagic ocean conditions appear to determine when strong young-of-the-year survival occurs. Water mass movements and temperature appear to be related to recruitment success (Sigler et al. 2001). Above-average young of the year survival was somewhat more likely with northerly winter currents and much less likely for years when the drift was southerly. Recruitment success also appeared related to water temperature. Recruitment was above average in 61 percent of the years when temperature was above average, but was above average in only 25 percent of the years when temperature was below average. Recruitment success did not appear to be directly related to the presence of El Ninos or eddies, but these phenomena could potentially influence recruitment indirectly in years following their occurrence (Sigler et al. 2001).

While pelagic oceanic conditions determine the egg, larval, and juvenile survival through their first summer, juvenile sablefish spend 3 to 4 years in demersal habitat along the shorelines and continental shelf before they recruit to their adult habitat, primarily along the upper continental slope, outer continental shelf, and deep gulleys. As juveniles in the inshore waters and on the continental shelf, they are subject to a myriad of factors that determine their ability to grow, compete for food, avoid predation, and otherwise survive to adults. Perhaps demersal conditions that may have been brought about by bottom trawling (habitat, bycatch, and increased competitors) have limited the ability of the large year classes that, though abundant at the young-of-the-year stage, survive to adults.

Size at 50 percent maturity is as follows:

BS: males 65 cm, females 67 cm

AI: males 61 cm, females 65 cm

GOA: males 57 cm, females 65 cm

At the end of the second summer (~1.5 years old), they are 35 to 40 cm long.

1.2.2 Fishery

The major fishery for sablefish in Alaska uses longlines; however sablefish are valuable in the trawl fishery as well. Sablefish enter the longline fishery at 4 to 5 years of age, perhaps slightly younger in the trawl fishery. The longline fishery takes place between March 1 and November 15. The take of the trawl

share of sablefish occurs primarily in association with fisheries for other species, such as rockfish, where they are taken as allowed bycatch. Grenadier (*Albatrossia pectoralis* and *Corphaenoides acrolepis*), deeper dwelling rockfish, such as shortraker, rougheye, and thornyhead rockfish are the primary bycatch in the longline sablefish fishery. Halibut also are taken. By regulation, there is no directed trawl fishery for sablefish; however, directed fishing standards have allowed some trawl hauls to target sablefish, where the bycatch is similar to the longline fishery, in addition perhaps to some deep dwelling flatfish. Pot fishing for sablefish has increased in the Bering Sea and Aleutian Islands in recent years as a response to depredation of longline catches by killer whales.

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In addition to the fishery for sablefish, there are significant fisheries for other species that may have an effect on the habitat of sablefish, primarily juveniles. As indicated above, before moving to adult habitat on the slope and deep gulleys, sablefish 2 to 4 years of age reside on the continental shelf, where significant trawl fisheries have taken place. It is difficult to evaluate the potential effect such fisheries could have had on sablefish survival, as a clear picture of the distribution and intensity of the groundfish fishery prior to 1997 has not been available. It is worth noting however, that the most intensely trawled area from 1998 to 2002 which is just north of the Alaska Peninsula, was closed to trawling by Japan in 1959 and apparently was untrawled until it was opened to U.S. trawling in 1983 (Witherell 1997, Fredin 1987). Juvenile sablefish of the 1977 year class were observed in the western portion of this area by the AFSC trawl survey in 1978 to 1980 at levels of abundance that far exceed levels that have been seen since (Umeda et al 1983). Observations of 1-year-old and young-of-the-year sablefish in inshore waters from 1980 to 1990 indicate that above-average egg to larval survival has occurred for a number of year classes since.

1.2.3 Relevant Trophic Information

Larval sablefish feed on a variety of small zooplankton ranging from copepod naupli to small amphipods. The epipelagic juveniles feed primarily on macrozooplankton and micronekton (i.e., euphausiids).

In their demersal stage, juvenile sablefish less than 60 cm feed primarily on euphausiids, shrimp, and cephalopods (Yang and Nelson 2000, Yang et al 2006) while sablefish greater than 60 cm feed more on fish. Both juvenile and adult sablefish are considered opportunistic feeders. Fish most important to the sablefish diet include pollock, eulachon, capelin, Pacific herring, Pacific cod, Pacific sand lance, and some flatfish, with pollock being the most predominant (10 to 26 percent of prey weight, depending on year). Squid, euphasiids,pandalid shrimp, tanner crabs, and jellyfish were also found, squid being the most important of the invertebrates (Yang and Nelson 2000, Yang et al 2006). Feeding studies conducted in Oregon and California found that fish made up 76 percent of the diet (Laidig et al. 1997). Off the southwest coast of Vancouver Island, euphausiids dominated sablefish diet (Tanasichuk 1997). Among other goundfish in the GOA, the diet of sablefish overlaps mostly with that of large flatfish, arrowtooth flounder and Pacific halibut (Yang and Nelson 2000).

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Nearshore residence during their second year provides sablefish with the opportunity to feed on salmon fry and smolts during the summer months, while young-of-the-year sablefish are commonly found in the stomachs of salmon taken in the Southeast Alaska troll fishery during the late summer.

1.2.4 Stock Condition

The estimated productivity and sustainable yield of the combined GOA,BS, and AI sablefish stock have declined steadily since the late 1970s. This is demonstrated by a decreasing trend in recruitment and subsequent estimates of biomass reference points and the inability of the stock to rebuild to the target biomass levels despite the decreasing level of the targets and fishing rates below the target fishing rate. While years of strong young-of-the-year survival has occurred in the 1980s and the1990s, the failure of strong recruitment to the mature stage suggests a decreased survival of juveniles during their residence as 2 to 4 year olds on the continental shelf.

1.2.5 Habitat and Biological Associations

Egg/Spawning

Larvae

Juveniles

Adults - other than depth, none is noted

Habitat and Biological Associations: Sablefish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	14 to 20 days	NA	late winter-early spring: Dec-Apr	USP, LSP, BSN	P,200-3000 m	NA	U	
Larvae	up to 3 months	copepod nauplii, small copepodites, etc.	spring-summer: Apr-July	MCS, OCS, USP, LSP, BSN	N, neustonic near surface	NA	U	
Early Juveniles	up to 3 years	small prey fish, sandlance, salmon, herring, etc		OCS, MCS, ICS, during first summer, then obs in BAY, IP, till end of 2nd summer; not obs'd till found on shelf	P when offshore during first summer, then D, SD/SP when inshore	NA when pelagic. The bays where observed were soft bottomed, but not enough obs. to assume typical.	U	
Late Juveniles	3 to 5 years	opportunistic: other fish,shellfish, worms, jellyfish, fishery discards	all year	continental slope, and deep shelf gullies and fjords.	Presumably D	varies	U	
Adults	5 to 35+ years	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	apparently year around, spawning movements (if any) are undescribed	continental slope, and deep shelf gullies and fjords.	Presumably D	varies	U	

1.2.6 Additional Sources of Information

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Juveniles:

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Comment [f2]: Witherell and Yang reference moved to Literature section

Deleted: Witherell, D 1997. A brief history of bycatch management measures for EBS groundfish fisheries. Marine Fisheries Review¶
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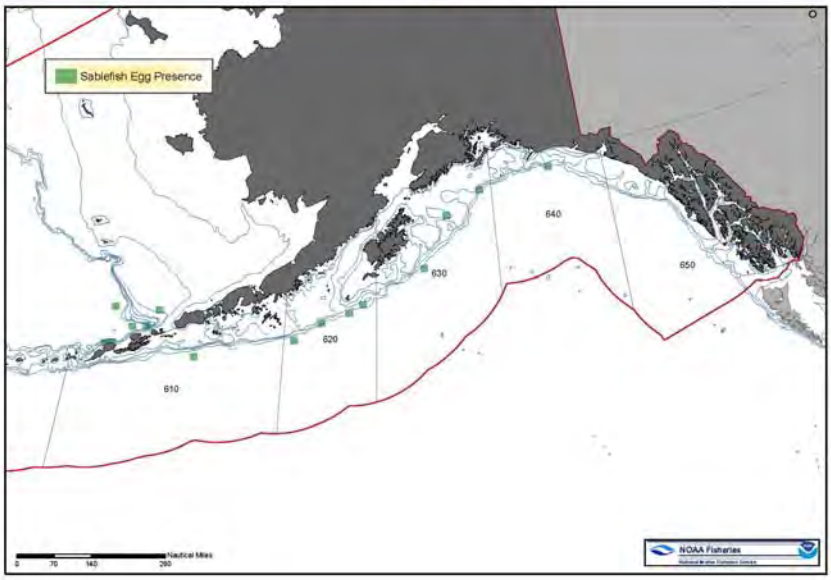
Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-26 to E-28 Sablefish (eggs, larvae, late juveniles/adults)

Figure E-26
GOA Sablefish Egg Presence



[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] **GOA sablefish**

Figure E-27
GOA Sablefish Larval Presence

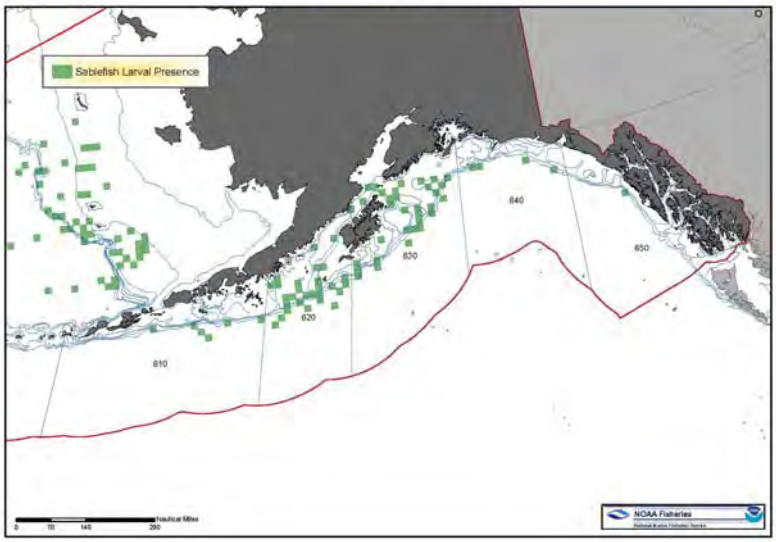
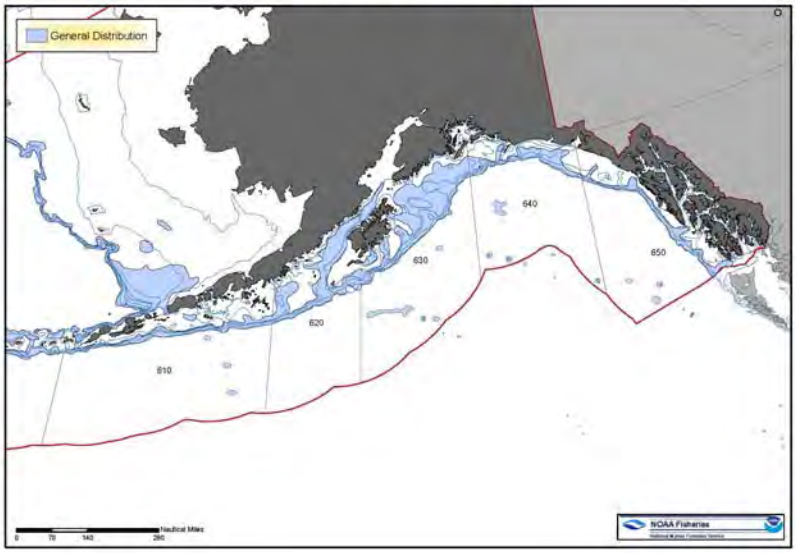


Figure E-28
GOA Sablefish Late Juveniles/Adults



1.2.8 Evaluation of Effects on EFH of Groundfish Species

The fishing effects analysis is performed to evaluate whether the fisheries, as they are currently conducted off Alaska, will affect habitat that is essential to the welfare of the managed fish populations 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 above analysis has 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 each managed species and whether they constitute an effect to EFH that is more than minimal.

Comment [f3]: Need to see what this analysis says.

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 forgoing analysis has indicated substantial effects to some habitat features in some locations, many of which are within the spatial boundaries of the EFH of a species that may use them in a life-history function. These habitat changes may or may not affect the welfare of that 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.

The Effects of Fishing on EFH analysis in the EFH EIS was designed to answer the question: "Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature?" The following text summarizes the results of the analysis for each managed species. The details of the analysis for each species, including the habitat connections and the evaluation of effects, are contained in Section B.3.3 of Appendix B of the EFH EIS (NMFS 2005) and are incorporated by reference.

1.2.8.1 Sablefish (GOA and BSAI)

Issue	Evaluation
Spawning/Breeding	MT
Growth to Maturity	U (Unknown)
Feeding	U (Unknown)

Summary of Effects—The estimated productivity and sustainable yield of sablefish have declined steadily since the late 1970s. This is demonstrated by a decreasing trend in recruitment and subsequent estimates of biomass reference points and the inability of the stock to rebuild to target biomass levels despite the decreasing level of the targets and fishing rates below the target fishing rate. While years of strong young-of-the-year survival have occurred in the 1980s and 1990s, the failure of strong recruitment to the mature stage suggests a decreased survival of juveniles during their residence as 2 to 4-year-olds on the continental shelf. While climate-related changes are a possible cause for reduced productivity, the observations noted above are consistent with possible effects of fishing on habitat and resulting changes in the juvenile ecology of sablefish, possibly through increased competition for food and space. Given the concern for the decline in the sustainable yield of sablefish, the possibility of the role of fishing effects on juvenile sablefish habitat, and the need for a better understanding of the possible causes, an MT rating is not merited, and sablefish growth to maturity and feeding is rated unknown.

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GOA yellowfin sole Worksheet

1. EFH Description Update

No new information warrants a change to the EFH text description or the EFH distribution maps by life stage.

2. New Information

A few text edits were made which are specific to Gulf of Alaska yellowfin sole.

3. Research and Information Needs

Distribution of eggs, larvae and early juvenile stages is mostly unknown (undocumented).

4. Fishing Activities

No new information regarding changes in the distribution of fishing intensity warrant an update of the fishing effects analysis summarized in the FMP.

5. Habitat Areas of Particular Concern (HAPC)

No HAPC are identified for Gulf of Alaska yellowfin sole.

6. Conservation recommendations

There are no EFH conservation recommendations for the Council from this five-year update.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Yellowfin sole	1	1	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Yellowfin Sole

Eggs: EFH for yellowfin sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper (200 to 500 m) slope throughout the GOA, as depicted in Figure E-7.

Larvae: EFH for larval yellowfin sole is the general distribution area for this life stage, located in pelagic waters along the shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure E-8.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile yellowfin sole is the general distribution area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are soft substrates consisting mainly of sand, as depicted in Figure E-9.

Adults: EFH for adult yellowfin sole is the general distribution area for this life stage, located in the lower portion of the water column within nearshore bays and along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are soft substrates consisting mainly of sand, as depicted in Figure E-9.

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Yellowfin sole**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Yellowfin Sole	M					x	x																		x			
	LJ					x	x																		x			
	EJ					x																			x			
	L					x	x																			x		
	E					x	x																			x		

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Yellowfin Sole	M							x	x				x						
	LJ							x	x				x						
	EJ							x	x				x						
	L																		
	E																		

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Yellowfin sole**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Yellowfin Sole	M																									
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Yellowfin Sole	M	10.5				x					x										x	x	x					

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Yellowfin sole**

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Yellowfin Sole	M							X		X			X			X		X		X					X					X	
	LJ							X		X			X			X		X		X					X						
	EJ				X																										
	L	X		X																											
	E																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrestrial Mammals
Yellowfin Sole	M																														
	LJ								X							X															
	EJ								X							X															
	L																														
	E																														

1.2 Yellowfin Sole (Limanda aspera)

Yellowfin sole is part of the shallow water flatfish management complex in the GOA.

1.2.1 Life History and General Distribution

Yellowfin sole are distributed in North American waters from off British Columbia, Canada (approximately lat. 49° N) to the Chukchi Sea (about lat. 70° N) and south along the Asian coast to about lat. 35° N off the South Korean coast in the Sea of Japan. Adults exhibit a benthic lifestyle and are consistently caught in shallow areas along the Alaska Peninsula and around Kodiak Island during resource assessment surveys in the GOA.. From over-winter grounds near the shelf margins, adults begin a migration onto the inner shelf in April or early May each year for spawning and feeding. A protracted and variable spawning period may range from as early as late May through August occurring primarily in shallow water. Fecundity varies with size and was reported to range from 1.3 to 3.3 million eggs for fish 25 to 45 cm long. Larvae have primarily been captured in shallow shelf areas in the Kodiak Island area and have been measured at 2.2 to 5.5 mm in July and 2.5 to 12.3 mm in late August - early September in the Bering Sea. The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach approximately 15 cm. The estimated age of 50 percent maturity is 10.5 years (approximately 29 cm) for females based on samples collected in 1992 and 1993. Natural mortality rate is believed to range from 0.12 to 0.16.

The approximate upper size limit of juvenile fish is 27 cm.

1.2.2 Fishery

Yellowfin sole are classified as part of the shallow water flatfish management complex and are caught in bottom trawls directed at northern and southern rock sole and in pursuit of other bottom-dwelling species. Recruitment begins at about age 6 and they are fully selected at age 13.

Relevant Trophic Information

Groundfish predators include Pacific cod, skates, and Pacific halibut, mostly on fish ranging from 7 to 25 cm standard length.

1.2.3 Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Summertime spawning and feeding on sandy substrates typically nearshore in shallow shelf areas feeding mainly on bivalves, polychaetes, amphipods and echiurids. Wintertime migration to deeper waters of the shelf margin to avoid extreme cold water temperatures, feeding diminishes.

Deleted: occupy separate winter spawning and summertime feeding distributions on the EBS shelf

Deleted: Eggs have been found to the limits of inshore ichthyoplankton sampling over a widespread area to at least as far north as Nunivak Island.

Deleted: both as a

Deleted: fishery and

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Deleted: Historically, the fishery has occurred throughout the mid and inner BS shelf during ice-free conditions although much effort has been directed at the spawning concentrations in nearshore northern Bristol Bay.

Deleted: They are caught as bycatch in Pacific cod, bottom pollock and other flatfish fisheries and are caught with these species and Pacific halibut in yellowfin sole directed fisheries.¶

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Deleted: Widespread distribution mainly on the middle and inner portion of the shelf,

Habitat and Biological Associations: Yellowfin sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	summer	BAY, BCH	P			
Larvae	2 to 3 months?	U phyto/zoo plankton?	summer autumn?	BAY BCH ICS	P			
Early Juveniles	to 5.5 years	polychaetes bivalves amphipods echiurids	all year	BAY ICS OCS MCS	D	S[1]		
Late Juveniles	5.5 to 10 years	polychaetes bivalves amphipods echiurids	all year	BAY ICS, OCS, MCS IP	D	S[1]		
Adults	10+ years	polychaetes bivalves amphipods echiurids	spawning/ feeding May-August non-spawning Nov.-April	BAY BEACH ICS, MCS, OCS IP	D	S[1]	ice edge	

[1]Pers. Comm. Dr. Robert McConnaughey

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1.2.4 Literature

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Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-7 to E-9 Yellowfin sole (eggs, larvae, late juveniles/adults)

Figure E-7
GOA Yellowfin Sole Egg Presence

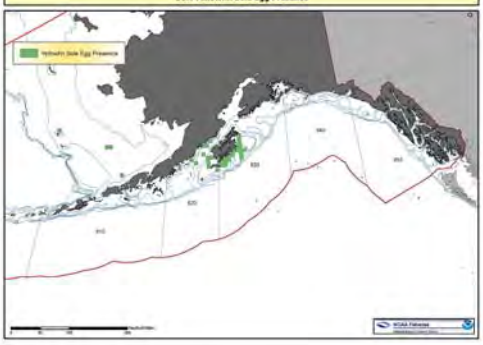


Figure E-8
GOA Yellowfin Sole Larval Presence

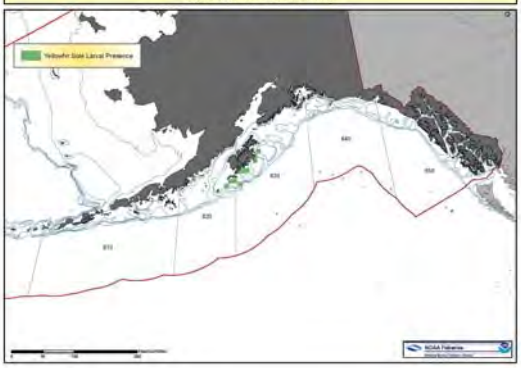
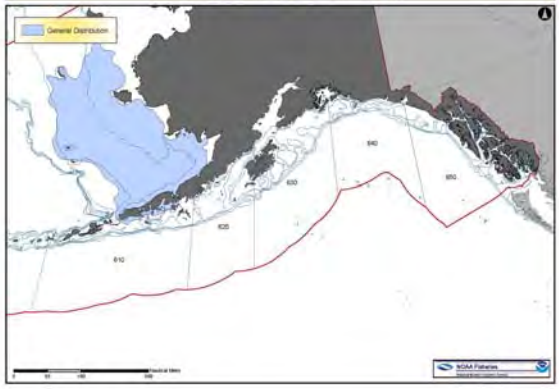


Figure E-9
GOA Yellowfin Sole Late Juveniles/Adults



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1.2.5 Evaluation of Effects on EFH of Groundfish Species

1.2.5.1 Shallow Water Flatfish (GOA)

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—The nearshore areas inhabited by early juveniles of GOA shallow water flatfish are mostly unaffected by current fishery activities. Adult and late juvenile rock sole concentrations, as a proxy for GOA shallow water flatfish, primarily overlap with shallow water habitats (13 percent) (Table B.3-3 of the EFH EIS). The predicted reduction of infaunal prey in this overlap is 1 percent. Given this level of disturbance, it is unlikely that adult feeding would be negatively impacted, and effects are believed to be minimal or temporary for rock sole. It is unknown, however, for the other seven species of the shallow water flatfish complex.

The level of information available for rock sole and the other species of the shallow water complex are insufficient to estimate the stock size relative to B_{MSY}, although trawl survey abundance estimates indicate a stable to increasing level of biomass since 1984. Because the population biomass level required to produce long-term sustainability is unknown, the impacts of the effects of fishing on the habitat required for spawning, adult feeding, or juvenile survival and growth to maturity are unknown.

GOA northern rock sole Worksheet

1. EFH Description Update

A new section is developed for northern rock sole (need to change the heading numbers). Much of the previous text descriptions which referred to the combined rock sole species is still relevant for diet and substrate preference by life history stage.

2. New Information

Orr, J. W. and A. C. Matarese. 2000. Revision of the genus *Lepidopsetta* Gill, 1862 (Teleostei: Pleuronectidae) based on larval and adult morphology, with a description of a new species from the North Pacific Ocean and Bering Sea. Fish. Bull. 98:539-582 (2000).

3. Research and Information Needs

Diet information differentiated between the two rock sole forms needs to be documented. This information may already exist in the AFSC database.

4. Fishing Activities

No new information regarding changes in the distribution of fishing intensity warrant an update of the fishing effects analysis summarized in the FMP.

5. Habitat Areas of Particular Concern (HAPC)

No HAPC are identified for northern rock sole.

6.Conservation recommendations

There are no EFH conservation recommendations for the Council from this five-year update.

[Pulled from GOA Groundfish FMP, sections 4.2.2, 4.2.2.1, 4.2.2.2]GOA Northern Rock sole

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Rock sole	x	1	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Northern Rock Sole

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: EFH for larval northern rock sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 1,000 m) throughout the GOA, as depicted in Figure E-12.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure E-13.

Deleted: BSAI

Adults: EFH for adult northern rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure E-13.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Rock sole**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Rock Sole	M					x	x	x																	x			
	LJ					x	x																		x			
	EJ					x																			x			
	L					x	x	x																		x		
	E					x	x	x																	x			

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Rock Sole	M							x	x				x						
	LJ							x	x				x						
	EJ							x	x				x						
	L			x															
	E																		

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Rock sole**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Rock Sole	M																									
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Rock Sole	M	9				x					x						x	x	x									

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Rock sole**

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Rock Sole	M									X			X			X	X														
	LJ									X			X			X	X														
	EJ				X																										
	L	X		X																											
	E																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Rock Sole	M																														
	LJ							X	X					X		X															
	EJ																														
	L																														
	E																														

1.2 Rock sole (Lepidopsetta bilineatus)

The shallow water flatfish management complex in the GOA consists of nine species: northern rock sole (Lepidopsetta polyxystra), southern rock sole (Lepidopsetta bileneata), yellowfin sole (Limanda aspera), starry flounder (Platichthys stellatus), butter sole (Isopsetta isolepis), English sole (Parophrys vetulus), Alaska plaice (Pleuronectes quadrituberculatus) and sand sole (Psettichthys melanostictus). The two rock sole species in the GOA have distinct characteristics and overlapping distributions. These two species of rock sole and yellowfin sole are the most abundant and commercially important species of this management complex in the GOA, and the description of their habitat and life history best represents the shallow water complex species.

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1.2.1 Life History and General Distribution

Norhtern rock sole are distributed from Puget Sound through the Bering Sea and Aleutian Islands to the Kuril Islands, overlapping with southern rock sole in the GOA (Orr and Matarese 2000). Centers of abundance occur off the Kamchatka Peninsula (Shubnikov and Lisovenko 1964), British Columbia (Forrester and Thompson 1969), the central GOA, and in the southeastern BS (Alton and Sample 1975). Adults exhibit a benthic lifestyle and, in the EBS, occupy separate winter (spawning) and summertime feeding distributions on the continental shelf. Northern rock sole spawn during the winter-early spring period of December-March. Soviet investigations in the early 1960s established two spawning concentrations: an eastern concentration north of Unimak Island at the mouth of Bristol Bay and a western concentration eastward of the Pribilof Islands between 55°30' and 55°0' N and approximately 165°2' W (Shubnikov and Lisovenko 1964). Northern rock sole spawning in the Gulf of Alaska has been found to occur at depths of 43 to 61 m (Stark and Somerton 2002). Spawning females deposit a mass of eggs that are demersal and adhesive (Alton and Sample 1975). Fertilization is believed to be external. Incubation time is temperature dependent and may range from 6.4 days at 11ºC to about 25 days at 2.9ºC (Forrester 1964). Newly hatched larvae are pelagic and have occurred sporadically in EBS plankton surveys (Waldron and Vinter 1978). Kamchatka larvae are reportedly 20 mm in length when they assume their side-swimming, bottom-dwelling form (Alton and Sample 1975, Orr and Matarese 2000). Forrester and Thompson (1969) report that by age 1 they are found with adults on the continental shelf during summer.

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In the springtime, after spawning, northern rock sole begin actively feeding and exhibit a widespread distribution thoughout the shallow waters of the continental shelf. This migration has been observed on both the eastern (Alton and Sample 1975) and western (Shvetsov 1978) areas of the BS and in the GOA. Summertime trawl surveys indicate most of the population can be found at depths from 50 to 100 m (Armistead and Nichol 1993). The movement from winter/spring to summer grounds is in response to warmer temperatures in the shallow waters and the distribution of prey on the shelf seafloor (Shvetsov 1978). In September, with the onset of cooling in the northern latitudes, northern rock sole begin the return migration to the deeper wintering grounds. Fecundity varies with size and was reported to be 450,000 eggs for fish 42 cm long. Larvae are pelagic, but their occurrence in plankton surveys in the EBS is rare (Musienko 1963). Juveniles are separate from the adult population, remaining in shallow areas until they reach age 1 (Forrester 1969). The estimated age of 50 percent maturity is 7 years for northern rock sole females (approximately 33 cm). The natural mortality rate is believed to range from 0.18 to 0.20 (Turnock et al. 2002).

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Deleted: During this time they spread out and form much less dense concentrations than during the spawning period.

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The approximate upper size limit of juvenile fish is 34 cm.

1.2.2 Fishery

Northern rock sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 4 and they are fully selected at age 11.

Historically, the fishery has nearshore to the Kodiak Island area and along the Alaska peninsula. They are caught as bycatch in Pacific cod, bottom pollock, and other flatfish fisheries and are caught with these species and Pacific halibut in rock sole directed fisheries.

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1.2.3 Relevant Trophic Information

Groundfish predators to rock sole include Pacific cod, walleye pollock, skates, Pacific halibut, and yellowfin sole, mostly on fish ranging from 5 to 15 cm standard length.

1.2.4 Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, juveniles inhabit shallow areas at least until age 1.

Adults: Summertime feeding on primarily sandy substrates of the EBS shelf. Widespread distribution mainly on the middle and inner portion of the shelf, feeding on bivalves, polychaetes, amphipods and miscellaneous crustaceans. Wintertime migration to deeper waters of the shelf margin for spawning and to avoid extreme cold water temperatures, feeding diminishes.

Habitat and Biological Associations: Rock sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter	OCS	D			
Larvae	2 to 3 months?	U phyto/zoo plankton?	winter/spring	OCS MCS ICS	P			
Early Juveniles	to 3.5 years	polychaetes bivalves amphipods misc. crust.	all year	BAY ICS OCS MCS	D	S[1],G		
Late Juveniles	up to 9 years	polychaetes bivalves amphipods misc. crust.	all year	BAY ICS OCS MCS	D	S[1],G		
Adults	9+ years	polychaetes bivalves amphipods misc. crust.	Feeding May-September Spawning Dec.-April	MCS ICS MCS OCS	D	S[1], G	ice edge	

[1]Pers. Comm. Dr. Robert McConnaughey

1.2.5 Literature

Alton, M.S., and T.M. Sample. 1976. Rock sole (Family Pleuronectidae) p. 461-474. *In*: Demersal fish and shellfish resources in the BS in the baseline year 1975. Principal investigators Walter T. Pereyra, Jerry E. Reeves, and Richard Bakkala. U.S. Dep. Comm., Natl. Oceanic Atmos. Admin., Natl. Mar. Serv., Northwest and Alaska Fish Center, Seattle, WA. Processed Rep., 619 p.

Armistead, C.E., and D.G. Nichol. 1993. 1990 Bottom Trawl Survey of the EBS Continental Shelf. U.S. Dep. Commer., NOAA Tech. Mem. NMFS-AFSC-7, 190 p.

Auster, P.J., R.J. Malatesta., R.W. Langton., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

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Forrester, C.R., and J.A. Thompson. 1969. Population studies on the rock sole, *Lepidopsetta bilineata*, of northern Hecate Strait British Columbia. Fish. Res. Bd. Canada, Tech. Rep. No. 108, 1969. 104 p.

Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the EBS from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Musienko, L.N. 1963. Ichthyoplankton of the BS (data of the BS expedition of 1958-59). Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 48 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 50)239-269. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1968, p. 251-286. In P. A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part I. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT67-51203.

Orr, J. W. and A. C. Matarese. 2000. Revision of the genus *Lepidopsetta* Gill, 1862 (Teleostei: Pleuronectidae) based on larval and adult morphology, with a description of a new species from the North Pacific Ocean and Bering Sea. Fish. Bull. 98:539-582 (2000).

Shubnikov, D.A., and L.A. Lisovenko. 1964. Data on the biology of rock sole in the southeastern BS. Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 49 (Izv. Tikookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 51) : 209-214. (Transl. In Soviet Fisheries Investigations in the Northeast Pacific, Part II, p. 220-226, by Israel Program Sci. Transl., 1968, available Natl. Tech. Inf. Serv., Springfield, VA, as TT 67-51204).

Shvetsov, F.G. 1978. Distribution and migrations of the rock sole, *Lepidopsetta bilineata*, in the regions of the Okhotsk Sea coast of Paramushir and Shumshu Islands. J. Ichthol., 18 (1), 56-62, 1978.

Stark, J.W., and D. A. Somerton. 2002. Maturation, spawning and growth of rock soles off Kodiak Island in the GOA. J. Fish. Biology (2002) 61, 417-431.

Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 2002. Flatfish. In Appendix B Stock Assessment and Fishery Evaluation for Groundfish Resources of the GOA Region. Pages 169-197. Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. U. S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv. Seattle, WA, Processed rep., 88 p.

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Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-12 to E-13 Rock sole (larvae, late juveniles/adults)

Figure E-12
GOA Rock Sole Larval Presence

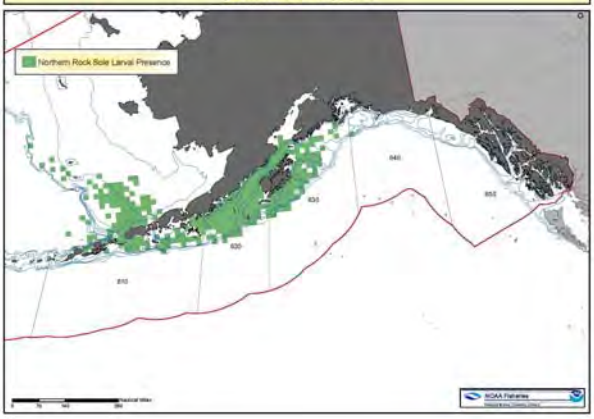
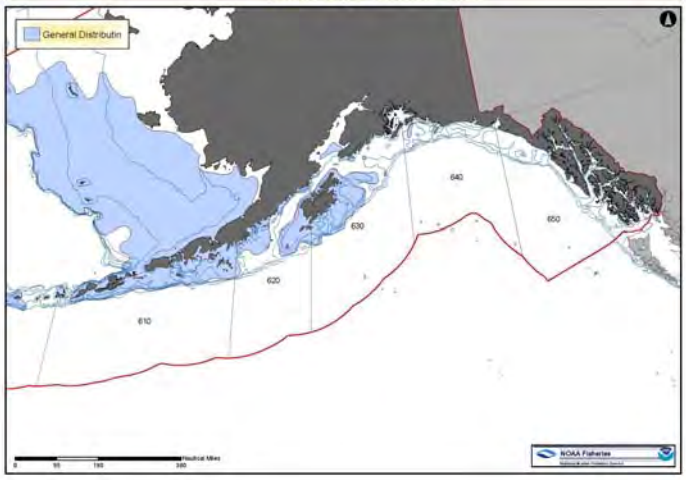


Figure E-13
GOA Rock Sole Late Juveniles/Adults



1.2.6 Evaluation of Effects on EFH of Groundfish Species

[NOTE: there is no entry specifically for rock sole]

Shallow Water Flatfish (GOA)

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—The nearshore areas inhabited by early juveniles of GOA shallow water flatfish are mostly unaffected by current fishery activities. Adult and late juvenile rock sole concentrations, as a proxy for GOA shallow water flatfish, primarily overlap with shallow water habitats (13 percent) (Table B.3-3 of the EFH EIS). The predicted reduction of infaunal prey in this overlap is 1 percent. Given this level of disturbance, it is unlikely that adult feeding would be negatively impacted, and effects are believed to be minimal or temporary for rock sole. It is unknown, however, for the other seven species of the shallow water flatfish complex.

The level of information available for rock sole and the other species of the shallow water complex are insufficient to estimate the stock size relative to B_{MSY}, although trawl survey abundance estimates indicate a stable to increasing level of biomass since 1984. Because the population biomass level required to produce long-term sustainability is unknown, the impacts of the effects of fishing on the habitat required for spawning, adult feeding, or juvenile survival and growth to maturity are unknown.

GOA southern rock sole Worksheet

1. EFH Description Update

A new section is developed for southern rock sole (need to change the heading numbers). Much of the previous text descriptions which referred to the combined rock sole species is still relevant for diet and substrate preference by life history stage.

2. New Information

Orr, J. W. and A. C. Matarese. 2000. Revision of the genus *Lepidopsetta* Gill, 1862 (Teleostei: Pleuronectidae) based on larval and adult morphology, with a description of a new species from the North Pacific Ocean and Bering Sea. Fish. Bull. 98:539-582 (2000).

3. Research and Information Needs

Diet information differentiated between the two rock sole forms needs to be documented. This information may already exist in the AFSC database.

4. Fishing Activities

No new information regarding changes in the distribution of fishing intensity warrant an update of the fishing effects analysis summarized in the FMP.

5. Habitat Areas of Particular Concern (HAPC)

No HAPC are identified for southern rock sole.

6.Conservation recommendations

There are no EFH conservation recommendations for the Council from this five-year update.

[Pulled from GOA Groundfish FMP, sections 4.2.2, 4.2.2.1, 4.2.2.2]GOA Southern Rock sole

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Rock sole	x	1	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Southern Rock Sole

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: EFH for larval southern rock sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 1,000 m) throughout the GOA, as depicted in Figure E-12.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile southern rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure E-13.

Adults: EFH for adult southern rock sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand, gravel, and cobble, as depicted in Figure E-13.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Rock sole**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Rock Sole	M					x	x	x																	x			
	LJ					x	x																		x			
	EJ					x																			x			
	L					x	x	x																		x		
	E					x	x	x																	x			

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Rock Sole	M							x	x				x						
	LJ							x	x				x						
	EJ							x	x				x						
	L			x															
	E																		

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Rock sole**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Rock Sole	M																									
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Rock Sole	M	9				x					x						x	x	x									

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Rock sole

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Rock Sole	M									X			X			X	X														
	LJ									X			X			X	X														
	EJ				X																										
	L	X		X																											
	E																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Rock Sole	M																														
	LJ							X	X					X		X															
	EJ																														
	L																														
	E																														

1.2 Southern rock sole (Lepidopsetta bilineatus)

The shallow water flatfish management complex in the GOA consists of nine species: southern rock sole (Lepidopsetta bileneata), northern rock sole (Lepidopsetta polyxystra), yellowfin sole (Limanda aspera), starry flounder (Platichthys stellatus), butter sole (Isopsetta isolepis), English sole (Parophrys vetulus), Alaska plaice (Pleuronectes quadrituberculatus) and sand sole (Psettichthys melanostictus). The rock sole resource in the GOA consists of two separate species; a northern and a southern form which have distinct characteristics and overlapping distributions. The two species of rock sole and yellowfin sole are the most abundant and commercially important species of this management complex in the GOA, and the description of their habitat and life history best represents the shallow water complex species.

1.2.1 Life History and General Distribution

Southern rock sole are distributed from Baja California waters north into the GOA and the eastern Aleutian Islands. Centers of abundance occur off the Kamchatka Peninsula (Shubnikov and Lisovenko 1964), British Columbia (Forrester and Thompson 1969), the central GOA, and to a lesser extent in the extreme southeastern BS (Alton and Sample 1975, Orr and Matarese 2000). Adults exhibit a benthic lifestyle and occupy separate winter (spawning) and summertime feeding distributions on the continental shelf. Southern rock sole spawn during the summer in the Gulf of Alaska (Stark and Somerton 2002). Before they were identified as two separate species, Russian investigations in the early 1960s established two spawning concentrations: an eastern concentration north of Unimak Island at the mouth of Bristol Bay and a western concentration eastward of the Pribilof Islands between 55°30' and 55°0' N and approximately 165°2' W (Shubnikov and Lisovenko 1964). Southern rock sole spawning in the Gulf of Alaska was found to occur at depths of 35 and 120 m. Spawning females deposit a mass of eggs that are demersal and adhesive (Alton and Sample 1975). Fertilization is believed to be external. Incubation time is temperature dependent and may range from 6.4 days at 11ºC to about 25 days at 2.9ºC (Forrester 1964). Newly hatched larvae are pelagic (Waldron and Vinter 1978) and have been captured on all sides of Kodiak Island and along the Alaska Peninsula (Orr and Matarese 2000). Kamchatka larvae are reportedly 20 mm in length when they assume their side-swimming, bottom-dwelling form (Alton and Sample 1975) and have been present in nearshore juvenile sampling catches around Kodiak Island in September and October (Abookire et al 2007). Forrester and Thompson (1969) report that age 1 fish are found with adults on the continental shelf during summer.

In the springtime southern rock sole begin actively feeding and commence a migration to the shallow waters of the continental shelf to spawn in summer. Summertime trawl surveys indicate most of the population can be found at depths from 50 to 100 m (Armistead and Nichol 1993). The movement from winter/spring to summer grounds may be a response to warmer temperatures in the shallow waters and the distribution of prey on the shelf seafloor (Shvetsov 1978). In September, with the onset of cooling in the northern latitudes, southern rock sole begin the return migration to the deeper wintering grounds. Fecundity varies with size and was reported to be 450,000 eggs for fish 42 cm long. Larvae are pelagic and settlement occurs in September and October. The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach age 1 (Forrester 1969). The estimated age of 50 percent maturity is 9 years for southern rock sole females at approximately 35 cm length (Stark and Somerton 2002). The natural mortality rate is believed to range from 0.18 to 0.20 (Tournock et al. 2002).

The approximate upper size limit of juvenile fish is 34 cm.

1.2.2 Fishery

Southern rock sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 4 and they are fully selected at age 11.

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Deleted: , but their occurrence in plankton surveys in the EBS is rare (Musienko 1963).
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Historically, the fishery has occurred on continental shelf areas proximate to Kodiak Island. They are caught as bycatch in Pacific cod, bottom pollock, and other shallow water flatfish species and are caught with these species and Pacific halibut in rock sole directed fisheries.

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1.2.3 Relevant Trophic Information

Groundfish predators to southern rock sole include Pacific cod, walleye pollock, skates, Pacific halibut, and yellowfin sole, mostly on fish ranging from 5 to 15 cm standard length.

1.2.4 Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, juveniles inhabit shallow areas at least until age 1.

Adults: Summertime feeding and spawning on primarily sandy substrates of the EBS shelf. Widespread distribution mainly on the middle and inner portion of the shelf, feeding on bivalves, polychaetes, amphipods and miscellaneous crustaceans. Wintertime migration to deeper waters of the shelf margin to avoid extreme cold water temperatures, feeding diminishes.

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Habitat and Biological Associations: Southern Rock sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	summer	OCS	D			
Larvae	2 to 3 months?	U phyto/zoo plankton?	summer	OCS MCS ICS	P			
Early Juveniles	to 3.5 years	polychaetes bivalves amphipods misc. crust.	all year	BAY ICS OCS MCS	D	S[1],G		
Late Juveniles	up to 9 years	polychaetes bivalves amphipods misc. crust.	all year	BAY ICS OCS MCS	D	S[1],G		
Adults	9+ years	polychaetes bivalves amphipods misc. crust.	Feeding May-September Spawning June-August	MCS ICS MCS OCS	D	S[1], G	ice edge	

[1]Pers. Comm. Dr. Robert McConnaughey

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1.2.5 Literature

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Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-12 to E-13 Rock sole (larvae, late juveniles/adults)

Figure E-12
GOA Rock Sole Larval Presence

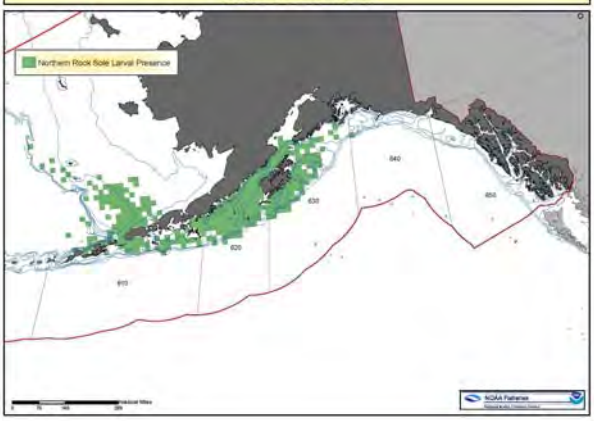
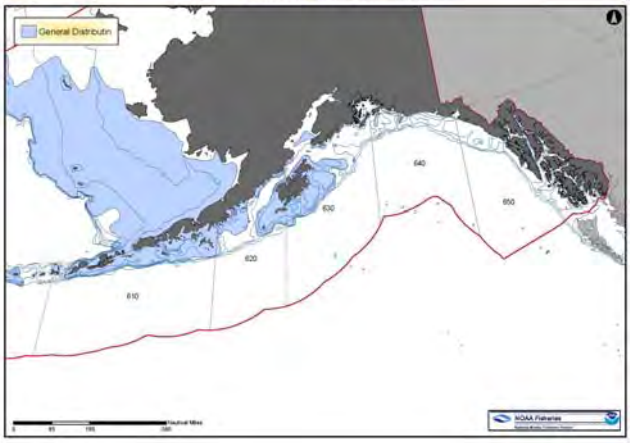


Figure E-13
GOA Rock Sole Late Juveniles/Adults



1.2.6 Evaluation of Effects on EFH of Groundfish Species

[NOTE: there is no entry specifically for rock sole]

Shallow Water Flatfish (GOA)

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—The nearshore areas inhabited by early juveniles of GOA shallow water flatfish are mostly unaffected by current fishery activities. Adult and late juvenile rock sole concentrations, as a proxy for GOA shallow water flatfish, primarily overlap with shallow water habitats (13 percent) (Table B.3-3 of the EFH EIS). The predicted reduction of infaunal prey in this overlap is 1 percent. Given this level of disturbance, it is unlikely that adult feeding would be negatively impacted, and effects are believed to be minimal or temporary for rock sole. It is unknown, however, for the other seven species of the shallow water flatfish complex.

The level of information available for southern rock sole and the other species of the shallow water complex are insufficient to estimate the stock size relative to B_{MSY}, although trawl survey abundance estimates indicate a stable to increasing level of biomass since 1984. Because the population biomass level required to produce long-term sustainability is unknown, the impacts of the effects of fishing on the habitat required for spawning, adult feeding, or juvenile survival and growth to maturity are unknown.

GOA Alaska plaice Worksheet

1. EFH Description Update

No new information warrants a change to the EFH text description or the EFH distribution maps by life stage.

2. New Information

A few text edits were made which are specific to Gulf of Alaska Alaska plaice. I added the diet information which was missing from Table D-3 but was summarized in section 1.2.3.

3. Research and Information Needs

Any spawning information such as type (batch or broadcast?) and documentation of spawning location.

4. Fishing Activities

No new information regarding changes in the distribution of fishing intensity warrant an update of the fishing effects analysis summarized in the FMP.

5. Habitat Areas of Particular Concern (HAPC)

No HAPC are identified for Gulf of Alaska Alaska plaice.

6. Conservation recommendations

There are no EFH conservation recommendations for the Council from this five-year update.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Alaska plaice	1	1	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Alaska Plaice

Eggs: EFH for Alaska plaice eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA in the spring, as depicted in Figure E-14.

Larvae: EFH for larval Alaska plaice is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure E-15.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile Alaska plaice is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure E-16.

Adults: EFH for adult Alaska plaice is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the BSAI wherever there are softer substrates consisting of sand and mud, as depicted in Figure E-16.

EFH 5-year report - Appendix 2

[Pulled from Appendix D, BSAI Groundfish FMP, Tables D.1-D.3] **GOA AK plaice**

Table D.1 Summary of habitat associations.

BSA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Alaska Plaice	M					x	x	x																	x			
	LJ					x	x	x																	x			
	EJ					x	x																		x			
	L					x	x	x																		x		
	E					x	x	x																		x		

BSA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Alaska Plaice	M							x	x				x						
	LJ							x	x				x						
	EJ							x	x				x						
	L			x															
	E																		

BSA Groundfish	Structure	Community Associations	Oceanographic Properties

EFH 5-year report - Appendix 2

[Pulled from Appendix D, BSAI Groundfish FMP, Tables D.1-D.3] GOA AK plaice

Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Alaska Plaice	M																									
	LJ																									
	EJ																									
	L																									
	E																									

Table Error! No text of specified style in document.**.2 Summary of biological associations.**

BSAI Groundfish		Reproductive Traits																									
		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
Alaska Plaice	M	6-7				x													x	x	x							

Table Error! No text of specified style in document.**.3 Summary of predator and prey associations**

BSAI Groundfish	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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Alaska plaice	A									X			X																		

EFH 5-year report - Appendix 2

[Pulled from Appendix D, BSAI Groundfish FMP, Tables D.1-D.3] **GOA AK plaice**

BSAI Groundfish		Prey of																													
Species		**Jellyfish**	**Starfish**	**Chaetognaths (arrowworms)**	**Crab**	**Herring**	**Salmon**	**Pollock**	**Pacific cod**	**Ling cod**	**Rockfish**	**Rock Sole**	**Flathead Sole**	**Yellowfin sole**	**Arrowtooth flounder**	**Hailbut**	**Salmon Shark**	**Northern Fur Seal**	**Harbor Seal**	**Steller sea lion**	**Dalls Porpoise**	**Beluga whale**	**Killer Whale**	**Minke whale**	**Eagles**	**Murres**	**Puffin**	**Kittiwake**	**Gull**	**Terrerstrial Mammals**

[NOTE: Alaska Plaice is not included in the GOA FMP life history descriptions. I have included the section from the BSAI FMP below. If the species description should stay in the GOA FMP, please edit accordingly.]

1.2 Alaska Plaice (Pleuronectes quadrituberculatus)

Alaska plaice are managed as part of the shallow water flatfish assemblage in the Gulf of Alaska.

Deleted: Formerly a constituent of the "other flatfish" management category, Alaska plaice were split out in recent years and are managed as a separate stock

1.2.1 Life History and General Distribution

Alaska plaice inhabit continental shelf waters of the North Pacific ranging from the Gulf of Alaska to the Bering and Chukchi Seas and in Asian waters as far south as Peter the Great Bay (Pertseva-Ostroumova 1961; Quast and Hall 1972). Adults exhibit a benthic lifestyle and live year round on the shelf and move seasonally within its limits (Fadeev 1965). Alaska plaice are caught in near shore areas along the Alaska Peninsula and Kodiak Island in summer resource assessment surveys. From over-winter grounds near the shelf margins, adults begin a migration onto the central and northern shelf of the eastern Bering Sea, primarily at depths of less than 100 m, although it is unknown if this behavior is also consistent with the Gulf of Alaska . Spawning usually occurs in March and April on hard sandy ground (Zhang 1987). The eggs and larvae are pelagic and transparent and have been found in ichthyoplankton sampling in late spring and early summer over a widespread area of the continental shelf, particulary in the Shelikof Strait area (Waldron and Favorite 1977).

Fecundity estimates (Fadeev 1965) indicate female fish produce an average of 56 thousand eggs at lengths of 28 to 30 cm and 313 thousand eggs at lengths of 48 to 50 cm. The age or size at metamorphosis is unknown. The estimated length of 50% maturity is 32 cm from collections made in March and 28 cm from April, which corresponds to an age of 6 to 7 years. Natural mortality rate estimates range from 0.19 to 0.22 (Wilderbuer and Zhang 1999).

The approximate upper size limit of juvenile fish is 27cm.

1.2.2 Fishery

Caught in bottom trawls primarily in pursuit of other bottom-dwelling species such as flatfish of the shallow water group. Recruitment begins at about age 6 and they are fully selected at age 12. Relevant Trophic Information

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Deleted: The fishery occurs throughout the mid and inner Bering Sea shelf during ice-free conditions .In recent years catches have been low due to a lack of targeting and they are now primarily caught as bycatch in Pacific cod, bottom pollock, yellowfin sole and other flatfish fisheries and are caught with these species and Pacific halibut the directed fishery.¶

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Groundfish predators include Pacific halibut (Novikov, 1964) yellowfin sole, beluga whales and fur seals (Salveson 1976).

1.2.3 Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2-3 months until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Summertime feeding on sandy substrates of the eastern Bering Sea shelf. Wide-spread distribution mainly on the middle, northern portion of the shelf, feeding on polychaete, amphipods and echiurids (Livingston and DeReynier 1996). Wintertime migration to deeper waters of the shelf margin to avoid extreme cold water temperatures. Feeding diminishes until spring after spawning.

Habitat and Biological Associations: Alaska plaice

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	spring and summer	ICS, MCS OCS	P			
Larvae	2-4 months?	U phyto/zoo plankton?	spring and summer	ICS, MCS	P			
Juveniles	up to 7 years	polychaete amphipods echiurids	all year	ICS, MCS	D	S+M[1]		
Adults	7+ years	polychaete amphipods echiurids	Spawning March-May Non-spawning and feeding June.-February	ICS, MCS ICS, MCS	D	S+M[1]	ice edge	

[1]Pers. Comm. Dr. Robert McConnaughey (206) 526-4150

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1.2.4 Literature

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[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] **GOA AK plaice**

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-14 to E-16 Alaska Plaice (eggs, larvae, late juveniles/adults)

Figure E-14
GOA Alaska Plaice Egg Presence

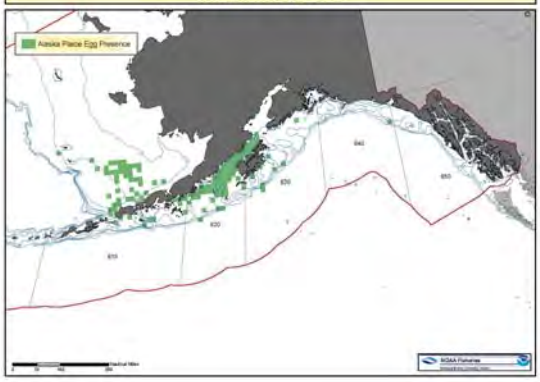


Figure E-15
GOA Alaska Plaice Larval Presence

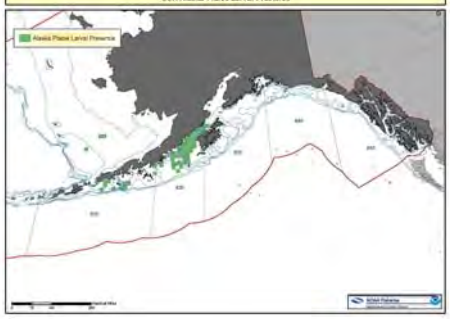
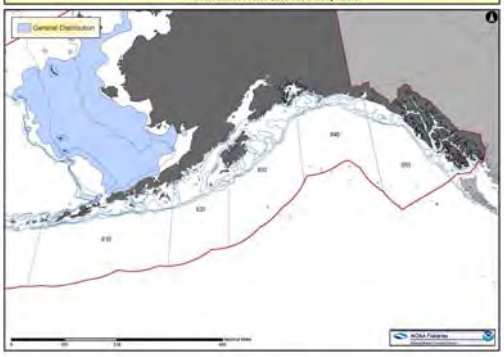


Figure E-16
GOA Alaska Plaice Late Juveniles/Adults



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1.2.5 Evaluation of Effects on EFH of Groundfish Species

[NOTE: The Alaska Plaice fishery is not included in the GOA FMP effects on EFH section. I have included the shallow water flatfish section from the GOA FMP below, as well as the Alaska plaice section from the BSAI FMP below. If either fishery description should stay in the GOA FMP, please edit accordingly.]

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1.2.5.1 Shallow Water Flatfish (GOA)

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—The nearshore areas inhabited by early juveniles of GOA shallow water flatfish are mostly unaffected by current fishery activities. Adult and late juvenile rock sole concentrations, as a proxy for GOA shallow water flatfish, primarily overlap with shallow water habitats (13 percent) (Table B.3-3 of the EFH EIS). The predicted reduction of infaunal prey in this overlap is 1 percent. Given this level of disturbance, it is unlikely that adult feeding would be negatively impacted, and effects are believed to be minimal or temporary for rock sole. It is unknown, however, for the other seven species of the shallow water flatfish complex.

The level of information available for rock sole and the other species of the shallow water complex are insufficient to estimate the stock size relative to B_{MSY}, although trawl survey abundance estimates indicate a stable to increasing level of biomass since 1984. Because the population biomass level required to produce long-term sustainability is unknown, the impacts of the effects of fishing on the habitat required for spawning, adult feeding, or juvenile survival and growth to maturity are unknown.

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1.2.5.2 Alaska Plaice (BSAI)

Issue	Evaluation
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by Alaska plaice early juveniles are mostly unaffected by current fishery activities. Adult and late juvenile Alaska plaice concentrations in the BSAI primarily overlap with the EBS sand habitat (42 percent) and the EBS sand/mud habitat (52 percent) (Table B.3-3 of the EFH EIS). These fish would be affected by reductions in infaunal prey. However, the levels of reduction in those concentration overlaps are predicted to be less than 1 percent for EBS sand and 2 percent for EBS sand/mud habitat. Given this level of disturbance, it is unlikely that the adult feeding has been or would be negatively impacted. The diet and length-weight analysis presented in the preceding sections supports this assertion. The trawl survey CPUE analysis also did not provide evidence of spatial shifts on the population level in response to areas of high fishing effort impacts.

The Alaska plaice stock is currently at a high level of abundance (Spencer et al. 2004) and well above the MSST. There have been no observations of a decline in length or weight at age for this stock over the 22 years of trawl survey sampling. Therefore, the combined evidence from diet analysis, individual fish length-weight analysis, examination of recruitment, stock biomass, and CPUE trends indicate that effects of the reductions in habitat features from fishing are either minimal or temporary for BS Alaska plaice.

Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? Y or N If yes, explain.

Text description: Yes. Some new information on egg and larval distributions, maturity, and spawning has become available.
NOTE BY DIANA EVANS: Author was referring to the FMP text here, not specifically to the text description of EFH for flathead sole. I clarified with author that the EFH description is still accurate, and does not warrant change at this time.

Maps: Yes. The map of distribution of larvae should be updated with latest information from the EcoFOCI Ichthyoplankton Information System (IIS).

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2[*])?
No.

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.

References were updated in the revision.

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

None.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

The level of information for the early juvenile life stage is inadequate to change the current level from "Unknown" to "Level 1".

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions.

No, the new information does not impact the definition of EFH for any of the life stages of this species. Also, the effects of fishing activities on EFH for this species are still thought to be minimal and temporary for all life stages.

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[*] EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list.

No.

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain.

None. Fishing activities are thought to have only minimal and temporary effects on Dover sole in the Gulf of Alaska.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Dover sole	1	1	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Dover Sole

Eggs: EFH for Dover sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-20.

Larvae: EFH for larval Dover sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-21.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile Dover sole is the general distribution area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of sand and mud, as depicted in Figure E-22.

Adults: EFH for adult Dover sole is the general distribution area for this life stage, located in the lower portion of the water column along the middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of sand and mud, as depicted in Figure E-22.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Dover sole**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Dover Sole	M					x	x	x	x	x	x	x													x			
	LJ					x	x	x	x	x															x			
	EJ					x	x																		x			
	L					x	x	x	x	x																x		
	E					x	x	x	x	x																x		

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Dover Sole	M							x	x			x							
	LJ							x	x			x							
	EJ							x	x			x							
	L			x															
	E																		

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Dover sole**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Dover Sole	M																									
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Dover Sole	M	6.7	11			x					x							x	x	x	x							

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Dover sole

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Dover Sole	M												X						X											
	LJ												X						X											
	EJ																													
	L	X		X																										
	E																													

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GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Dover Sole	M							X								X														
	LJ							X								X														
	EJ																													
	L																													
	E																													

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1.2 Dover sole (Microstomus pacificus)

1.2.1 Life History and General Distribution

Dover sole are distributed in deep waters of the continental shelf and upper slope from northern Baja California to the BS and the western AI (Hart 1973, Miller and Lea 1972). They exhibit a widespread distribution throughout the GOA. Adults are demersal and are mostly found in water deeper than 300 m in the winter but occur in highest biomass in the 100- to 200-m depth range during summer in the GOA (Turnock et al. 2004). The spawning period off Oregon is reported to range from January through May (Hunter et al. 1992). Off California, Dover sole spawn in deep water, and the larvae eventually settle in the shallower water of the continental shelf. They gradually move down the slope into deeper water as they grow and reach sexual maturity (Jacobson and Hunter 1993,Vetter et al. 1994, Hunter et al. 1990). For mature adults, most of the biomass may inhabit the oxygen minimum zone in deep waters Spawning in the GOA has been observed from January through August, with a peak period in May (Hirschberger and Smith 1983), although a more recent study found spawning limited to February through May (Abookire and Macewicz, 2003). Eggs have been collected in neuston and bongo nets in the summer, east of Kodiak Island (Kendall and Dunn 1985), but the duration of the incubation period is unknown. Larvae were captured in bongo nets only in summer over mid-shelf and slope areas (Kendall and Dunn 1985). The age or size at metamorphosis is unknown, but the pelagic larval period is known to be protracted and may last as long as 2 years (Markle et al. 1992). Pelagic postlarvae as large as 48 mm have been reported, and the young may still be pelagic at 10 cm (Hart 1973). Dover sole are batch spawners, and Hunter et al. (1992) concluded that the average 1 kg female spawns its 83,000 advanced yolked oocytes in about nine batches. A comparison of maturity studies from Oregon and the GOA indicates that females mature at similar age in both areas (6-7 years), but GOA females are much larger (44 cm) than their southern counterparts (33 cm) at 50% maturity (Abookire and Macewicz, 2003). Juveniles less than 25 cm are rarely found with the adult population from bottom trawl surveys (Martin and Clausen 1995). The natural mortality rate used in recent stock assessments is 0.085 yr^{-1} based on a maximum observed age in the GOA of 54 years (Stockhausen et al. 2007).

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1.2.2 Fishery

Dover sole are caught in bottom trawls, both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 5. They are caught as bycatch in the rex sole, thornyhead, and sablefish fisheries, and they are caught with these species and Pacific halibut in Dover sole directed fisheries.

1.2.3 Relevant Trophic Information

Dover sole commonly feed on brittle stars, polychaetes and other miscellaneous worms (Aydin et al., 2007; Buckley et al., 1999). Important predators include walleye pollock and Pacific halibut (Aydin et al. 2007).

Deleted: Groundfish predators include Pacific cod and most likely arrowtooth flounder

1.2.4 Habitat and Biological Associations

Larvae/Juveniles: Dover sole are planktonic larvae for up to 2 years until metamorphosis occurs; juvenile distribution is unknown.

Adults: Dover sole are winter and spring spawners, and summer feeding occurs on soft substrates (combination of sand and mud) of the continental shelf and upper slope. Shallower summer distribution occurs mainly on the middle to outer portion of the shelf and upper slope. Dover sole commonly feed on brittle stars, polychaetes and other miscellaneous worms (Aydin et al., 2007; Buckley et al., 1999).

Deleted: They feed mainly on polychaetes, annelids, crustaceans, and mollusks (Livingston and Goiney 1983)

Habitat and Biological Associations: Dover sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	spring summer	ICS? MCS OCS USP	P			
Larvae	up to 2 years	U phyto/zoo plankton?	all year	ICS? MCS OCS USP	P			
Early Juveniles	to 3 years	polychaetes amphipods annelids	all year	MCS? ICS?	D	S, M		
Late Juveniles	3 to 5 years	polychaetes amphipods annelids	all year	MCS? ICS?	D	S, M		
Adults	5+ years	polychaetes amphipods annelids	Spawning Jan-August non-spawning July-January	MCS OCS USP	D	S, M		

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mollusks

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Vetter, R.D., E.A. Lynn, M. Garza, and A.S. Costa. 1994. Depth zonation and metabolic adaptation in Dover sole, *Microstomus pacificus*, and other deep-living flatfishes: factors that affect the sole. Mar. Biol. (1994) 120:145-159.

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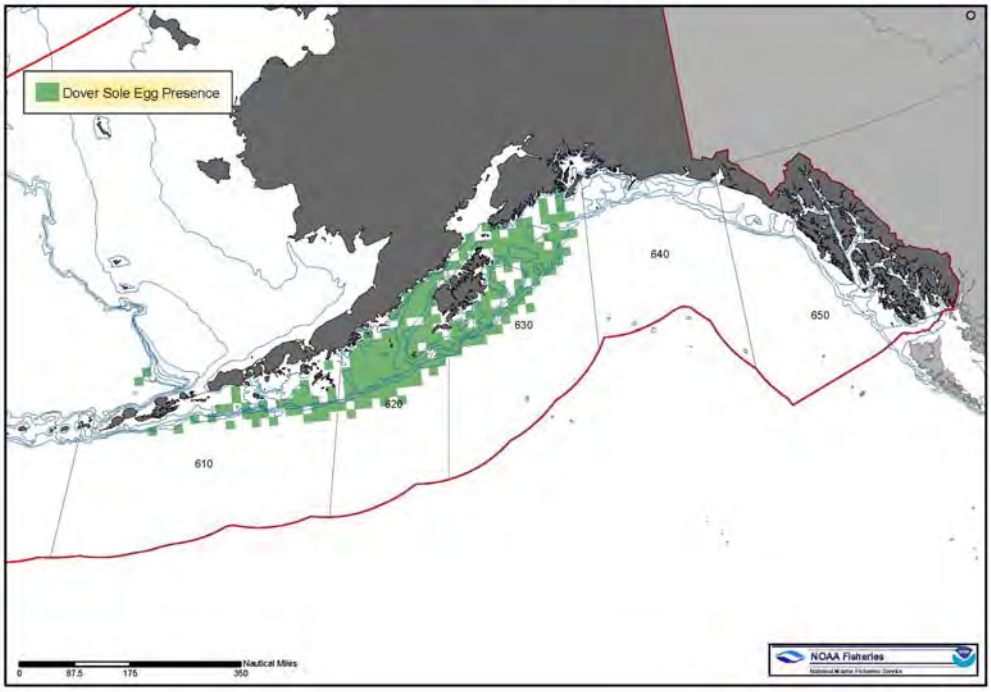
Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-20 to E-22 Dover sole (eggs, larvae, late juveniles/adults)

Figure E-20
GOA Dover Sole Egg Presence



[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] GOA Dover sole

Figure E-21
GOA Dover Sole Larval Presence

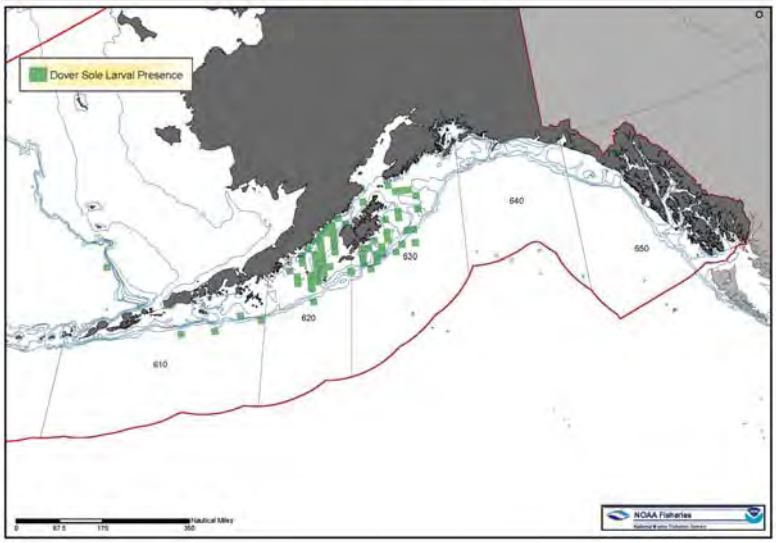
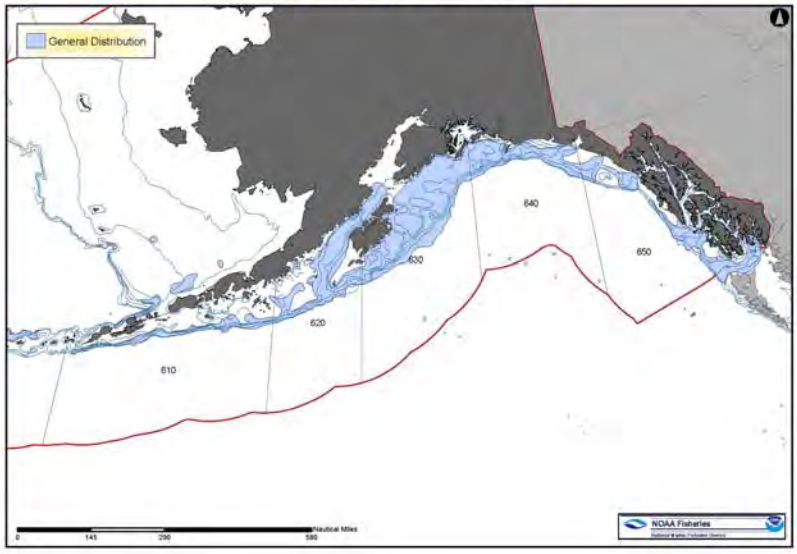


Figure E-22
GOA Dover Sole Late Juveniles/Adults



1.2.6 Evaluation of Effects on EFH of Groundfish Species

[NOTE: effects section is written only for deep water flatfish]

Deep Water Flatfish (GOA)

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—The nearshore areas inhabited by early juveniles of GOA deepwater flatfish are mostly unaffected by current fishery activities. Adult and late juvenile Dover sole concentrations in the GOA, as a proxy for GOA deepwater flatfish, primarily overlap with deepwater shelf habitat (58 percent), slope habitat (19 percent), and shallow water habitat (21 percent) (Table B.3-3 of the EFH EIS). This species is dependent on infaunal prey. However, reductions of infaunal prey in those concentration overlaps are predicted to be 1 percent for each of those habitats. Given this level of disturbance, it is unlikely that the adult feeding would be negatively impacted.

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The level of information available for the species other than Dover sole is insufficient to estimate the stock size relative to B_{MSY}. Because these levels are unknown for most of the species in this complex, the impacts of the effects of fishing on the habitat required for spawning, adult feeding, or juvenile survival and growth to maturity for the deep water complex are unknown.

Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? Y or N If yes, explain.

Text description: Yes. Some new information on egg and larval distributions, maturity, and spawning has become available.
NOTE BY DIANA EVANS: Author was referring to the FMP text here, not specifically to the text description of EFH for flathead sole. I clarified with author that the EFH description is still accurate, and does not warrant change at this time.

Maps: Yes. The map of distribution of larvae should be updated with latest information from the EcoFOCI Ichthyoplankton Information System (IIS).

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2*)?
No.

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.

References were updated in the revision.

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

None.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

The level of information for the early juvenile life stage is inadequate to change the current level from "Unknown" to "Level 1".

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions.

No, the new information does not impact the definition of EFH for any of the life stages of this species. Also, the effects of fishing activities on EFH for this species are still thought to be minimal and temporary for all life stages.

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* EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list.

No.

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain.

None. Fishing activities are thought to have only minimal and temporary effects on flathead sole in the Gulf of Alaska.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Rex sole	1	1	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Rex Sole

Eggs: EFH for rex sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA in the spring, as depicted in Figure E-17.

Larvae: EFH for larval rex sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA, as depicted in Figure E-18.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for juvenile rex sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure E-19.

Adults: EFH for adult rex sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are substrates consisting of gravel, sand, and mud, as depicted in Figure E-19.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA rex sole**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Rex Sole	M					x	x	x	x	x															x			
	LJ					x	x	x	x																x			
	EJ					x	x																		x			
	L					x	x	x	x																	x		
	E					x	x	x	x																	x		

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Rex Sole	M							x	x				x						
	LJ							x	x				x						
	EJ							x	x				x						
	L							x	x										
	E																		

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA rex sole**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Rex Sole	M																									
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Rex Sole	M	24cm		16cm		x												x	x	x	x	x	x					

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA rex sole

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Rex Sole	M							X		X			X					X													
	LJ							X		X			X					X													
	EJ																														
	L	X		X																											
	E																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Rex Sole	M														X															
	LJ														X															
	EJ																													
	L																													
	E																													

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1.2 Rex sole (Glyptocephalus zachirus)

1.2.1 Life History and General Distribution

Rex sole are distributed from Baja California to the BS and western AI (Hart 1973, Miller and Lea 1972). They are most abundant at depths between 100 and 200m and are found fairly uniformly throughout the Gulf of Alaska (GOA) outside the spawning season. The spawning period off Oregon is reported to range from January through June with a peak in March and April (Hosie and Horton 1977). Using data from research surveys, Hirschberger and Smith (1983) found that spawning in the GOA occurred from February through July, with a peak period in April and May, although they had few, if any, observations from October to February. More recently, Abookire (2006) found evidence for spawning starting in October and ending in June, based on one year's worth of monthly histological sampling (October through July) that included both research survey and fishery samples. It seems reasonable, then, that the actual spawning season extends from October to July. Fecundity estimates from samples collected off the Oregon coast ranged from 3,900 to 238,100 ova for fish 24 to 59 cm (Hosie and Horton 1977). During the spawning season, adult rex sole concentrate along the continental slope, but also appear on the outer shelf (Abookire and Bailey, 2007). Eggs are fertilized near the sea bed, become pelagic, and probably require a few weeks to hatch (Hosie et al. 1977). Abookire and Bailey (2007) concluded that larval duration is about 9 months in the GOA (rather than 12 months as found by Pearcy et al., 1977, off the coast of Oregon) and that size-at-transformation for rex sole is 49-72 mm. Although maturity studies from Oregon indicate that females are 50 percent mature at 24 cm, females in the GOA achieve 50% maturity at larger size (35.2 cm) and grow faster such that they achieve 50% maturity at about the same age (5.1 years) as off Oregon (Abookire, 2006). Juveniles less than 15 cm are rarely found with the adult population. The natural mortality rate used in recent stock assessments is 0.17 (Stockhausen et al., 2007).

1.2.2 Fishery

Rex sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3 or 4. They are caught as bycatch in the Pacific ocean perch, Pacific cod, bottom pollock, and other flatfish fisheries and are caught with these species and Pacific halibut in rex sole directed fisheries.

1.2.3 Relevant Trophic Information

Based on results from an ecosystem model for the Gulf of Alaska (Aydin et al., 2007), rex sole in the Gulf of Alaska occupy an intermediate trophic level. Polychaetes, euphasiids, and miscellaneous worms were the most important prey for rex sole. Other major prey items included benthic amphipods, polychaetes, and shrimp (Livingston and Goiney, 1983; Yang, 1993; Yang and Nelson, 2000). Important predators on rex sole include longnosed skate and arrowtooth flounder.

1.2.4 Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for an unknown time period until metamorphosis occurs, juvenile distribution is unknown.

Adults: Spring spawning and summer feeding on a combination of sand, mud and gravel substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf, feeding mainly on polychaetes, euphausids and miscellaneous worms.

Deleted: , and are widely distributed throughout the GOA

Deleted: Adults exhibit a benthic lifestyle and are generally found in water deeper than 300 m.

Deleted: From over-winter grounds near the shelf margins, adults begin a migration onto the mid and outer continental shelf in April or May each year.

Deleted: Spawning

Deleted: was observed

Deleted: (Hirschberger and Smith 1983)

Deleted: Eggs have been collected in neuston and bongo nets mainly in the summer, east of Kodiak Island (Kendall and Dunn 1985), but the duration of the incubation period is unknown. Larvae were captured in bongo nets only in summer over midshelf and slope areas (Kendall and Dunn 1985). Fecundity estimates from samples collected off the Oregon coast ranged from 3,900 to 238,100 ova for fish 24 to 59 cm (Hosie and Horton 1977). The age or size at metamorphosis is unknown

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Deleted: and females at 24 cm

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Deleted: Turnock et al. 2002

Deleted: The approximate upper size limit of juvenile fish is 15cm for males and 23 cm for females.¶

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Deleted: Groundfish predators include Pacific cod and most likely arrowtooth flounder.

Deleted: amphipods,

Deleted: snow crabs

Habitat and Biological Associations: Rex sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	several weeks	NA	Oct - July	ICS? MCS OCS	P			
Larvae	9 months	U phyto/zoo plankton?	spring summer	ICS? MCS OCS	P			
Juveniles	ages 1-5 years	polychaetes euphausiids misc. worms	all year	MCS ICS OCS	D	G, S, M		
Adults	ages 5-33 years	polychaetes amphipods euphausiids misc. worms	Spawning Oct.-July non-spawning July-Sep	MCS, OCS USP	D	G, S, M		

Deleted: Feb
Deleted: May
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Deleted: U
Deleted: ¶ amphipods
Deleted: 2 years
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Deleted: Tanner crab
Deleted: 2+ years
Deleted: Feb-May
Deleted: ¶
Deleted: May-January
Deleted: Tanner crab

1.2.5 Literature

Abookire, A.A. 2006. Reproductive biology, spawning season, and growth of female rex sole (*Glyptocephalus zachirus*) in the Gulf of Alaska. Fish. Bull. 104: 350-359.

Abookire, A.A. and K.M. Bailey. 2007. The distribution of life cycle stages of two deep-water pleuronectids, Dover sole (*Microstomus pacificus*) and rex sole (*Glyptocephalus zachirus*), at the northern extent of their range in the Gulf of Alaska. J. Sea Res. 57:198-208.

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Aydin, K., S. Gaichas, I. Ortiz, D. Kinzey, and N. Friday. 2007. A comparison of the Bering Sea, Gulf of Alaska, and Aleutian Islands large marine ecosystems through food web modeling. U.S. Dep. Commer., NOAA NMFS Tech Memo. NMFS-AFSC-178. 298 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada, Bull. No. 180. 740 p.

Hosie, M.J., and H.F. Horton. 1977. Biology of the rex sole, *Glyptocephalus zachirus*, in waters off Oregon. Fish. Bull. Vol. 75, No. 1, 1977, p. 51-60.

Hirschberger, W.A., and G.B. Smith. 1983. Spawning of twelve groundfish species in the Alaska and Pacific coast regions. 50 p. NOAA Tech. Mem. NMFS F/NWC-44. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. NOAA Tech. Rep. NMFS 20, U.S. Dep. Commer, NOAA, Natl. Mar. Fish. Serv.

Livingston, P.A., and B.J. Goiney, Jr. 1983. Food habits literature of North Pacific marine fishes: a review and selected bibliography. NOAA Tech. Mem. NMFS F/NWC-54, U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv.

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Matarese, A.C., D.M. Blood, S.J. Piquelle and J. Benson. 2003.Atlas of abundance and distribution patterns of ichthyoplankton form the northeast Pacific Ocean and Bering Sea ecosystems based on research conducted by the Alaska Fisheries Science Center (1972-1996). NOAA Prof. Paper NMFS 1. 281 p.

Miller, D.J., and R.N. Lea. 1972. Guide to the coastal marine fishes of California. Calif. Dep. Fish. Game, Fish. Bull. 157, 235 p.

Stockhausen, W.T., B. Matta, B.J. Turnock, M.E. Wilkins and M.H. Martin. 2007. 6. Gulf of Alaska Rex Sole Stock Assessment. *In* Appendix B: Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. p 399-450. North Pac. Fish. Mgmt. Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

Yang, M. S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M.-S. and M.W. Nelson. 2000. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990, 1993, and 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-112, 174 p.

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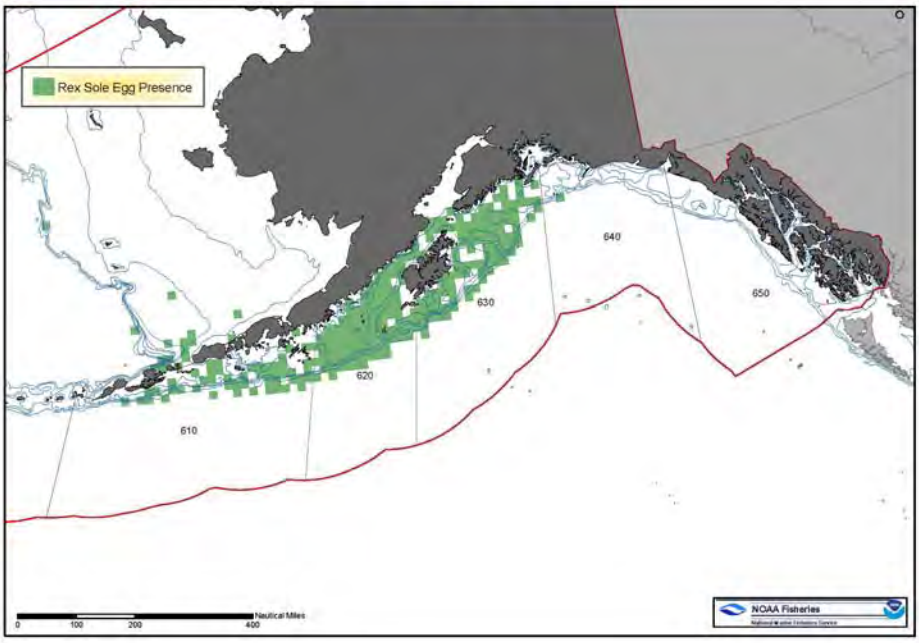
Deleted: Turnock, B.J., T.K. Wilderbuer, and E. S. Brown. 2002. Flatfish. *In* Stock assessment and fishery evaluation Report for the groundfish resources of the GOA. p 169-197. North Pac. Fish. Mgmt. Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.¶

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-17 to E-19 Rex sole (eggs, larvae, late juveniles/adults)

Figure E-17
GOA Rex Sole Egg Presence



[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] GOA rex sole

Figure E-18
GOA Rex Sole Larval Presence

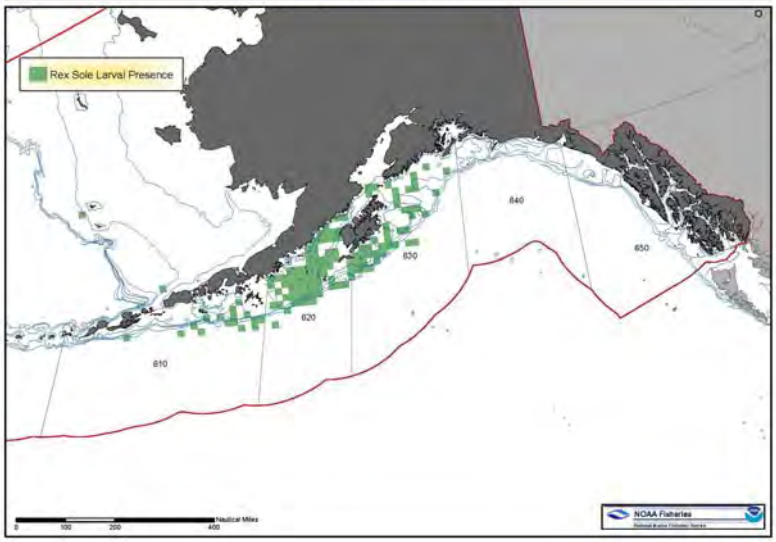
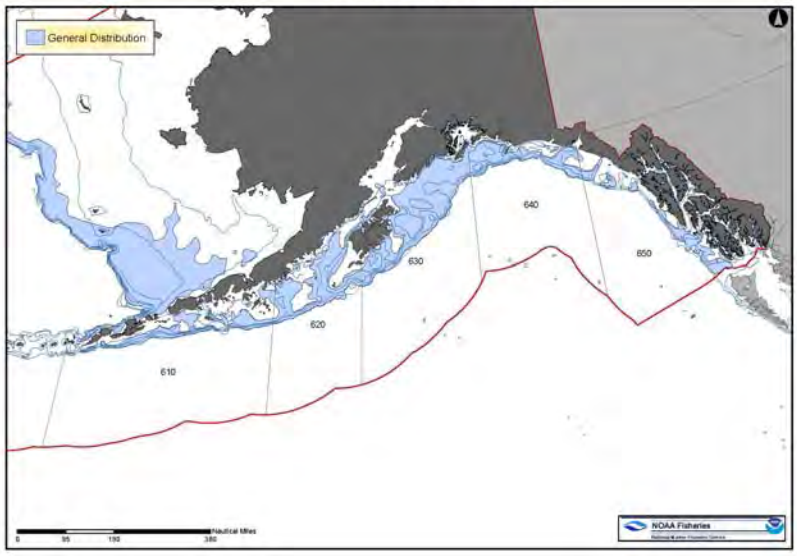


Figure E-19
GOA Rex Sole Late Juveniles/Adults



1.2.6 Evaluation of Effects on EFH of Groundfish Species

The fishing effects analysis is performed to evaluate whether the fisheries, as they are currently conducted off Alaska, will affect habitat that is essential to the welfare of the managed fish populations 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 above analysis has 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 each managed 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 forgoing analysis has indicated substantial effects to some habitat features in some locations, many of which are within the spatial boundaries of the EFH of a species that may use them in a life-history function. These habitat changes may or may not affect the welfare of that 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.

The Effects of Fishing on EFH analysis in the EFH EIS was designed to answer the question: "Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature?" The following text summarizes the results of the analysis for each managed species. The details of the analysis for each species, including the habitat connections and the evaluation of effects, are contained in Section B.3.3 of Appendix B of the EFH EIS (NMFS 2005) and are incorporated by reference.

Rex Sole (GOA)

Issue	Evaluation
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by rex sole early juveniles are mostly unaffected by current fishery activities. Adult and late juvenile rex sole concentrations in the GOA primarily overlap with deepwater shelf habitat (51 percent) and slope habitat (14 percent) (Table B.3-3 of the EFH EIS). These fish would be affected by reductions in infaunal prey. However, the predicted reductions in these concentration overlaps are 1 percent for deepwater shelf habitat and 1 percent for slope habitat. Given this level of disturbance, it is unlikely that the adult feeding would be negatively impacted. Additionally, stock assessment modeling indicates that rex sole have been at a stable level above B_{MSY} for the past 20 years. The combined evidence from individual fish length-weight analysis, examination of recruitment, stock biomass, adult and juvenile distribution, and CPUE trends indicate that the effects of the reductions in habitat features from fishing are minimal or temporary for GOA rex sole.

GOA Arrowtooth flounder

Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

The 2009 review does not warrant change to the EFH text description or the EFH distribution maps by life stage and does not change the level of information known for the species life stage.

2. New Information

No new information is used in the review that is not listed in the revisions to the FMP text.

3. Research and Information Needs

It would be desirable to know if arrowtooth flounders are broadcast or batch spawners.
It would also be informative to know there role, if any, in the pelagic zone.

4. Fishing Activities

No new information suggests that the fishing effects analysis summarized in the FMP should be updated.

5. Habitat Areas of Particular Concern (HAPC)

The are no known ecologically significant, rare, or sensitive sites that are particularly vulnerable to human perturbation.

6. Conservation recommendations

No EFH conservation recommendations for arrowtooth flounder for the Council from the current review.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Arrowtooth flounder	x	1	x	1	1

NOTES: "1" indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Arrowtooth Flounder

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: EFH for larval arrowtooth flounder is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-10.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile arrowtooth flounder is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure E-11.

Adults: EFH for adult arrowtooth flounder is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50), middle (50 to 100 m), and outer (100 to 200 m) shelf and upper slope (200 to 500 m) throughout the GOA wherever there are softer substrates consisting of gravel, sand, and mud, as depicted in Figure E-11.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Arrowtooth

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Arrowtooth Flounder	M					x	x	x	x	x	x														x			
	LJ					x	x	x																	x			
	EJ					x	x																		x			
	L					x	x	x	x	x																x		
	E					x	x	x	x	x															x			

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Arrowtooth Flounder	M							x	x	x			x						
	LJ							x	x	x			x						
	EJ							x	x	x			x						
	L			x															
	E																		

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Arrowtooth**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Arrowtooth Flounder	M																									
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Arrowtooth Flounder	M	5		4		x											x	x	x	x							x	x

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Arrowtooth

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Arrowtooth Flounder	M												X	X				X	X	X			X	X						X	
	LJ												X					X	X	X			X	X						X	
	EJ				X																										
	L	X		X																											
	E																														

GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Arrowtooth Flounder	M																													
	LJ							X	X																					
	EJ																													
	L																													
	E																													

1.2 Arrowtooth flounder (Atheresthes stomias)

1.2.1 Life History and General Distribution

Arrowtooth flounder are distributed in North American waters from central California to the EBS on the continental shelf and upper slope.

Adults exhibit a benthic lifestyle and occupy separate winter and summer distributions on the EBS shelf. From over-winter grounds near the shelf margins and upper slope areas, adults begin a migration onto the middle and inner shelf in April or early May each year with the onset of warmer water temperatures. A protracted and variable spawning period may range from as early as September through March (Rickey 1994, Hosie 1976). Little is known of the fecundity of arrowtooth flounder. Larvae have been found from ichthyoplankton sampling over a widespread area of the EBS shelf in April and May and also on the continental shelf east of Kodiak Island during winter and spring (Waldron and Vinter 1978, Kendall and Dunn 1985). Nearshore sampling in the Kodiak Island area indicates that newly settled larvae are in the 40 to 60 mm size range (Norcross et al. 1996). Juveniles are separate from the adult population, remaining in shallow areas until they reach the 10 to 15 cm range (Martin and Clausen 1995). The estimated length at 50 percent maturity is 28 cm for males (4 years) and 37 cm for females (5 years) from samples collected off the Washington coast (Rickey 1994) and 47 cm for GOA females (Zimmerman 1997). The natural mortality rate used in stock assessments differs by sex with females estimated at 0.2 and male natural mortality estimated at 0.35 (Turnock et. al 2009, Wilderbuer et al. 2009).

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The approximate upper size limit of juvenile fish is 27cm in males and 46 cm in females.

1.2.2 Fishery

Arrowtooth flounder are caught in bottom trawls usually in pursuit of other higher value bottom-dwelling species. Historically, they have been undesirable to harvest due to a flesh softening condition caused by protease enzyme activity. Recruitment begins at about age 3 and females are fully selected at age 10. They are caught as bycatch in Pacific cod, bottom pollock, sablefish, and other flatfish fisheries.

1.2.3 Relevant Trophic Information

Arrowtooth flounder are very important as a large, aggressive and abundant predator of other groundfish species. Groundfish predators include Pacific cod and pollock, mostly on small fish.

1.2.4 Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 3 months until metamorphosis occurs, juveniles usually inhabit shallow areas until about 10 cm in length.

Adults: Widespread distribution mainly on the middle and outer portions of the continental shelf, feeding mainly on walleye pollock and other miscellaneous fish species when arrowtooth flounder attain lengths greater than 30 cm. Wintertime migration to deeper waters of the shelf margin and upper continental slope to avoid extreme cold water temperatures and for spawning.

Habitat and Biological Associations: Arrowtooth flounder

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter, spring?	ICS OCS	P			
Larvae	2 to 3 months?	U phyto/zoo plankton?	spring summer?	BAY ICS OCS	P			
Juveniles	males - 4 years females - 5 years	euphausiids crustaceans amphipods pollock	all year	ICS OCS USP	D	GMS[1]		
Adults	males - 4+ years females- 5+ years	pollock misc. fish Gadidae sp. Euphausiids	spawning Nov-March non-spawning April-Oct.	ICS OCS USP BAY	D	GMS[1]	ice edge (EBS)	

[1]Pers. Comm., Dr. Robert McConnaughey

1.2.5 Literature

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Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. NOAA Tech. Rep. NMFS 20, U. S. Dep. Commer, NOAA, Natl. Mar. Fish. Serv.

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Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 GOA Bottom Trawl Survey. U.S. Dept. Commer., NOAA, Natl. Mar. Fish. Serv., NOAA Tech. Mem. NMFS-AFSC-59, 217 p.

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Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 2009. Arrowtooth flounder. *In* Stock Assessment and Fishery Evaluation Report for the groundfish resources of the GOA, Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

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Wilderbuer, T.K., and D. G. Nichol and K. Aydin. 2009. Arrowtooth flounder. *In* Stock Assessment and Fishery Evaluation Report for the groundfish resources of the BSAI, Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Zimmerman, M. 1997. Maturity and fecundity of arrowtooth flounder, Atheresthes stomias, from the GOA. Fish. Bull. 95:598-611 (1997).

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Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-10 to E-11 Arrowtooth flounder (larvae, late juveniles/adults)

Figure E-10
GOA Arrowtooth Flounder Larval Presence

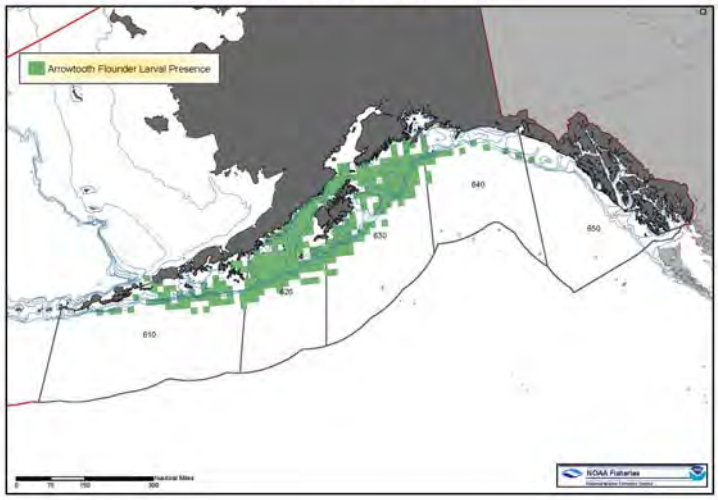
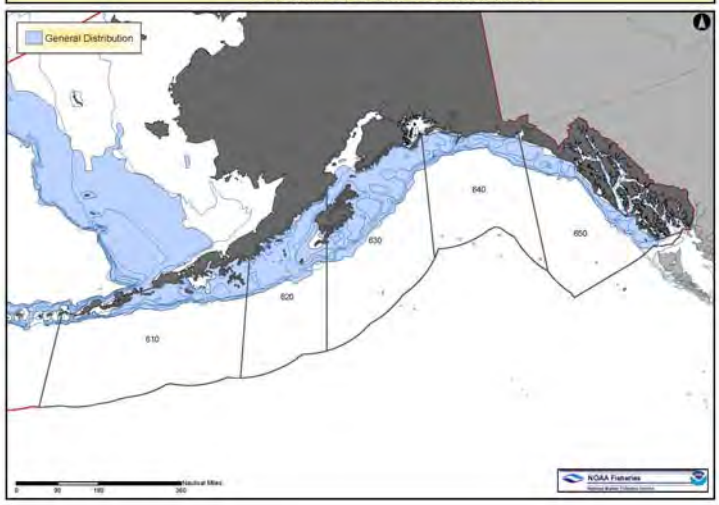


Figure E-11
GOA Arrowtooth Flounder Late Juveniles/Adults



1.2.6 Evaluation of Effects on EFH of Groundfish Species

Arrowtooth Flounder (BSAI and GOA)

Issue	Evaluation
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by arrowtooth flounder early juveniles are mostly unaffected by current fishery activities. Adult and late juvenile concentrations primarily overlap the EBS sand/mud habitat (34 percent) and the GOA deep shelf habitat (35 percent) (Table B.3-3 of the EFH EIS). Overall, epifaunal prey reduction in those overlaps is predicted to be 3 percent for EBS sand/mud and 1 percent for GOA deep shelf habitats. Given this level of disturbance, and the large percentage of the diet of arrowtooth flounder not including epifauna prey, it is unlikely that the adult feeding would be negatively impacted. The arrowtooth flounder stock is currently at a high level of abundance due to sustained above-average recruitment in the 1980s and 1990s (Turnock et al. 2009). No change in weight and length at age has been observed in this stock from bottom trawl surveys conducted from 1984 through 2003.

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The BS arrowtooth flounder stock is currently at a high level of abundance due to sustained above-average recruitment in the 1980s (Wilderbuer et al. 2009). The productivity of the stock is currently believed to correspond to favorable atmospheric forces in which larvae are advected to nearshore nursery areas (Wilderbuer et al. 2002). The GOA stock has increased steadily since the 1970s and is at a very high level. Therefore, the combined evidence from individual fish length-weight analysis, length at age analysis, examination of recruitment, stock biomass, and CPUE trends indicate that the effects of the reductions in habitat features from fishing are minimal or temporary for BSAI and GOA arrowtooth flounder.

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Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? Y or N If yes, explain.

Text description: Yes. Some new information on egg duration, larval size at metamorphosis, maturity, and spawning, has become available. In addition, some of the material retained the label "BSAI" rather than "GOA"--this has been replaced.
NOTE BY DIANA EVANS: Author was referring to the FMP text here, not specifically to the text description of EFH for flathead sole. I clarified with author that the EFH description is still accurate, and does not warrant change at this time.

Maps: Yes. The map of distribution of larvae should be updated with latest information from the EcoFOCI Ichthyoplankton Information System (IIS).

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2[*])?
No.

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.

References were updated in the revision.

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

None.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

While more information exists regarding early juvenile distribution and EFH requirements in the GOA than in the BSAI, it does not seem complete enough to change the level of information for this life stage from "Unknown" to "Level 1".

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions.

[*] EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

No, the new information does not impact the definition of EFH for any of the life stages of this species. Also, the effects of fishing activities on EFH for this species are still thought to be minimal and temporary for all life stages.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list.

No.

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain.

None. Fishing activities are thought to have only minimal and temporary effects on flathead sole in the Gulf of Alaska.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Flathead sole	1	1	x	1	1

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NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Flathead Sole

Eggs: EFH for flathead sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-23.

Larvae: EFH for larval flathead sole is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-24.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for juvenile flathead sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are softer substrates consisting of sand and mud, as depicted in Figure E-25.

Adults: EFH for adult flathead sole is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), and outer (100 to 200 m) shelf throughout the GOA wherever there are softer substrates consisting of sand and mud, as depicted in Figure E-25.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Flathead

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Flathead Sole	M					x	x	x	x																x			
	LJ					x	x	x																	x			
	EJ					x	x																		x			
	L					x	x	x																		x		
	E					x	x	x																		x		

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GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Flathead Sole	M							x	x	x			x		x				
	LJ							x	x	x			x		x				
	EJ							x	x										
	L			x									x						
	E																		

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Flathead

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Flathead Sole	M																									
	LJ																									
	EJ																									
	L																									
	E																									

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Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																										
		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
Flathead Sole	M	8.7				x					x								x	x	x	x						

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Flathead

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Flathead Sole	M							X					X			X		X	X	X										
	LJ							X					X					X	X	X										
	EJ				X			X					X					X	X	X										
	L	X		X																										
	E																													

GOA Groundfish		Prey of																											
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull
Flathead Sole	M							X	X						X	X				X									
	LJ							X	X						X														
	EJ							X	X						X														
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	E																												

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1.2 Flathead sole (Hippoglossoides elassodon)

1.2.1 Life History and General Distribution

Flathead sole are distributed from northern California, off Point Reyes, northward along the west coast of North America and throughout the GOA and the BS, the Kuril Islands, and possibly the Okhotsk Sea (Hart 1973).

Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions in the GOA. From over-winter grounds near the shelf margins, adults begin a migration onto the mid and outer continental shelf in April or May each year for feeding. In the GOA, the spawning period may start as early as March but is known to occur in April through June, primarily in deeper waters near the margins of the continental shelf. Eggs are large (2.75 to 3.75 mm) and females have egg counts ranging from about 72,000 (20 cm fish) to almost 600,000 (38 cm fish). Eggs hatch in 9 to 20 days depending on incubation temperatures within the range of 2.4 to 9.8°C and have been found in ichthyoplankton sampling on the western portion of the GOA shelf in April through June (Porter, 2004). Porter (2004) found that egg density increased late in development such that mid-stage eggs were found near the surface but eggs about to hatch were found at depth (125-200 m). Larvae absorb the yolk sac in 6 to 17 days, but the extent of their distribution is unknown. Nearshore sampling indicates that newly settled larvae are in the 30 to 50 mm size range (Norcross et al. 1996, Abookire et al., 2001). Flathead sole females in the GOA become 50 percent mature at 8.7 years or about 33 cm (Stark, 2004). Juveniles less than age 2 have not been found with the adult population, remaining in shallow areas. The natural mortality rate used in recent stock assessments is 0.2 (Stockhausen et al., 2007).

1.2.2 Fishery

Flathead sole are caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3. They are caught as bycatch in Pacific cod, bottom Pollock and other flatfish fisheries and are caught with these species and Pacific halibut in flathead sole directed fisheries.

1.2.3 Relevant Trophic Information

Based on results from an ecosystem model for the Gulf of Alaska (Aydin et al., 2007), flathead sole in the Gulf of Alaska occupy an intermediate trophic level as both juvenile and adults. Pandalid shrimp and brittle stars were the most important prey for adult flathead sole in the Gulf of Alaska (64% by weight in sampled stomachs; Yang and Nelson, 2000), while euphausids and mysids constituted the most important prey items for juvenile flathead sole. Other major prey items included polychaetes, mollusks, bivalves and hermit crabs for both juveniles and adults. Commercially important species that were consumed included age-0 Tanner crab (3%) and age-0 walleye pollock (< 0.5% by weight).

Important predators on flathead sole include arrowtooth flounder, walleye pollock, Pacific cod, and other groundfish (Aydin et al., 2007). Pacific cod and Pacific halibut are the major predators on adults, while arrowtooth flounder, sculpins, walleye pollock and Pacific cod are the major predators on juveniles.

1.2.4 Habitat and Biological Associations

Larvae: Planktonic larvae for 3 to 5 months until metamorphosis occurs.

Juveniles: usually inhabit shallow areas (<100 m), preferring muddy habitats.

Adults: Spring spawning and summer feeding on sand and mud substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf, feeding mainly on pandalid shrimp and brittle stars.

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Habitat and Biological Associations: Flathead sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	15-20 days	NA	winter	ICS MCS OCS	P			
Larvae	3-5 months	U phyto/zoo plankton?	spring summer	ICS MCS OCS	P			
Juveniles	age 0-8 yrs	euphausids and mysids	all year	ICS MCS	D	M		
Adults	age 8-33 yrs	Pandalid shrimp and brittle stars	Spawning Mar-June non-spawning July-Feb	ICS MCS OCS	D	S+M		

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1.2.5 Literature

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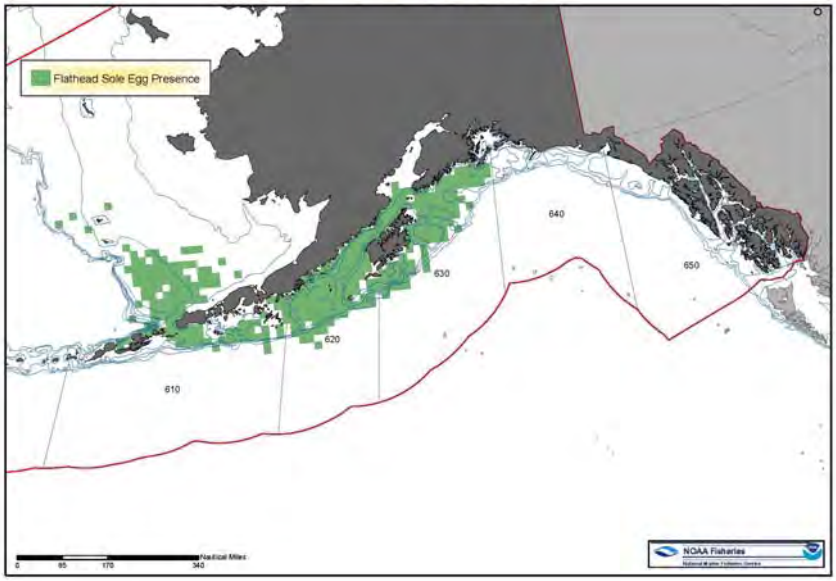
Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-23 to E-25 Flathead sole (eggs, larvae, late juveniles/adults)

Figure E-23
GOA Flathead Sole Egg Presence



[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] GOA Flathead

Figure E-24
GOA Flathead Sole Larval Presence

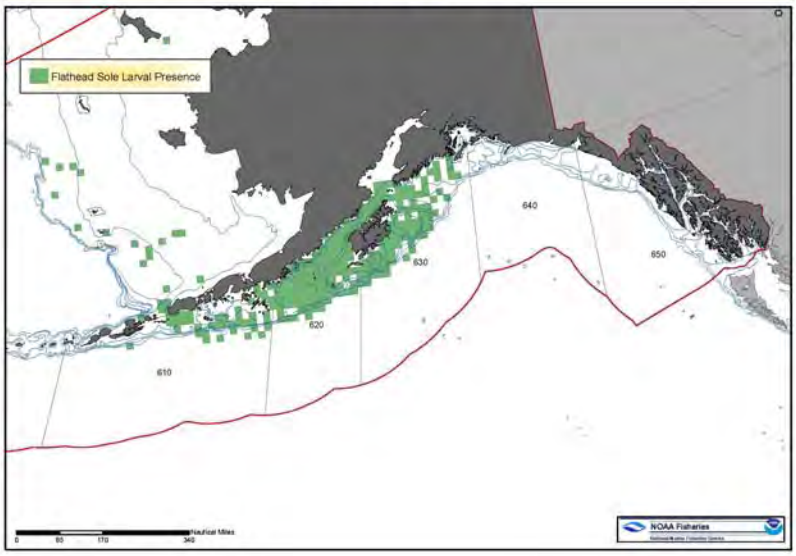
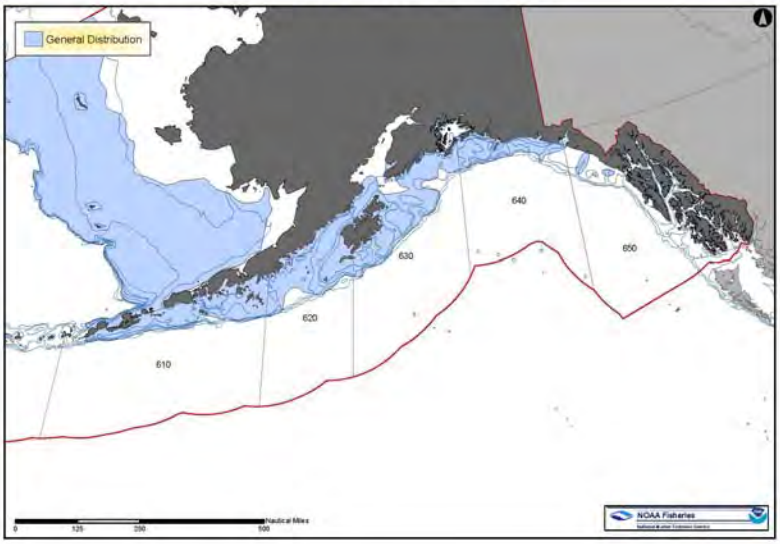


Figure E-25
GOA Flathead Sole Late Juveniles/Adults



1.2.6 Evaluation of Effects on EFH of Groundfish Species

1.2.6.1 Flathead Sole (GOA)

Issue	Evaluation
Spawning/breeding	MT (Minimal or temporary effect)
Feeding	MT (Minimal or temporary effect)
Growth to maturity	MT (Minimal or temporary effect)

Summary of Effects—The nearshore areas inhabited by flathead sole early juveniles are mostly unaffected by current fishery activities. Adult and late juvenile flathead sole concentrations in the GOA primarily overlap with the deepwater shelf during winter (15 percent) and shallow water habitats during summer (14 percent, Table B.3-3 of the EFH EIS). This species would be affected by reductions in the availability of infaunal and epifaunal prey. Both infaunal and epifaunal prey are predicted to be reduced 1 percent in concentration overlaps with deepwater shelf areas and less than 1 percent in shallow water habitat. Given this level of disturbance, it is unlikely that the adult feeding would be negatively impacted. Additionally, stock assessment modeling indicates that flathead sole have been at a stable level above B_{MSY} for the past 20 years.

The combined evidence from individual fish length-weight analysis, examination of recruitment, stock biomass, adult and juvenile distribution, and CPUE trends indicate that the effects of the reductions in habitat features from fishing are minimal or temporary for GOA flathead sole.

GOA POP 2009 5-year review worksheet

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? ***Yes.*** *Minor changes to the text and tables were changed to reflect current and previously excluded information. The maps are adequate.*

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2[*])? ***No.***

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here. ***No.***

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future. *There are some EFH habitat studies being conducted at Little Port Walter Field station by Pat Malecha on POP juveniles. There also have been several submarine dive studies that will be published in the future related to Pacific ocean perch habitat and catchability*

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

There is little information on larval, post-larval, or early juvenile stages slope rockfish. Habitat requirements for these stages are mostly unknown. Habitat requirements for later stage juvenile and adult fish are anecdotal or conjectural. Research needs to be done on the bottom habitat of the major fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on these biota. Additionally, Pacific ocean perch are undersampled by the current survey design. The stock assessment would benefit from additional survey effort on the continental slope. Further research on trawl catchability and trawlable/untrawlable grounds would be very useful.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions. ***No.*** *The Central GOA Rockfish Pilot program has the potential effect of spreading effort in time and space and the increase in pelagic trawling will likely decrease effects of fishing.*

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list. ***No.***

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider?

Explain. ***No.***

---

[*] EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Pacific ocean perch	x	1	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Pacific Ocean Perch and "Other Slope" Rockfish

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: EFH for larval Pacific ocean perch is the general distribution area for this life stage, located in the middle to lower portion of the water column along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m), and upper slope (200 to 500 m) throughout the GOA as depicted in Figure E-29.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile Pacific ocean perch is the general distribution area for this life stage, located in the middle to lower portion of the water column along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m), and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure E-30.

Adults: EFH for adult Pacific ocean perch is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates consisting of cobble, gravel, mud, sandy mud, or muddy sand, as depicted in Figure E-30.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA POP

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Pacific Ocean Perch	M							x	x	x								x	x	x	x			x	x	x		
	LJ					x	x	x	x																			
	EJ					x	x	x																x	x	x	x	x
	L																						x	x		x	x	

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GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Pacific Ocean Perch	M	x					x	x	x	x	x	x	x	x	x	x	x	x	x
	LJ	x																x	x
	EJ	x								x								x	x
	L	x																	

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA POP**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Pacific Ocean Perch	M														x											
	LJ																									
	EJ																									
	L																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Pacific Ocean Perch	M	10.5	20.0				x			x	x														x	x	x	x

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA POP

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Pacifc Ocean Perch	M							X		X	X									X										
	LJ							X		X	X									X										
	EJ																													
	L			X	X																									

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GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Pacifc Ocean Perch	M									X						X														
	LJ									X						X														
	EJ						X			X	X					X														
	L																													

1.2 Pacific Ocean perch

1.2.1 Life History and General Distribution

Pacific ocean perch (Sebastes alutus, POP) has a wide distribution in the North Pacific from southern California around the Pacific rim to northern Honshu Island, Japan, including the BS. The species appears to be most abundant in northern British Columbia, the GOA, and the AI (Allen and Smith 1988). Adults are found primarily offshore on the outer continental shelf and the upper continental slope in depths from 150 to 420 m. Seasonal differences in depth distribution have been noted by many investigators. In the summer, adults inhabit shallower depths, especially those between 150 and 300 m. In the fall, the fish apparently migrate farther offshore to depths from approximately 300 to 420 m. They reside in these deeper depths until about May, when they return to their shallower summer distribution (Love et al. 2002). This seasonal pattern is probably related to summer feeding and winter spawning. Although small numbers of Pacific ocean perch are dispersed throughout their preferred depth range on the continental shelf and slope, most of the population occurs in patchy, localized aggregations (Hanselman et al. 2001). Pacific ocean perch are generally considered to be semi-demersal, but there can at times be a significant pelagic component to their distribution. Pacific ocean perch often move off-bottom at night to feed, apparently following diel euphausiid migrations. Commercial fishing data in the GOA since 1995 show that pelagic trawls fished off-bottom have accounted for as much as 20 percent of the annual harvest of this species.

There is much uncertainty about the life history of Pacific ocean perch, although generally more is known than for other rockfish species (Kendall and Lenarz 1986). The species appears to be viviparous (the eggs develop internally and receive at least some nourishment from the mother), with internal fertilization and the release of live young. Insemination occurs in the fall, and sperm are retained within the female until fertilization takes place approximately 2 months later. The eggs hatch internally, and parturition (release of larvae) occurs in April and May. Information on early life history is very sparse, especially for the first year of life. Pacific ocean perch larvae are thought to be pelagic and drift with the current. Oceanic conditions may sometimes cause advection to suboptimal areas (Ainley et al. 1993), resulting in high recruitment variability. However, larval studies of rockfish have been hindered by difficulties in species identification since many larval rockfish species share the same morphological characteristics (Kendall 2001). Genetic techniques using allozymes (Seeb and Kendall 1991) and mitochondrial DNA (Li 2004) are capable of identifying larvae and juveniles to species, but are expensive and time-consuming. Post-larval and early young-of-the-year Pacific ocean perch have been positively identified in offshore, surface waters of the GOA (Gharrett et al. 2002), which suggests this may be the preferred habitat of this life stage. Transformation to a demersal existence may take place within the first year (Carlson and Haight 1976). Small juveniles probably reside inshore in very rocky, high relief areas and begin to migrate to deeper offshore waters of the continental shelf by age 3 (Carlson and Straty 1981). As they grow, they continue to migrate deeper, eventually reaching the continental slope, where they attain adulthood.

Pacific ocean perch is a slow growing species, with a low rate of natural mortality (estimated at 0.06), a relatively old age at 50 percent maturity (10.5 years for females in the GOA), and a very old maximum age of 98 years in Alaska (84 years maximum age in the GOA) (Hanselman et al. 2007a). Age at 50 percent recruitment to the commercial fishery has been estimated to be between 7 and 8 years in the GOA. Despite their viviparous nature, the fish is relatively fecund with number of eggs/female in Alaska ranging from 10,000 to 300,000, depending upon size of the fish (Leaman 1991).

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For GOA, the upper size limit of juvenile fish is 38 cm for females; it is unknown for males, but is presumed to be slightly smaller than for females based on what is commonly the case in other species of Sebastes.

1.2.2 Fishery

The Pacific ocean perch is the most abundant GOA rockfish and the most important commercially. The species was fished intensely in the 1960s by foreign factory trawlers (350,000 mt at its peak in 1965), and the population declined drastically due to this pressure. The domestic fishery began developing in 1985. Quotas climbed rapidly, and the species was declared overfished in 1989. A rebuilding plan was put into place, and quotas were small in the early 1990s. After some good recruitments and high survey biomass estimates, the stock was declared to be recovered in 1995. Pacific ocean perch are caught almost exclusively with trawls. Before 1996, nearly all the catch was taken by factory trawlers using bottom trawls, but a sizeable portion (up to 20 percent some years) has also been taken by pelagic trawls since then. Also in 1996, a shore-based fishery developed that consisted of smaller vessels operating out of the port of Kodiak. These shore-based trawlers now account for more than 50 percent of the catch in the central GOA. The fishery in the Gulf in recent years has occurred in the summer months, especially July, due to management regulations. Reflecting the summer distribution of this species, the fishery is concentrated in a relatively narrow depth band at approximately180 to 250 m along the outer continental shelf and shelf break, inside major gullies and trenches running perpendicular to the shelf break, and along the upper continental slope. Major fishing grounds include Ommaney Trough (which is no longer fished because of an Council amendment that prohibits trawling in the eastern GOA), Yakutat Canyon, Amatuli Trough, off Portlock and Albatross Banks, Shelikof Trough, off Shumagin Bank, and south of Unimak and Unalaska Islands. A localized depletion analysis has shown that after fairly intense fishing, localized areas recovered to their former levels in the following year (Hanselman et al. 2007b).

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In 2007, the Central Gulf of Alaska Rockfish Pilot Program was implemented to enhance resource conservation and improve economic efficiency for harvesters and processors who participate in the Central Gulf of Alaska rockfish fishery. This is a five year rationalization program that establishes cooperatives among trawl vessels and processors which receive exclusive harvest privileges for rockfish management groups. The primary rockfish management groups are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish. Potential effects of this program on Pacific ocean perch include: 1) Extended fishing season lasting from May 1 – November 15, 2) changes in spatial distribution of fishing effort within the Central GOA, 3) Improved at-sea and plant observer coverage for vessels participating in the rockfish fishery, 4) a higher potential to harvest 100% of the TAC in the Central GOA region.

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Major bycatch species in the GOA Pacific ocean perch trawl fishery from 1994 to 1996 (the most recent years for which an analysis was done) included (in descending order by percent bycatch rate) other species of rockfish, arrowtooth flounder, and sablefish. Among the other species of rockfish, northern rockfish and shortraker/rougheye were most common, followed by pelagic shelf rockfish (Ackley and Heifetz 2001).

Because collection of small juvenile Pacific ocean perch is virtually unknown in any existing type of commercial fishing gear, it is assumed that fishing does not occur in their habitat. Trawling on the offshore fishing grounds of adults may affect the composition of benthic organisms, but the impact of this on Pacific ocean perch or other fish is unknown.

1.2.3 Relevant Trophic Information

Pacific ocean perch are mostly planktivorous (Carlson and Haight 1976, Yang 1993, 1996, Yang and Nelson 2000, Yang 2003). In a sample of 600 juvenile perch stomachs, Carlson and Haight (1976) found that juveniles fed on an equal mix of calanoid copepods and euphausiids. Larger juveniles and adults fed primarily on euphausiids and, to a lesser degree, on copepods, amphipods, and mysids (Yang and Nelson 2000). In the AI, myctophids have increasingly comprised a substantial portion of the Pacific ocean perch diet, which also compete for euphausiid prey (Yang 2003). It has been suggested that Pacific ocean perch and walleye pollock compete for the same euphausiid prey. Consequently, the large removals of Pacific

ocean perch by foreign fishermen in the GOA in the 1960s may have allowed walleye pollock stocks to greatly expand in abundance.

Pacific ocean perch predators are likely sablefish, Pacific halibut, and sperm whales (Major and Shippen 1970). Juveniles are consumed by seabirds (Ainley et al. 1993), other rockfish (Hobson et al. 2001), salmon, lingcod, and other large demersal fish.

1.2.4 Habitat and Biological Associations

Egg/Spawning: Little information is known. Insemination is thought to occur after adults move to deeper offshore waters in the fall. Parturition is reported to occur from 20 to 30 off-bottom at depths from 360 to 400 m.

Larvae: Little information is known. Earlier information suggested that after parturition, larvae rise quickly to near surface, where they become part of the plankton. More recent data from British Columbia indicates that larvae may remain at depths 175 m for some period of time (perhaps 2 months), after which they slowly migrate upward in the water column.

Post-larvae and early young-of-the year: A recent, preliminary study has identified Pacific ocean perch in these life stages from samples collected in epipelagic waters far offshore in the GOA (Gharrett et al. 2002). Some of the samples were as much as 180 km from land, beyond the continental slope and over very deep water.

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Juveniles: Again, information is very sparse, especially for younger juveniles. It is unknown how long young-of-the-year remain in a pelagic stage before eventually becoming demersal. At ages 1 to 3, the fish probably live in very rocky inshore areas. Afterward, they move to progressively deeper waters of the continental shelf. Older juveniles are often found together with adults at shallower locations of the continental slope in the summer months.

Adults: Commercial fishery and research data have consistently indicated that adult Pacific ocean perch are found in aggregations over reasonably smooth, trawlable bottom of the outer continental shelf and upper continental slope (Westrheim 1970; Matthews et al. 1989; Krieger 1993). Generally, they are found in shallower depths (150 to 300 m) in the summer, and deeper (300 to 420 m) in the fall, winter, and early spring. Observations from a manned submersible in Southeast Alaska found adult Pacific ocean perch associated with pebble substrate on flat or low-relief bottom (Krieger 1993). Pacific ocean perch have been observed in association with sea whips in both the GOA (Krieger 1993) and the BS (Brodeur 2001). The fish can at times also be found off-bottom in the pelagic environment, especially at night when they may move up in the water column to feed. There presently is little evidence to support previous conjectures that adult Pacific ocean perch populations might be denser in rough, untrawlable bottom.

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Habitat and Biological Associations: Pacific ocean perch

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	Internal incubation; ~90 d	NA	Winter-spring	NA	NA	NA	NA	NA
Larvae	U;2 months (?)	U; assumed to be micro-zooplankton	Spring-summer	ICS, MCS, OCS, USP, LSP, BSN	P	NA	U	U
Post-larvae/ early juvenile	U; 2 months to ?	U	Summer to ?	LSP, BSN	Epipelagic	NA	U	U
Juveniles	<1 year (?) to 10 years	Calanoid copepods (young juv.); Euphausiids (older juv.)	All year	ICS, MCS, OCS, USP	D	R (<age 3); CB,G,?M, ?SM,?MS (>age 3)	U	U
Adults	10 to 84 years of age (98 years in AI)	Euphausiids	Insemination (fall); Fertilization, incubation (winter); Larval release (spring); Feeding in shallower depths (summer)	OCS, USP	D, SD, P	CB, G,? M, ? SM,?MS	U	U

Deleted: Eggs

1.2.5 Additional Source of Information

Larvae: NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, Bruce Wing; NMFS, Alaska Fisheries Science Center, FOCI program, Ann Matarese; Art Kendall, AJALA Enterprises, La Conner, WA.

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[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] **GOA POP**

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figure E-30 Pacific ocean perch (late juveniles/adults)

Figure E-29
GOA Rockfish Larval Presence

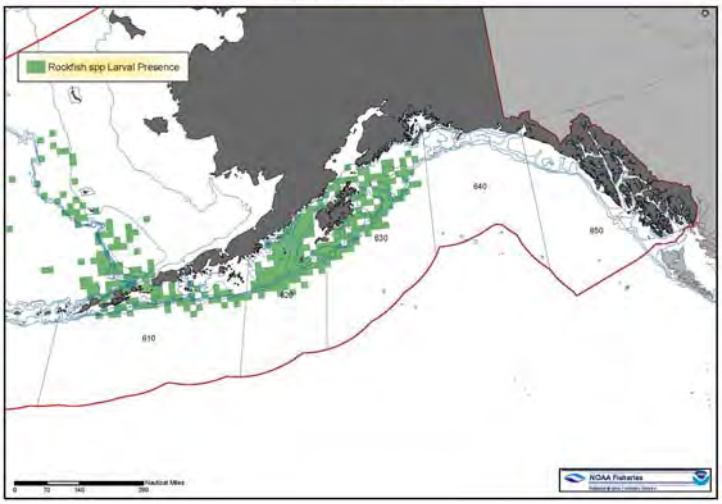
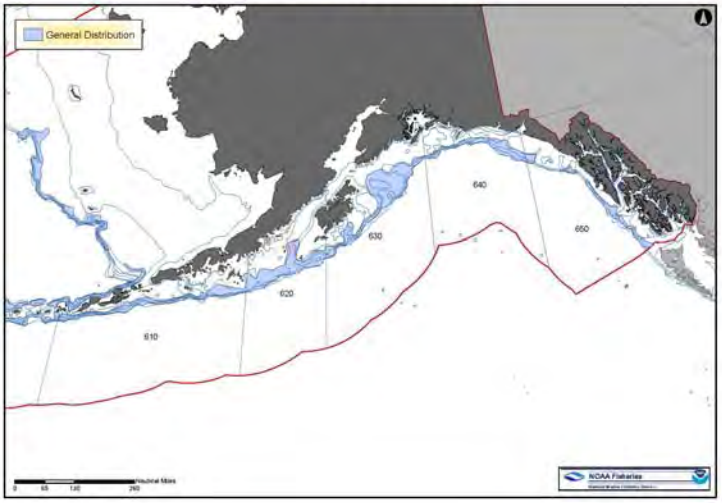


Figure E-30
GOA Pacific Ocean Perch Late Juveniles/Adults



1.2.7 Evaluation of Effects on EFH of Groundfish Species

Pacific Ocean Perch (GOA)

Issue	Evaluation
Spawning/Breeding	U (Unknown effect)
Growth to Maturity	U (Unknown effect)
Feeding	MT (Minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of Pacific ocean perch are either unknown or negligible; however, caution is warranted. There is some information to suggest that bottom trawling has a negative impact on benthic habitat, especially sponges. The LEI analysis indicates that there is a potential for minor reductions in living substrates inhabited by Pacific ocean perch. Whether the potential loss of these substrates would have an effect on spawning/breeding of Pacific ocean perch is unknown. Any effect on their ability to feed would likely be negligible. Very little information is available on these aspects of their life history, however, and further investigation may prove otherwise. A reduction in living structure may jeopardize these fishes' ability to grow to maturity. Several observations have shown juvenile red rockfish to be associated with sponges. The extent of this association is largely unknown, but it may be important if these substrates increase survival rates by acting as refugia to juveniles or adults. Significant differences in growth were found between heavily trawled and lightly trawled areas, but the cause is unknown. Current stock status trends show no indications of fishing impacting the ability of the stock to maintain MSY.

GOA Northern Rockfish EFH Update – August 2009

Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? ***No. Although a number of minor changes were made to the text, these changes were not substantive.***

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2[*])? ***No.***

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here. ***No.***

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

3. Research and Information Needs

Is research needed or do data gaps exist? ***Yes.*** Briefly explain and list in order of priority.

Except for adults, there is almost no information on life history or habitat of northern rockfish in the GOA. At this time, identification of northern rockfish larvae and post-larvae is not possible, even using genetic methods. Additional genetic studies are needed to determine genetic markers that will positively identify northern rockfish to species. Few small juvenile northern rockfish have been caught in either the fishery or by surveys; studies are needed to locate and sample these young fish before their habitat requirements can be determined. Manned submersible studies on the outer shelf and upper slope have observed small red rockfish associated with corals and sponges. New studies need to be done to identify these fish to species and determine if they include northern rockfish. Although much more is known about adult fish, even their habitat requirements remain largely conjectural or based on circumstantial evidence. Research needs to be done on the bottom habitat of the major fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on these biota.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions. ***No, although the spatial distribution of the fishery has changed since the original analysis. When the original EFH EIS for GOA northern rockfish was prepared, fishery catches were described as being particularly concentrated in one relatively small area, the "Snakehead" south of Kodiak Island. More recent catch data***

[*] EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

show this area no longer produces large catches and that localized depletion likely occurred here as a result of the heavy fishing effort in the 1990s. Fishing is now more dispersed over other fishing grounds, which is probably beneficial to the habitat of these fish. In addition, the Central GOA Rockfish Pilot Program, which includes northern rockfish, has the potential effect of spreading effort in space and time and also will likely decrease the effects of fishing.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list. ***No***

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain. ***No***

[Pulled from GOA Groundfish FMP, sections 4.2.2, 4.2.2.1, 4.2.2.2]GOA Northern rockfish

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Northern rockfish	x	x	x	x	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

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1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Northern Rockfish

Eggs: Eggs develop internally, so EFH description is not applicable.

Larvae: No EFH determined. Insufficient information is available.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: No EFH Description Determined. Insufficient information is available.

Adults: EFH for adult northern rockfish is the general distribution area for this life stage, located in the lower portions of the water column along the outer continental shelf (75 to 200 m) and upper slope (200 to 300 m) in the central and western GOA wherever there are substrates of cobble and rock, as depicted in Figure E-32.

Deleted: No

Deleted: EFH Description Determined. Insufficient information is available.

Deleted: EFH for larval northern rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-29, General Distribution of Rockfish Larvae.

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Northern rockfish

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Northern Rockfish	M						x	x										x							x			
	LJ						x	x										x	x						x			
	EJ																									x		
	L																											

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Northern Rockfish	M																	x	x
	LJ																		
	EJ																		
	L																		

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Northern rockfish

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Northern Rockfish	M																									
	LJ																									
	EJ																									
	L																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Northern Rockfish	M	13					x			x	x								x	x	x							

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Northern rockfish

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Northern Rockfish	M				X			X			X																				
	LJ																														
	EJ																														
	L																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Northern Rockfish	M																														
	LJ																														
	EJ																														
	L																														

1.2 Northern rockfish

1.2.1 Life History and General Distribution

Northern rockfish range from northern British Columbia through the GOA and AI to eastern Kamchatka and the Kuril Islands, including the BS (Mecklenburg et al. 2002). The species is most abundant from about Portlock Bank in the central GOA to the western end of the AI; it is rarely found in the eastern GOA. In the GOA, adult fish appear to be concentrated at discrete, relatively shallow offshore banks of the outer continental shelf (Clausen and Heifetz 2002). Typically, these banks are separated from land by an intervening stretch of deeper water. The preferred depth range is ~75 to 150 m in the GOA. Information available at present suggests the fish are mostly demersal, as very few have been caught off-bottom or in pelagic trawls (Clausen and Heifetz 2002). In common with many other rockfish species, northern rockfish tend to have a localized, patchy distribution, even within their preferred habitat, and most of the population occurs in aggregations. Most of what is known about northern rockfish is based on data collected during the summer months from the commercial fishery or in research surveys. Consequently, there is little information on seasonal movements or changes in distribution for this species.

Life history information on northern rockfish is extremely sparse. The fish are assumed to be viviparous, as other *Sebastes* appear to be, with internal fertilization and incubation of eggs. Observations during research surveys in the GOA suggest that parturition (larval release) occurs in the spring, and is mostly completed by summer. Pre-extrusion larvae have been described (Kendall 1989), but field-collected larvae cannot be unequivocally identified to species at present, even using genetic techniques (Li et al. 2006). Length of the larval stage is unknown, but the fish apparently metamorphose to a pelagic juvenile stage, which also has been described (Matarese et al. 1989). However, similar to the larvae, smaller-sized post-larval northern rockfish cannot be positively identified at present, even with genetic methods (Kondzela et al. 2007). There is no information on when the juveniles become benthic or what habitat they occupy. Older juveniles are found on the continental shelf, generally at locations inshore of the adult habitat (Clausen and Heifetz).

Northern rockfish is a slow growing species, with a low rate of natural mortality (estimated at 0.06), a relatively old age at 50 percent maturity (12.8 years for females in the GOA), and an old maximum age of 67 years in the GOA (Heifetz et al. 2007). Size at 50% maturity for females has been estimated to be 36 cm; it is unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*. No information on fecundity is available.

1.2.2 Fishery

Northern rockfish are caught almost exclusively with bottom trawls. The majority of the catch in the GOA comes from depths of 75 to 125 m (Clausen and Heifetz 2002). Age at 50 percent recruitment is unknown. Before 2007, the fishery in the GOA occurred in the summer months, especially July, due to management regulations. With the implementation of the Central Gulf Rockfish Pilot Porgram in 2007, catches have been spread out more throughout the year (Heifetz et al. 2007). From 1990 to 1998, catches were concentrated at five relatively shallow, offshore banks of the outer continental shelf, which include Portlock Bank, Albatross Bank, the "Snakehead" south of Kodiak Island, Shumagin Bank, and Davidson Bank (Clausen and Heifetz 2002). Of these, the Snakehead was especially productive. Outside of these banks, catches were generally sparse. Since 1998, Portlock, Albatross, and Shumagin Banks have generally continued to be important, but the amount taken from the Snakehead has diminished greatly (Heifetz et al. 2008). An analysis of catch data indicated that significant depletion of northern rockfish likely occurred in the Snakehead in the 1990s (Hanselman et al. 2007); subsequently, it appears that catch rates in this area have not recovered.

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The major bycatch species in the GOA northern rockfish trawl fishery in 1994-96 included (in descending order by percent bycatch rate): dusky rockfish, "other slope rockfish", and Pacific ocean perch (Ackley and Heifetz 2001). Of these, dusky rockfish was by far the most common bycatch, having a bycatch rate as high as 34 percent, depending on the year.

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1.2.3 Relevant Trophic Information

Although no comprehensive food study of northern rockfish in the GOA has been done, one small study indicated euphausiids were by far the predominant food item of adults (Yang 1993). Food studies in the AI have also shown northern rockfish to be planktivorous, with euphausiids and copepods being the main prey items (Yang 1996, 2003). Other foods consumed in the AI included Chaetognaths (arrow worms), amphipods, squid, and polychaetes.

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Predators of northern rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth founder.

1.2.4 Habitat and Biological Associations

Egg/Spawning: No information known, except that parturition probably occurs in the spring.

Larvae: No information known. Larval studies are not possible at present because larvae have not been positively identified to species, even when genetic techniques have been used.

Juveniles: No information known for small juveniles (<20 cm), except that post-larval fish apparently undergo a pelagic phase immediately after metamorphosis from the larval stage. How long the pelagic stage lasts, and when juveniles assume a demersal existence, is unknown. Observations from manned submersibles in offshore waters of the GOA (e.g., Krieger 1993; Freese and Wing 2003) have consistently indicated that small juvenile rockfish are associated with benthic living and non-living structure and appear to use this structure as refuge. The living structure includes corals and sponges. Although the juvenile rockfish could not be identified to species in the submersible studies, the studies suggest that small juvenile northern rockfish possibly utilize these habitats. Large juvenile northern rockfish have been taken in bottom trawls at various localities of the continental shelf, usually inshore of the adult fishing grounds (Clausen and Heifetz 2002). Substrate preference of these larger juveniles is unknown.

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Adults: Commercial fishery and research survey data have consistently indicated that adult northern rockfish in the GOA are primarily found on offshore banks of the outer continental shelf at depths of 75 to 150 m. Preferred substrate in this habitat has not been documented, but observations from trawl surveys suggest that large catches of northern rockfish are often associated with hard or rough bottoms. For example, some of the largest catches in the trawl surveys have occurred in hauls in which the net hung-up on the bottom or was torn by a rough substrate (Clausen and Heifetz 2002). Generally, the fish appear to be demersal, and most of the population occurs in large aggregations. There is no information on seasonal migrations. Northern rockfish often co-occur with dusky rockfish.

Habitat and Biological Associations: Northern Rockfish

Stage - EFH Level	Duration or Age	Diet/ Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	NA	NA	NA	NA	NA	NA	NA
Larvae	U	U	Spring-summer	U	P (assumed)	NA	U	U
Early Juveniles	From end of larval stage to ?	U	Summer to ?	U	?P	U	U	U
Late Juveniles	to 13 years	U	All year	MCS, OCS	D	U	U	U
Adults	13 to 67 years of age	Euphausiids	U, except that larval release is probably in the spring in the GOA	OCS	D	CB, R	U	Often co-occur with dusky rockfish

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1.2.5 Additional Sources of Information

Eggs and Larvae: None at present.

Older juveniles and adults: NMFS, Alaska Fisheries Science Center, Auke Bay Laboratories, David Clausen.

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[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] **GOA Northern rockfish**

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-29 and E-32 Northern rockfish (larvae, adults)

Figure E-29
GOA Rockfish Larval Presence

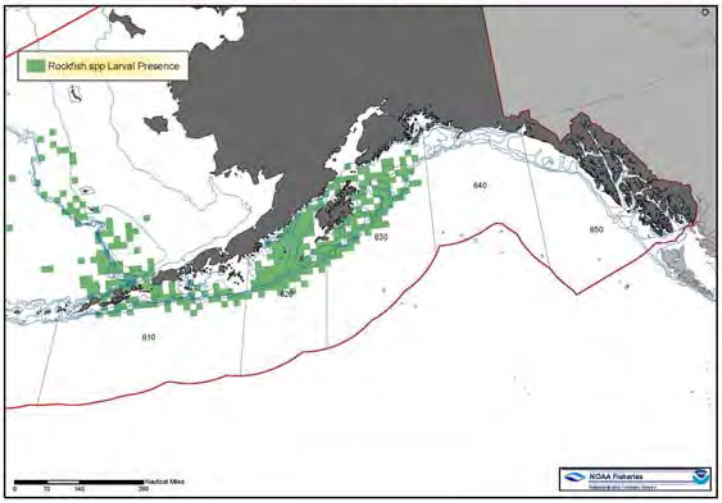
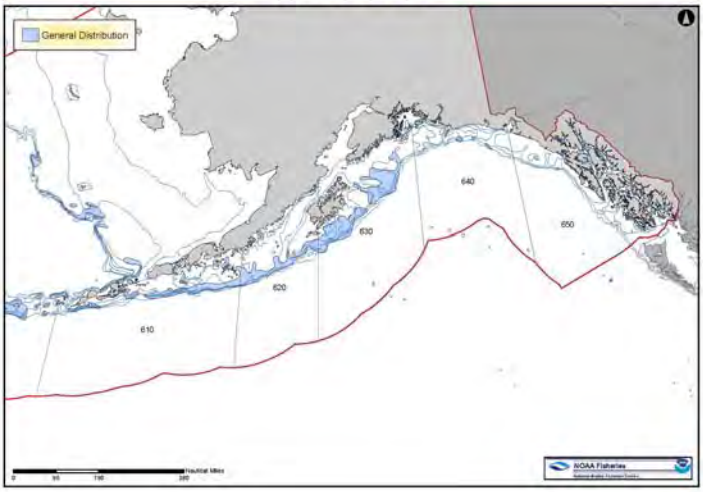


Figure E-32
GOA Northern Rockfish Adults



[Pulled from Appendix F.1.5, GOA Groundfish FMP, effects on EFH] GOA Northern rockfish

1.2.7 Evaluation of Effects on EFH of Groundfish Species

Northern Rockfish (GOA)

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

Summary of Effects—Although northern rockfish may eat a small amount of epifaunal prey, such as polychaetes, the largest component of their diet is euphausiids; thus, the percent reductions in epifaunal prey would not be expected to have a significant impact on their feeding. There is no evidence that links habitat features with northern rockfish accomplishing the spawning/breeding process. Consequently, a reduction in living and non-living structure would not be expected to have an effect on spawning/ breeding of GOA northern rockfish. A reduction in living and non-living structure may reasonably jeopardize growth to maturity due to a reduction of refuge habitat for juvenile GOA northern rockfish. However, no scientific studies have been conducted that specifically identify northern rockfish associations with living or non-living structures or the nature of those associations if they exist. Consequently, the effect of a reduction in living or non-living structures on northern rockfish accomplishing the growth to maturity process is unknown. Current stock status trends show no indications of fishing impacting the ability of the stock to maintain MSY, and there is no evidence to suggest that the potential reductions in living and non-living structure on growth and survival to maturity affects the ability of GOA northern rockfish to fulfill its role in a healthy ecosystem.

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GOA Shortraker Rockfish EFH Update – November 2009

Worksheet – species-specific determinations on whether EFH needs to be changed (please refer to Item B under instructions above)

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? ***Yes. GOA shortraker rockfish were grouped together with GOA rougheye rockfish in the original EFH EIS because the two species were managed as a complex at that time. Thus, descriptive text and maps were based on the combined species. Shortraker rockfish in the GOA was separated as a management category from rougheye rockfish 2005, and completely new text and maps for shortraker rockfish were prepared for this update.***

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2[*])? ***Not really applicable because the original EFH assessment was for shortraker/rougheye combined, whereas this update is only for shortraker rockfish. Adult shortraker and rougheye rockfish appear to occupy a very similar habitat on the slope, so much of the older EFH discussion for adults of the two species remains true when applied just to shortraker. However, in comparison with rougheye, much less is known about juvenile shortrakers. The new text for shortraker rockfish emphasizes the lack of knowledge for this life stage.***

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here. ***No.***

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

3. Research and Information Needs

Is research needed or do data gaps exist? ***Yes.*** Briefly explain and list in order of priority.

There is very little information on larval, post-larval, or juvenile shortraker rockfish, especially juveniles, which are rarely caught in any sampling gear. Studies are needed to locate and sample these young fish before their habitat requirements can be determined. Although more is known about adult fish, the specifics of their habitat requirements need further research. For example, does a relationship exist between adult shortraker rockfish and Primnoa coral, and if so, how important is this relationship? Research needs to be done on the bottom habitat of the major fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on these biota.

[*] EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions. ***Again, not really applicable because this is a completely new update for shortraker rockfish separate from the original shortraker/rougheye EFH EIS. However, the current spatial distribution of fishery catches for shortraker rockfish is similar to that reported for the shortraker/rougheye group in the original EFH EIS. One change since the original EFH EIS is the 2007 implementation of the Central GOA Rockfish Pilot Program, which affects how the rockfish trawl fishery is carried out in this area. The Rockfish Pilot Program appears to have spread fishery effort in space and time, and this will likely decrease the effects of fishing on the bottom.***

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list. ***No***

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain. ***No***

[Pulled from GOA Groundfish FMP, sections 4.2.2, 4.2.2.1, 4.2.2.2]GOA Shortraker rougheye

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Shortraker/rougheye rockfish	x	x	x	x	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

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1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Shortraker Rockfish

Eggs: Eggs develop internally, so EFH description is not applicable.

Larvae: No EFH Description Determined. Insufficient information is available.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: No EFH Description Determined. Insufficient information is available.

Adults: EFH for adult shortraker rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the upper slope (200 to 500 m) region throughout the GOA wherever there are substrates consisting of mud, sand, sandy mud, muddy sand, rock, cobble, and gravel, as depicted in Figure E-31. Adults are especially found on steep slopes with frequent boulders.

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Deleted: EFH for larval shortraker and rougheye rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-29, General Distribution of Rockfish Larvae.¶

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Shortraker rougheye

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Shortraker rockfish	M								x	x										x					x			
	LJ																								x			
	EJ												x	x									x					
	L																									x		

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Shortraker rockfish	M					x		x	x	x	x	x	x	x	x	x	x	x	x
	LJ																		
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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Shortraker rougheye

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Shortraker rockfish	M							x								x										
	LJ																									
	EJ																									
	L																									

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Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Shortraker/Rougheye Rockfish	M	20+					x			x	x							x	x	x	x	x	x	x				

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Shortraker rougheye

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Shortraker/Rougheye	M													X						X				X							
Rockfish	LJ																														
	EJ																														
	L																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Shortraker/Rougheye	M																														
Rockfish	LJ																														
	EJ																														
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1.2 Shortraker Rockfish

1.2.1 Life History and General Distribution

Shortraker rockfish are found around the arc of the north Pacific from southern California to northern Japan, including the Bering Sea and the Sea of Okhotsk (Mecklenburg et al. 2002). They also occur on seamounts in the GOA (Maloney 2004). Except for the adult stage, information on the life history of shortraker rockfish is extremely limited. Similar to other *Sebastes*, the fish appear to be viviparous; fertilization is internal and the developing eggs receive at least some nourishment from the mother. Parturition (release of larvae) may occur from February through August (McDermott 1994). Larvae can be positively identified only by using genetic techniques (Gray et al. 2006), which greatly hinders study of this life stage. Based on genetic identification, a few larval shortraker rockfish have been found in coastal waters of Southeast Alaska (Gray et al. 2006). Post-larvae are also difficult to identify, but genetic identification confirmed the presence of two specimens in epipelagic offshore waters of the GOA over depths >1,000 m (Kondzela et al. 2007). It is unknown whether this very limited sampling of larval and post-larval fish is a good indication of the habitat preference of these life stages; clearly, additional sampling is needed. Similarly, almost nothing is known about juvenile shortraker rockfish in the GOA; only a few specimens <35 cm fork length have ever been caught by fishing gear in this region. Juveniles have been caught in somewhat larger numbers in bottom trawl surveys of the Aleutian Islands (e.g., Harrison 1993), but these data have not been analyzed to determine patterns of distribution or habitat preference. As adults, shortraker rockfish are demersal and inhabit depths from 328 to 3,937 feet (100 to 1,200 m) (Mecklenburg et al. 2002). However, survey and commercial fishery data indicate that the fish are most abundant along a narrow band of the continental slope at depths of 984 to 1,640 feet (300 to 500 m) (Ito 1999), where they often co-occur with rougheye and blackspotted rockfish. Within this habitat, shortraker rockfish tend to have a relatively even distribution when compared with the highly aggregated and patchy distribution of many other rockfish such as Pacific ocean perch (Clausen and Fujioka 2007).

Though relatively little is known about its biology and life history, shortraker rockfish appears to be a K-selected species with late maturation, slow growth, extreme longevity, and low natural mortality. Age of 50% maturity for female shortraker rockfish has been estimated to be 21.4 years for the Gulf of Alaska, with a maximum age of 116 years (Hutchinson 2004). Both these values are very old relative to other fish species. Another study reported an even older maximum age of 157 years (Munk 2001). Female length of 50% maturity has been estimated to be 44.9 cm (McDermott 1994). There is no information on age or length of maturity for males. Shortraker rockfish attains the largest size of any species in the genus *Sebastes*, with a maximum length of up to 47 inches (120 cm; Mecklenburg et al. 2002). Estimates of natural mortality for shortraker rockfish range between 0.027 and 0.042 (McDermott 1994), and a mortality of 0.03 has been used in recent stock assessments to determine values of acceptable biological catch and overfishing for the GOA (Clausen 2007).

1.2.2 Fishery

Shortraker rockfish since 2005 have been assigned their own values of ABC and TAC in the GOA, although technically there is no directed fishery. Instead, all the catch is taken as bycatch in other fisheries. Before 2005, shortraker rockfish were combined with rougheye rockfish for management purposes in the GOA. Shortraker rockfish can be caught with either bottom trawls or longlines. In recent years, each gear type has taken about one half the total catch (Clausen 2007). Most of the trawl catch comes as bycatch in the Pacific ocean perch fishery, whereas the longline catch is taken in the sablefish or Pacific halibut fishery. Although shortraker rockfish are supposedly a "bycatch only" species, present management regulations indirectly allow a limited amount of *de facto* targeted fishing on these fish by rockfish trawlers in some situations (Clausen 2007). In contrast, virtually all the longline catch of shortraker rockfish appears to come as "true" incidental catch. Shortaker rockfish is one of the most

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valuable rockfish species in Alaska in terms of landed price; consequently, the discard rate for this species is generally quite low.

1.2.3 Relevant Trophic Information

The diet of adult shortraker rockfish in the GOA is not well known, but shrimp, deepwater fish such as myctophids, and squid appear to be the major prey items (Yang and Nelson 2000; Yang et al. 2006). A food study in the AI with a larger sample size of shortraker rockfish also found the diet to be mostly myctophids, squid, and shrimp (Yang 2003). In addition, gammarid amphipods, mysids, and miscellaneous fish were important food items in some years. There is no information on predators of shortraker rockfish. Due to their large size, older shortraker rockfish likely have few potential predators other than very large animals such as sleeper sharks or sperm whales.

Habitat and Biological Associations

Egg/Spawning: The timing of reproductive events is apparently protracted. Similar to all *Sebastes*, egg development for shortraker rockfish is completely internal. One study suggested parturition (i.e., larval release) may occur from February to August (McDermott 1994). Another study indicated the peak month of parturition in Southeast Alaska was April (Westrheim 1975). There is no information as to when males inseminate females or if migrations occur for spawning/breeding.

Larvae: Information on larval shortraker rockfish is very limited. Larval shortraker rockfish have been identified in pelagic plankton tows in coastal Southeast Alaska (Gray et al. 2006). Larval studies are hindered because the larvae at present can be positively identified only by genetic analysis, which is both expensive and labor-intensive.

Post-larvae and early young-of-the year: One study used genetics to identify two specimens of post-larval shortraker rockfish from samples collected in epipelagic waters far offshore in the GOA beyond the continental slope (Kondzela et al. 2007). This limited information is the only documentation of habitat preference for this life stage.

Juveniles: Information is negligible regarding the habitat and biological associations of juvenile shortraker rockfish. Only a few specimens less than 14 inches (35 cm) fork length have ever been caught in the GOA. The habitat is presumably demersal, as all specimens caught in the GOA as well others caught in the AI (Harrison 1993) and off Russia (Orlov 2001) have been taken by bottom trawls.

Adults: Adult shortraker rockfish are demersal and in the GOA are concentrated at depths of 984 to 1,640 feet (300 to 500 m) along the continental slope. Much is this area is generally considered by fishermen to be steep and difficult to trawl. Observations from a manned submersible indicated that shortraker rockfish occurred over a wide range of habitats, but soft substrates of sand or mud usually had the highest densities of fish (Krieger 1992). However, this study also showed that habitats with steep slopes and frequent boulders were used at a higher rate than habitats with gradual slopes and few boulders. Another submersible study also found that shortraker and rougheye rockfish occur more frequently on steep slopes with numerous boulders (Krieger and Ito 1999). Although the study could not distinguish between the two species, it is highly probable that many of the fish were shortraker rockfish. Finally, a third submersible study found that "large" rockfish had a strong association with *Primnoa* spp. coral growing on boulders: less than 1 percent of the observed boulders had coral, but 85 percent of the "large" rockfish (which included redbanded rockfish along with shortraker and rougheye) were next to boulders with coral (Krieger and Wing 2002). Again, in this latter study, "large" rockfish were not positively identified, but it is likely based on location and depth that many were shortraker rockfish.

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Habitat and Biological Associations: Shortraker Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	N/A	N/A	N/A	N/A	N/A	N/A	
Larvae	U	U	Parturition: Feb-Aug	U; Bay	Probably P	N/A	U	
Post-larvae/ early juvenile	U	U	Summer to ?	LSP, BSN	Probably N	N/A	U	
Juveniles	Up to 21 years of age	U	U	OCS?; USP?	Probably D	U	U	
Adults	21 to >100 years of age	Shrimp Squid Myctophids	Year-round?	USP	D	M, S, R, SM, CB, MS, G, C; steep slopes and boulders	U	Observed associated with *Primnoa* coral

1.2.4 Additional Sources of Information

Larvae: Art Kendall, AJALA Enterprises, La Conner, WA.

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[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] GOA Shortraker rougheye

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-29 and E-31 Shortraker and rougheye rockfish (larvae, adults)

Figure E-29
GOA Rockfish Larval Presence

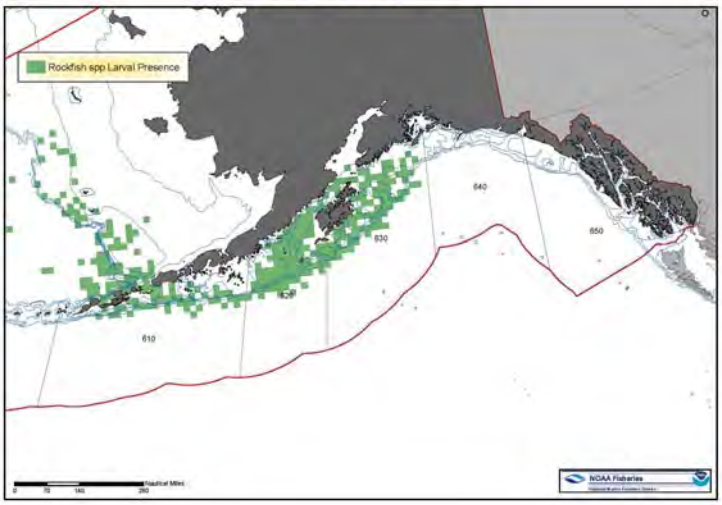
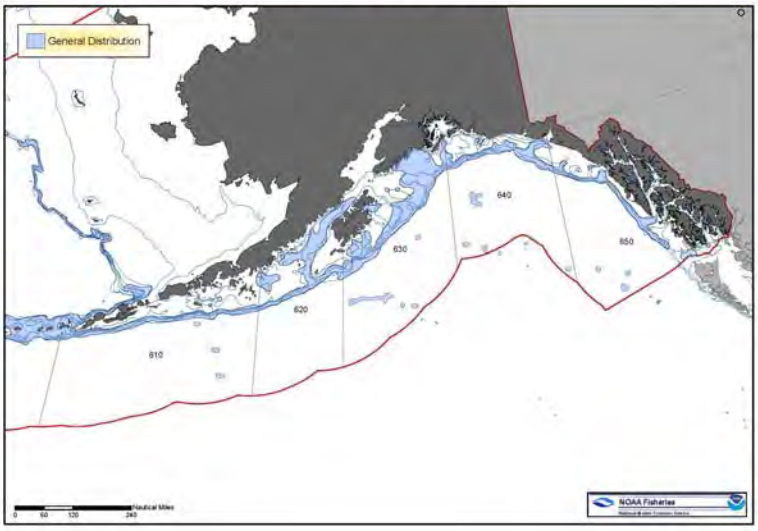


Figure E-31
GOA Shortraker/Rougheye Rockfish Adults



[Pulled from Appendix F.1.5, GOA Groundfish FMP, effects on EFH] GOA Shortraker rougheye

1.2.6 Evaluation of Effects on EFH of Groundfish Species

Shortraker Rockfish (GOA)

Issue	Evaluation
Spawning/Breeding	U (unknown effect)
Growth to Maturity	U (unknown effect)
Feeding	MT (minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of shortraker rockfish in the GOA are either unknown or minimal. There is not enough information available to determine whether the habitat impacts of fishing affect spawning or growth to maturity of these fish. Virtually nothing is known about the spawning behavior of shortraker rockfish, and information on juvenile life history is nil. However, adults inhabit areas subject to bottom trawling, so fishing may be affecting the habitat of these fish. Of particular concern is the observed association of adult shortraker rockfish with corals such as *Primnoa* spp. on rocky substrate of the slope. This coral is known to be easily damaged by bottom trawls, and it also may take years to recover from such damage. The fragile nature of corals and their long recovery time are reflected in the high values of LEI estimated for corals in this document. If corals are important to the long-term survival of adult shortraker rockfish, damage to corals by fishing gear may have a negative impact on these fish. Effects of fishing on the feeding of adult shortraker rockfish appears to be negligible, as their major food items are relatively small and some may be bathypelagic; therefore, these items are generally not retained in large amounts by demersal fishing gear.

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Deleted: The habitat requirements of juvenile rougheye rockfish on the shelf are unknown. However, several studies have observed unidentified small juvenile rockfish on the shelf associated with rocks or sponges. If juvenile rougheye rockfish utilize this habitat, they could be adversely affected by trawling.

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Shortraker and rougheye rockfish are estimated to attain ages in excess of 100 years, and one ageing laboratory has reported ages up to 157 years for shortraker and 205 years for rougheye (Chilton and Beamish 1982, Munk 2001).

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mated to be on the order of 0.01 to 0.04 (Archibald et al. 1981, McDermott 1994, Nelson and Quinn 1987, Clausen et al. 2003).

Length at 50 percent sexual maturity has been estimated to be about 45 cm fork length for female shortraker rockfish and about 44 cm fork length for female rougheye rockfish (McDermott 1994). For both species, the largest immature females were about 50 to 55 cm. For either species, there is no information on male size at maturity or on maximum size of juvenile males.

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found as far south as southern California, commercial quantities are primarily harvested from Washington north to Alaska waters. Shortraker and rougheye rockfish are presently managed as bycatch-only species in Alaska and are taken by both trawl and longline gear. In recent years, trawling has accounted for about 60 percent of the catch and longlining about 40 percent (Clausen et al. 2003). Commercial harvests usually occur on the slope from 984 to 1,640 feet (300 to 500 m) deep. Both species are associated with soft to rocky habitats along the continental slope, although boulders and steeply sloping terrain appear to be a desirable habitat feature for both species (Krieger 1992, Krieger and Ito 1999). Trawling in such habitats often requires specialized fishing skills to avoid gear damage and to keep the trawl in the proper fishing configuration. One study estimated age at recruitment for rougheye rockfish to be 30 years (Nelson and Quinn 1987), and it is probably on the order of 20+ years for shortraker rockfish. Shortraker and rougheye rockfish are often caught as bycatch in trawl fisheries for Pacific ocean perch and in longline fisheries for sablefish and halibut.

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Rougheye rockfish in Alaska feed primarily on shrimps (especially pandalids), and various fish species such as myctophids are also consumed (Yang and Nelson 2000; Yang 2003). However, smaller juvenile rougheye rockfish (less than 12 inches [30 cm] fork length) in the GOA also consume a substantial amount of smaller invertebrates such as amphipods, mysids, and isopods (Yang and Nelson 2000).

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however, based on a very small sample size in the Yang and Nelson (2000) study, the diet

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shrimp, and deepwater fish such as myctophids.

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It is uncertain what constitute the main predators on both species.

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One study indicated that vitellogenesis was present for 4 to 5 months and lasted from about July until late October and November (McDermott 1994). This

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and December through April for rougheye rockfish.

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, and it is likely that larval rougheye rockfish are also pelagic

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and one of rougheye rockfish in these life stages

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This is especially true for small juvenile shortraker rockfish, as o

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Juvenile shortraker rockfish are

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there have been no known catches in pelagic trawls or in off-bottom sampling gear. In contrast, juvenile rougheye rockfish 6 to 16 inches (15 to 40 cm) fork length are frequently caught in GOA bottom trawl surveys (Clausen et al. 2003). They are generally found at shallower, more inshore areas than adults. These areas range from inshore fiords to offshore waters of the continental shelf. Other than the fact that they have been taken on trawlable bottom, however, habitat preferences for juvenile rougheye rockfish are unknown.

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, Krieger and Wing 2002). Soft substrates of sand or mud usually had the highest densities, whereas hard substrates of bedrock, cobble, or pebble usually had the lowest adult densities (Krieger and Ito 1999). Habitats with steep slopes and frequent boulders were used at a higher rate than habitats with gradual slopes and few boulders (Krieger 1992, Krieger and Ito 1999). One of the submersible studies

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Archibald, C.P., W. Shaw, and B.M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B.C. coastal waters, 1977-79. Can. Tech. Rep. Fish. Aquat. Sci. 1048, 57 p.

Chilton, D.E., and R.J. Beamish. 1982. Age determination methods for fishes studied by the Groundfish Program at the Pacific Biological Station. Can. Spec. Publ. Fish. Aquat. Sci. 60, 102 p.

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Gharrett, A.J., Z. Li, C.M. Kondzela, and A.W. Kendall. 2002. Final report: species of rockfish (Sebastes spp.) collected during ABL-OCC cruises in the GOA in 1998-2002. (Unpubl. manuscr. available from the NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau AK 99801).

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Unpubl. manuscr. 22 p. (Available from NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau AK 99801)

GOA Rougheye and Blackspotted Rockfish 2009 5-year review worksheet

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? **Yes.** *Two distinct species of rougheye rockfish have been identified, rougheye and blackspotted rockfish. Changes to the text and tables reflect this and include previously excluded information. The first map of larval presence is adequate, since we have no specific information on rougheye and blackspotted rockfish larval distribution. The second map of adults should be updated to include only rougheye and blackspotted rockfish.*

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2[*])? **No**

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here. **No**

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future. *There are some genetic studies being conducted by T. Gharrett's lab at the University of Alaska Fairbanks on larval rougheye rockfish identification. Additionally, the 2009 NMFS trawl survey is currently collecting data on both rougheye and blackspotted rockfish to evaluate new identification techniques and potential population distribution differences.*

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

There is little information on larval, post-larval, or early juvenile stages of rougheye and blackspotted rockfish. Habitat requirements for these stages are mostly unknown. Habitat requirements for later stage juvenile and adult fish are anecdotal or conjectural. Research needs to be done on the bottom habitat of the major fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on these biota. Additionally, the current NMFS trawl survey design should extend into deeper waters (>300 m) to cover the range of primary habitat for rougheye and blackspotted rockfish. Further research on trawl and longline catchability, trawlable/untrawlable grounds, and natural mortality would be very useful.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions. **No.** *The Central GOA Rockfish Pilot program has the potential effect of spreading effort in time and space and the increase in pelagic trawling will likely decrease effects of fishing.*

---

[*] EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list. **No.**

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider?

Explain. **No.**

[Pulled from GOA Groundfish FMP, sections 4.2.2, 4.2.2.1, 4.2.2.2]GOA Rougheye/Blackspotted

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Rougheye and Blackspotted rockfish	x	x	x	x	1

NOTES: "1" indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

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1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Rougheye and Blackspotted Rockfish

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Eggs: Eggs developed internally, EFH description not applicable.

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Larvae: No EFH Description Determined. Insufficient information is available. The larval stage is pelagic but larval studies are hindered because the larvae at present can only be positively identified by genetic analysis, which is both expensive and labor-intensive.

Deleted: EFH for larval shortraker and rougheye rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-29, General Distribution of Rockfish Larvae

Early Juveniles: No EFH Description Determined. Insufficient information is available. The post-larvae and early young-of-the-year stages also appear to be pelagic. Genetic technique have been used recently to identify a few post-larval rougheye rockfish from samples collected in epipelagic waters far offshore in the Gulf of Alaska. This is the only documentation of habitat preference for this life stage.

Late Juveniles: No EFH Description Determined. Insufficient information is available.

Adults: EFH for adult rougheye and blackspotted rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) regions throughout the GOA wherever there are substrates consisting of mud, sand, sandy mud, muddy sand, rock, cobble, and gravel, as depicted in Figure E-31.

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EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Rougheye and Blackspotted

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surface	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Rougheye and Blackspotted Rockfish	M								x	x								x	x	x	x				x			
	LJ							x	x								x		x									
	EJ												x	x									x	x		x		
	L																						x			x		

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Rougheye and Blackspotted Rockfish	M							x	x	x	x	x	x	x	x	x	x	x	x
	LJ																	x	x
	EJ																		
	L																		

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EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Rougheye and Blackspotted

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Rougheye and Blackspotted Rockfish	M							x								x										
	LJ																									
	EJ																									
	L																									

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Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Rougheye and Blackspotted Rockfish	M	19+					x			x	x						x	x	x	x								

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EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA Rougheye and Blackspotted

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Rougheye and Blackspotted	M							X			X			X				X		X				X							
Rockfish	LJ									X										X											
	EJ																														
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GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Rougheye and Blackspotted	M								X							X														
Rockfish	LJ																													
	EJ																													
	L																													

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1.2 Rougheye and Blackspotted Rockfish

1.2.1 Life History and General Distribution

Orr and Hawkins (2008) formally verified the presence of two species, rougheye rockfish (*Sebastes aleutianus*) and blackspotted rockfish (*S. melanostictus*), in what was once considered a single variable species with light and dark color morphs. They used combined genetic analyses of 339 specimens from Oregon to Alaska to identify the two species and formulated general distribution and morphological characteristics for each. Rougheye rockfish is typically pale with spots absent from the dorsal fin and possible mottling on the body. Blackspotted rockfish is darker with spotting almost always present on the dorsal fin and body. The two species occur in sympatric distribution with rougheye extending farther south along the Pacific Rim and blackspotted extending into the western Aleutian Islands. The overlap is quite extensive (Gharrett et al. 2005, 2006). At present there is difficulty in field identification between the two species. Scientists and observers are currently evaluating new techniques to determine whether rapid and accurate field identification can occur. Ongoing research in this area may distinguish particular habitat preference that might be useful for separating the species and determine whether the two species have significantly different life history traits (i.e. age of maturity and growth). Until such information is available, it will be difficult to undertake distinct population assessments. In the stock assessment, rougheye and blackspotted rockfish are referred together as the rougheye rockfish complex.

Rougheye and blackspotted rockfish inhabit the outer continental shelf and upper continental slope of the northeastern Pacific. Their distribution extends around the arc of the North Pacific from Japan to Point Conception, California and includes the Bering Sea (Kramer and O'Connell 1988). The center of abundance appears to be Alaskan waters, particularly the eastern Gulf of Alaska (GOA). Adults in the GOA inhabit a narrow band along the upper continental slope at depths of 984 to 1,640 feet (300-500 m); outside of this depth interval, abundance decreases considerably (Ito, 1999). This species often co-occurs with shortraker rockfish (*Sebastes borealis*) in trawl or longline hauls.

Though relatively little is known about their biology and life history, rougheye and blackspotted rockfish appear to be K-selected with late maturation, slow growth, extreme longevity, and low natural mortality. Age and size at 50% maturity for female rougheye rockfish is estimated at 19 years and 44 cm, respectively (McDermott 1994). There is no information on male size at maturity or on maximum size of juvenile males. Rougheye is considered the oldest of the *Sebastes* spp. with a maximum age of 205 years (Chilton and Beamish 1982, Munk 2001). It is also considered one of the larger rockfish attaining sizes of up to 38 inches (98 cm) (Mecklenburg et al. 2002). Natural mortality is low, estimated to be on the order of 0.004 to 0.07 (Archibald et al. 1981, McDermott 1994, Nelson and Quinn 1987, Clausen et al. 2003, Shotwell et al. 2007).

1.2.2 Fishery

Although rougheye and blackspotted rockfish are found as far south as southern California, commercial quantities are primarily harvested from Washington north to Alaska waters. Commercial harvests usually occur on the slope from 984 to 1,640 feet (300 to 500 m) deep. Rougheye and blackspotted rockfish have been managed as "bycatch" only species since the creation of the shortraker/rougheye rockfish management subgroup in the Gulf of Alaska in 1991. Historically, Gulf-wide catches of the shortraker/rougheye subgroup have been consistently around 1,500-2,000 t in the years since 1992. Annual TAC's have been the major determining factor of these catch amounts, as TAC's have also ranged between ~1,500-2,000 t over these years. Rougheye are caught in either bottom trawls or with longline gear, and about half came from each gear type in recent years (Shotwell et al. 2007). Nearly all the longline catch of rougheye appears to come as "true" bycatch in the sablefish or halibut longline fisheries. Rougheye and blackspotted rockfish are associated with soft to rocky habitats along the

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continental slope, although boulders and steeply sloping terrain also appear to be a desirable habitat feature (Krieger and Ito 1999). Trawling in such habitats often requires specialized fishing skills to avoid gear damage and to keep the trawl in the proper fishing configuration. One study estimated age at recruitment for rougheye rockfish to be 30 years (Nelson and Quinn 1987).

Since 2005, rougheye and blackspotted rockfish were assessed separately from shortraker rockfish and assigned their own values of ABC and TAC in the GOA. Gulf-wide discard rates (percent of the total catch discarded within management categories) of fish in the shortraker/rougheye subgroup were available for the years 1991-2004, and range from approximately 10% to 42%. Beginning in 2005, discards for the rougheye rockfish complex are reported separately and range from 20% to 38%, which are relatively high when compared to other *Sebastes* species in the Gulf of Alaska (Shotwell et al. 2007).

In 2007, the Central Gulf of Alaska Rockfish Pilot Program was implemented to enhance resource conservation and improve economic efficiency for harvesters and processors who participate in the Central Gulf of Alaska rockfish fishery. This is a five year rationalization program that establishes cooperatives among trawl vessels and processors which receive exclusive harvest privileges for rockfish management groups. This implementation impacts primary management groups but will also effect secondary groups with a maximum retained allowance (MRA). The primary rockfish management groups are northern, Pacific ocean perch, and pelagic shelf rockfish, while the secondary species include rougheye and shortraker rockfish. Potential effects of this program to rougheye rockfish include: 1) changes in spatial distribution of fishing effort within the Central GOA, 2) improved at-sea and plant observer coverage for vessels participating in the rockfish fishery, 3) a higher potential to harvest 100% of the TAC in the Central GOA region, and 4) an extended fishing season lasting from May 1 – November 15. This should spread out the fishery in time and space, allowing for better prices for product and reducing the pressure of what was an approximately two week fishery in July.

1.2.3 Relevant Trophic Information

Rougheye rockfish in Alaska feed primarily on shrimps (especially pandalids), and various fish species such as myctophids are also consumed (Yang and Nelson 2000; Yang 2003). However, smaller juvenile rougheye rockfish (less than 12 inches [30 cm] fork length) in the GOA also consume a substantial amount of smaller invertebrates such as amphipods, mysids, and isopods (Yang and Nelson 2000). Recent food studies show the most common prey of rougheye as pandalid shrimp, euphausiids, and tanner crab (*Chionoecetes bairdi*). Other prey include octopi and copepods (Yang et al. 2006). Predators of rougheye rockfish likely include halibut (*Hippoglossus stenolepis*), Pacific cod (*Gadus macrocephalus*), and sablefish (*Anoplopoma fimbria*).

1.2.4 Habitat and Biological Associations

Egg/Spawning: As with other *Sebastes* species, rougheye and blackspotted rockfish are presumed to be viviparous, where fertilization and incubation of eggs is internal and embryos receive at least some maternal nourishment. There have been no studies on fecundity of rougheye in Alaska. One study on their reproductive biology indicated that rougheye had protracted reproductive periods, and that parturition (larval release) may take place in December through April (McDermott, 1994). There is no information as to when males inseminate females or if migrations for spawning/breeding occur.

Larvae: Information on larval rougheye and blackspotted rockfish is very limited. The larval stage is pelagic, but larval studies are hindered because the larvae at present can only be positively identified by genetic analysis, which is both expensive and labor-intensive.

Post-larvae and early young-of-the year: The post-larvae and early young-of-the-year stages also appear to be pelagic (Matarese et al. 1989, Kondzela et al. 2007). Genetic techniques have been used recently to identify a few post-larval rougheye rockfish from samples collected in epipelagic waters far offshore in

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Deleted: The timing of reproductive events is apparently protracted. One study indicated that vitellogenesis was present for 4 to 5 months and lasted from about July until late October and November (McDermott 1994). This study also reported that parturition (i.e., larval release) occurred mainly in February through August for shortraker rockfish and December through April for rougheye rockfish.

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the Gulf of Alaska (Kondzela et al. 2007), which is the only documentation of habitat preference for this life stage.

Juveniles: There is no information on when juvenile fish become demersal. Juvenile rougheye rockfish 6 to 16 inches (15 to 40 cm) fork length have been frequently taken in Gulf of Alaska bottom trawl surveys, implying the use of low relief, trawlable bottom substrates (Clausen et al. 2003). They are generally found at shallower, more inshore areas than adults and have been taken in a variety of locations, ranging from inshore fiords to offshore waters of the continental shelf. Studies using manned submersibles have found that large numbers of small, juvenile rockfish are frequently associated with rocky habitat on both the shallow and deep shelf of the GOA (Carlson and Straty 1981, Straty 1987). Another submersible study on the GOA shelf observed juvenile red rockfish closely associated with sponges that were growing on boulders (Freese and Wing 2004). Although these studies did not specifically identify rougheye rockfish, it is reasonable to suspect that juvenile rougheye rockfish may be among the species that utilize this habitat as refuge during their juvenile stage.

Adults: Adult rougheye and blackspotted rockfish are demersal and known to inhabit particularly steep, rocky areas of the continental slope, with highest catch rates generally at depths of 984 to 1,312 feet (300 to 400 m) in longline surveys (Zenger and Sigler 1992) and at depths of 984 to 1,640 feet (300 to 500 m) in bottom trawl surveys and in the commercial trawl fishery (Ito 1999). Observations from a manned submersible in this habitat indicate that the fish prefer steep slopes and are often associated with boulders and sometimes with *Primnoa* spp. coral (Krieger and Ito 1999, Krieger and Wing 2002). Within this habitat, rougheye rockfish tend to have a relatively even distribution when compared with the highly aggregated and patchy distribution of other rockfish such as Pacific ocean perch (*Sebastes alutus*) (Clausen and Fujioka, 2007).

Habitat and Biological Associations: Rougheye and Blackspotted Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	N/A	N/A	N/A	N/A	N/A	N/A	
Larvae	U	U	Parturition: Dec-Apr	U	Pelagic	N/A	U	
Post-larvae/ early juvenile	U	U	Summer to ?	LSP, BSN	Epipelagic	N/A	U	
Juveniles	Up to 20 years of age	Shrimp Mysids Amphipods Isopods	U	OCS, USP	D	U	U	
Adults	20 to >100 years of age	Shrimp Euphausiids Myctophids Tanner Crab	Year-round?	USP	D	M, S, R, SM, CB, MS, G, C steep slopes and boulders	U	Observed associated with *Primnoa* coral

1.2.5 Additional Sources of Information

Larvae: Art Kendall, AJALA Enterprises, La Conner, WA.

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Deleted: Little information is available regarding the habitats and biological associations of juvenile shortraker and rougheye rockfish. This is especially true for small juvenile shortraker rockfish, as only a few specimens less than 14 inches (35 cm) fork length have been caught in the GOA. Juvenile shortraker rockfish are presumably demersal, as there have been no known catches in pelagic trawls or in off-bottom sampling gear. In contrast, juvenile rougheye rockfish 6 to 16 inches (15 to 40 cm) fork length are frequently caught in GOA bottom trawl surveys (Clausen et al. 2003). They are generally found at shallower, more inshore areas than adults. These areas range from inshore fiords to offshore waters of the continental shelf. Other than the fact that they have been taken on trawlable bottom, however, habitat preferences for juvenile rougheye rockfish are unknown.

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EFH 5-year report - Appendix 2

[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] GOA Rougheye and Blackspotted

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-29 and E-31 Rougheye and blackspotted rockfish (larvae, adults)

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Figure E-29
GOA Rockfish Larval Presence

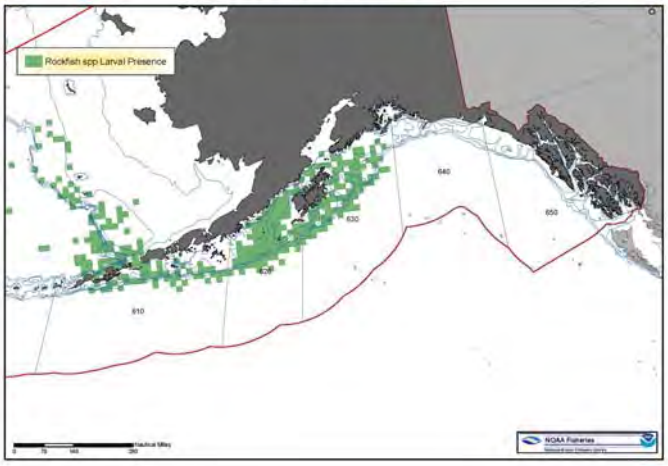
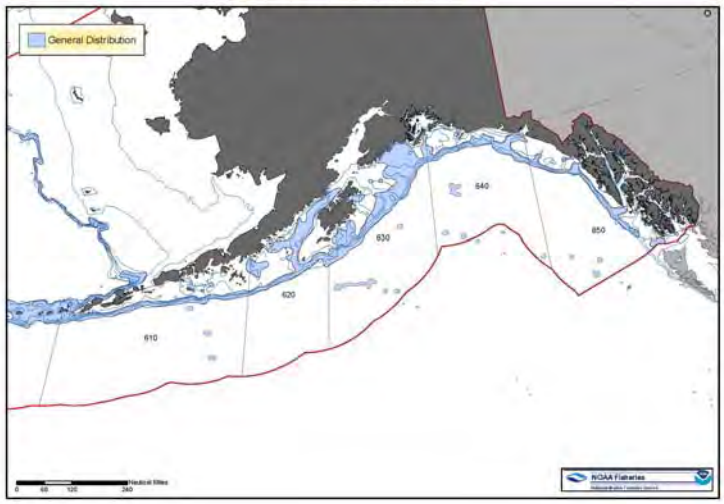


Figure E-31
GOA Shortraker/Rougheye Rockfish Adults



Comment [SKS1]: Title needs to be changed, and map should only reflect rougheye rockfish complex distribution.

1.2.7 Evaluation of Effects on EFH of Groundfish Species

Rougheye and Blackspotted Rockfish (GOA)

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Issue	Evaluation
Spawning/Breeding	U (unknown effect)
Growth to Maturity	U (unknown effect)
Feeding	MT (minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of rougheye and blackspotted rockfish in the GOA are unknown. There is not enough information available to determine whether the habitat impacts of fishing affect spawning or growth to maturity of these fish. Virtually nothing is known about the spawning behavior of these fish, and information on the juvenile life history of rougheye and blackspotted rockfish is very limited. However, adults inhabit areas subject to bottom trawling, as do juveniles of rougheye and blackspotted rockfish, so fishing may be affecting the habitat of these fish. Of particular concern is the observed association of adult rougheye and blackspotted rockfish with corals such as *Primnoa* spp. on rocky substrate of the slope. This coral is known to be easily damaged by bottom trawls, and it also may take years to recover from such damage. The fragile nature of corals and their long recovery time are reflected in the high values of LEI estimated for corals in this document. If corals are important to the long-term survival of adult rougheye and blackspotted rockfish, damage to corals by fishing gear may have a negative impact on these fish. The habitat requirements of juvenile rougheye and blackspotted rockfish on the shelf are unknown. However, several studies have observed unidentified small juvenile rockfish on the shelf associated with rocks or sponges. If juvenile rougheye rockfish utilize this habitat, they could be adversely affected by trawling. Effects of fishing on the feeding of rougheye and blackspotted rockfish appears to be negligible, as their major food items are relatively small and some may be bathypelagic; therefore, these items are generally not retained in large amounts by fishing gear.

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Page 5: [1] Deleted **Stacey Kalei Shotwell** **8/26/2009 3:05:00 PM**

Shortraker and rougheye rockfish are found around the arc of the north Pacific from southern California to northern Japan, including the BS (Mecklenburg et al. 2002). Both species are demersal. Rougheye rockfish inhabit depths ranging from 82 to 2,953 feet (25 to 900 m), and shortraker rockfish range from 328 to 3,937 feet (100 to 1,200 m) (Mecklenburg et al. 2002). However, survey and commercial fishery data indicate that the fish are most abundant along a narrow band of the continental slope at depths of 984 to 1,640 feet (300 to 500 m) (Ito 1999), where both shortraker and rougheye rockfish often co-occur in the same haul. Within this habitat, shortraker and rougheye rockfish tend to have a relatively even distribution when compared with the highly aggregated and patchy distribution of many other rockfish such as Pacific ocean perch[1]. Similar to other Sebastes, the fish appear to be viviparous (the eggs develop internally and receive at least some nourishment from the mother), with internal fertilization and the release of live young.

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Rougheye rockfish attain maturity relatively late in life, at about 20 years of age

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Age of maturity for shortraker rockfish is unknown, but is presumably similar to that of rougheye rockfish.

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Both species are among the largest Sebastes species in the north Pacific, attaining sizes of up to 47 inches (120 cm) for shortraker and 38 inches (97 cm) for rougheye rockfish

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Shortraker and rougheye rockfish are estimated to attain ages in excess of 100 years, and one ageing laboratory has reported ages up to 157 years for shortraker and 205 years for rougheye (Chilton and Beamish 1982, Munk 2001).

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Length at 50 percent sexual maturity has been estimated to be about 45 cm fork length for female shortraker rockfish and about 44 cm fork length for female rougheye rockfish (McDermott 1994). For both species, the largest immature females were about 50 to 55 cm. For either species, there is no information on male size at maturity or on maximum size of juvenile males.

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Shortraker and rougheye rockfish are presently managed as bycatch-only species in Alaska and are taken by both trawl and longline gear. In recent years, trawling has accounted for about 60 percent of the catch and longlining about 40 percent (Clausen et al. 2003). Commercial harvests usually occur on the slope from 984 to 1,640 feet (300 to 500 m) deep.

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Adult shortraker and rougheye rockfish are demersal and are concentrated at depths of 984 to 1,640 feet (300 to 500 m) along the continental slope. Observations from a manned submersible

[1] Clausen, D. M., and J. T. Fujioka. Variability in trawl survey catches of shortraker rockfish, rougheye rockfish, and Pacific ocean perch, and possible implications for survey design. Presentation at 2002 Western Groundfish Conference, Ocean Shores, WA, February 12-14, 2002.

indicate that these fish occur over a wide range of habitats (Krieger 1992, Krieger and Ito 1999, Krieger and Wing 2002). Soft substrates of sand or mud usually had the highest densities, whereas hard substrates of bedrock, cobble, or pebble usually had the lowest adult densities (Krieger and Ito 1999). Habitats with steep slopes and frequent boulders were used at a higher rate than habitats with gradual slopes and few boulders (Krieger 1992, Krieger and Ito 1999). One of the submersible studies found shortraker and rougheye rockfish had a strong association with Primnoa spp. coral growing on boulders: less than 1 percent of the observed boulders had coral, but 85 percent of the "large" rockfish (which included redbanded rockfish along with shortraker and rougheye) were next to boulders with coral (Krieger and Wing 2002).

GOA Dusky 2009 5-year review worksheet

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? ***Yes.*** *Minor changes to the text and tables were changed to reflect current and previously excluded information. The maps are adequate.*

Diana Evans note: author is referring to changes to the FMP text in general, not specifically to the description of EFH by life history stage.

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2[*])? ***No.***

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here. ***No.***

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

There is little information on larval, post-larval, or early juvenile stages slope rockfish. Habitat requirements for these stages are mostly unknown. Habitat requirements for later stage juvenile and adult fish are anecdotal or conjectural. Research needs to be done on the bottom habitat of the major fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on these biota. Additionally, dusky rockfish are undersampled by the current survey design. The stock assessment would benefit from additional survey effort on the continental slope. Further research on trawl catchability and trawlable/untrawlable grounds would be very useful.

3. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions. ***No.*** *The Central GOA Rockfish Pilot program has the potential effect of spreading effort in time and space and the increase in pelagic trawling will likely decrease effects of fishing.*

4. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list. ***No.***

5. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider?

Explain. ***No.***

[*] EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Dusky rockfish	x	1	x	x	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Dusky Rockfish

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: EFH for larval dusky rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-29, General Distribution of Rockfish Larvae.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: No EFH Description Determined. Insufficient information is available.

Adults: EFH for adult Dusky rockfish is the general distribution area for this life stage, located in the middle and lower portions of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates of cobble, rock, and gravel, as depicted in Figure E-35.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA dusky rockfish

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Dusky Rockfish	M							x	x									x		x	x				x			
	LJ						x	x										x		x					x			
	EJ																											
	L																											

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GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Dusky Rockfish	M									x								x	x
	LJ																		
	EJ																		
	L																		

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA dusky rockfish

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Dusky Rockfish	M																									
	LJ															x										
	EJ																									
	L																									

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Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Dusky Rockfish	M	11					x			x	x																	

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA dusky rockfish**

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Dusky Rockfish	M							X																							
	LJ																														
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GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Dusky Rockfish	M																													
	LJ																													
	EJ																													
	L																													

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1.2 Dusky rockfish *(Sebastes variabilis)*

Previously it was thought that there were two varieties of dusky rockfish, a dark colored variety inhabiting inshore, shallow waters, and a lighter colored variety inhabiting deeper water offshore. In 2004 these two varieties were designated as distinct species, the dark colored variety is now recognized as dark rockfish (*Sebastes ciliatus*) and the lighter colored variety is now recognized as dusky rockfish (*Sebastes variabilis*) (Orr and Blackburn 2004). In 2009 dark rockfish were removed from the GOA FMP to allow for more responsive management by the State of Alaska.

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1.2.1 Life History and General Distribution

Dusky rockfish range from central Oregon through the North Pacific Ocean and Bering Sea in Alaska and Russia to Japan. The center of abundance for dusky rockfish appears to be the GOA (Reuter 1999). The species is much less abundant in the Aleutian Islands and Bering Sea (Reuter and Spencer 2002). Adult dusky rockfish have a very patchy distribution, and are usually found in large aggregations at specific localities of the outer continental shelf. These localities are often relatively shallow offshore banks. Because the fish are taken with bottom trawls, they are presumed to be mostly demersal. Whether they also have a pelagic distribution is unknown, but there is no particular evidence of a pelagic tendency based on the information available at present. Most of what is known about dusky rockfish is based on data collected during the summer months from the commercial fishery or in research surveys. Consequently, there is little information on seasonal movements or changes in distribution for this species.

Life history information on dusky rockfish is extremely sparse. The fish are assumed to be viviparous, as are other Sebastes, with internal fertilization and incubation of eggs. Observations during research surveys in the GOA suggest that parturition (larval release) occurs in the spring, and is probably completed by summer. Another, older source, however, lists parturition as occurring "after May." Pre-extrusion larvae have been described, but field-collected larvae cannot be identified to species at present. Length of the larval stage, and whether a pelagic juvenile stage occurs, are unknown. There is no information on habitat and abundance of young juveniles (<25 cm fork length), as catches of these have been virtually nil in research surveys. Even the occurrence of older juveniles has been very uncommon in surveys, except for one year. In this latter instance, older juveniles were found on the continental shelf, generally at locations inshore of the adult habitat.

Dusky rockfish is a slow growing species, with a low rate of natural mortality estimated at 0.09. However, it appears to be faster growing than many other rockfish species. Maximum age is 51 to 59 years. Estimated age at 50 percent maturity for females is 11.3 years. No information on fecundity is available.

The approximate upper size limit of juvenile fish is 47 cm for females (size at 50 percent maturity is 43 cm); unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of Sebastes.

1.2.2 Fishery

Dusky rockfish are mostly caught with bottom trawl gear and to a much lesser extent by jig gear. In 2007, the Central Gulf of Alaska Rockfish Pilot Program was implemented to enhance resource conservation and improve economic efficiency for harvesters and processors who participate in the Central Gulf of Alaska rockfish fishery. This is a five year rationalization program that establishes cooperatives among trawl vessels and processors which receive exclusive harvest privileges for rockfish management groups. The primary rockfish management groups are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish. Potential effects of this program on Pacific ocean perch include: 1) Extended fishing season lasting from May 1 – November 15, 2) changes in spatial distribution of fishing

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effort within the Central GOA, 3) Improved at-sea and plant observer coverage for vessels participating in the rockfish fishery, 4) a higher potential to harvest 100% of the TAC in the Central GOA region. This Program, also makes dusky rockfish increasing available to jig and hook-and-line gear through a specific allocation of TAC.

A precise estimate of age at 50 percent recruitment is not available, but has been roughly estimated to be about 10 years based on length frequency information from the fishery. The fishery in the GOA in recent years has mostly occurred in the summer months, especially July, due to management regulations. Catches are concentrated at a number of relatively shallow, offshore banks of the outer continental shelf, especially the "W" grounds west of Yakutat, and Portlock Bank. Other fishing grounds include Albatross Bank, the "Snakehead" south of Kodiak Island, and Shumagin Bank. Outside of these banks, catches are generally sparse. Most of the trawl catch of dusky rockfish is taken at depths of 100 to 200 m offshore, while most of the catch by jig gear occurs in shallow, inshore waters.

Most of the trawl catch of dusky rockfish is taken at depths of 100 to 200 m offshore, while most of the catch by jig gear occurs in shallow, inshore waters.

1.2.3 Relevant Trophic Information

Although no comprehensive food study of dusky rockfish has been done, one smaller study in the GOA showed euphausiids to be the predominant food item of adults. Larvaceans, cephalopods, pandalid shrimp, and hermit crabs were also consumed.

Predators of dusky rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth flounder.

1.2.4 Habitat and Biological Associations

Egg/Spawning: No information known, except that parturition probably occurs in the spring, and may extend into summer.

Larvae: No information known.

Juveniles: No information known for small juveniles <25 cm fork length. Larger juveniles have been taken infrequently in bottom trawls at various localities of the continental shelf, usually inshore of the adult fishing grounds. A manned submersible study in the eastern Gulf observed juvenile (<40 cm) dusky rockfish associated with Primnoa spp. coral.

Adults: Commercial fishery and research survey data indicate that adult dusky rockfish are primarily found on offshore banks of the outer continental shelf at depths of 100 to 200 m. Type of substrate in this habitat has not been documented, but it may be rocky. During submersible dives on the outer shelf (40 to 50 m) in the eastern Gulf, adult dusky rockfish were observed in association with rocky habitats and in areas with extensive sponge beds where the fish were observed resting in large vase sponges (pers. Comm. V. O'Connell). Dusky rockfish are the most highly aggregated of the rockfish species caught in GOA trawl surveys. Outside of these aggregations, the fish are sparsely distributed. Because the fish are generally taken only with bottom trawls, they are presumed to be mostly demersal. Whether they also have a pelagic distribution is unknown, but there is no evidence of a pelagic tendency based on the information available at present. There is no information on seasonal migrations. Dusky rockfish often co-occur with northern rockfish.

Habitat and Biological Associations: Dusky Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	NA	U	NA	NA	NA	NA	NA
Larvae	U	U	Spring-summer	U	P (assumed)	NA	U	U
Early Juveniles	U	U	All year	U	U	U	U	U
Late Juveniles	Up to 11 years	U	U	ICS, MCS, OCS	D	CB, R, G	U	Observed associated with *Primnoa* coral
Adults	11 up to 51-59 years.	Euphausiids	U, except that larval release may be in the spring in the GOA	OCS, USP	D,	CB, R, G	U	Observed associated with large vase-type sponges

1.2.5 Additional Sources of Information

Eggs, Larvae, and Juveniles: None at present.

Adults: Rebecca Reuter, c/o NMFS, Alaska Fisheries Science Center, REFM Division.

1.2.6 Literature

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Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-29 and E-35 Dusky rockfish (larvae, adults)

Figure E-29
GOA Rockfish Larval Presence

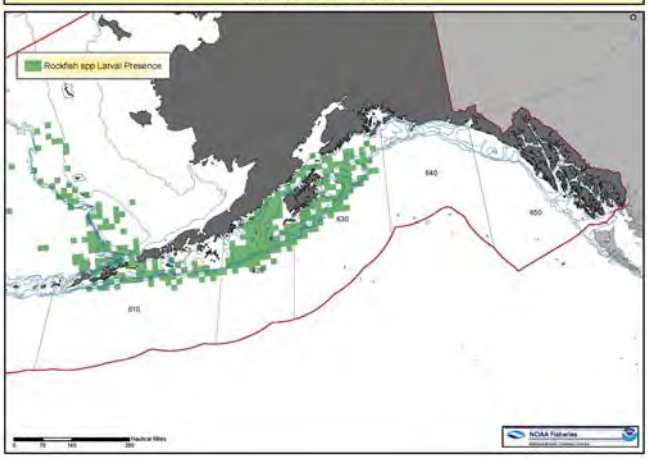
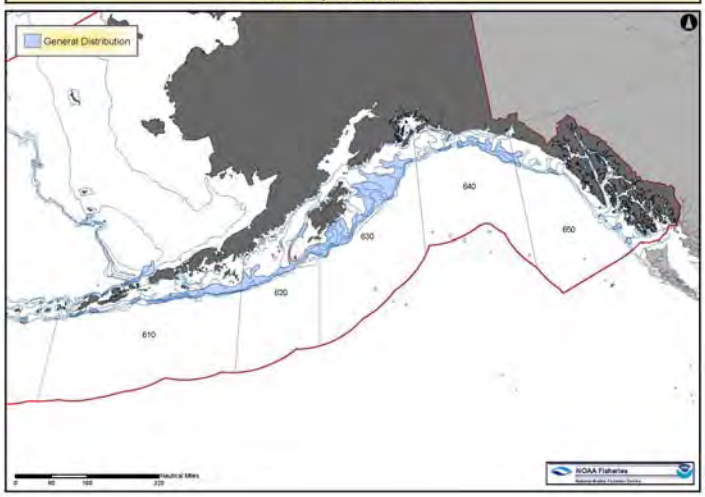


Figure E-35
GOA Dusky Rockfish Adults



1.2.7 Evaluation of Effects on EFH of Groundfish Species

Pelagic Shelf Rockfish (GOA)

Issue	Evaluation
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Growth to Maturity	U (Unknown effect)
Feeding	MT (Minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of dusky rockfish are either unknown or negligible; however, caution is warranted. There is some information to suggest that bottom trawling may have a negative impact on the benthic habitat, especially corals and sponges. The LEI analysis indicates that there is a potential for large reductions in living substrates and hard coral habitats that dusky rockfish inhabit. The potential loss of these habitats would likely not have an effect on spawning/breeding of dusky rockfish or their feeding behavior. Very little information is available on these aspects of their life history, however, and further investigation may prove otherwise. A reduction in living structure and hard corals may impede these fishes' ability to reach growth to maturity. Several observations have shown rockfish to be associated with sponges and coral. The extent of this association is largely unknown, though, but may be of significance if these substrates increase survival rates by acting as refugia to juveniles or adults. An age-structured model has recently been developed for dusky rockfish and indicates no obvious trends in recruitment or spawning biomass. Data for this model are limited, however, and recruitment in the years prior to 1977 is not known, making long-term effects difficult to detect.

Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? Y or N If yes, explain. YES I think that the map E-29 should have some indications in areas 640 and 650 for larval presence of rockfish. I know where we see juveniles but I think that Pat Maleca would have some ideas about the locations for larvae in those areas.

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2*)? No but I did change the early juvenile from an x to a 1 since we do see them and I added the same language for them in section 1.1.1.2

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future. I think the research that we are doing when we collect density information for the DSR stock assessment can also be useful for informing this work. Again, Pat Maleca of NMFS is doing relevant research on rockfish larvae that could inform this too.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority. I think more can be done regarding adult and juvenile fish associations with living habitats and also more can be done to identify larvae and their locations, do DSR larvae ever use eel grass beds like some other rockfish species do?

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Y or N Please explain. NO

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N If yes, list. This is hard to answer, but I think that the more dives we do the better idea we have of those places that are very special, (because of the overall make up of species and geology) or just very fishy or seem to be somehow isolated from other very fishy areas. One area seen once was particularly interesting because it was sort of flat but had lots of primnoa and this primnoa was providing structure and habitat in an otherwise

* EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

sort of flat silty area. Since there is no trawling in the EGOA this area might be just fine (unless the Fed trawl survey sweeps it!). I'm not sure I would suggest this area as a HAPC without further investigation and comparisons between it and other areas.

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain. Not at this time.

[Pulled from GOA Groundfish FMP, sections 4.2.2, 4.2.2.1, 4.2.2.2]GOA yelloweye rockfish

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Yelloweye rockfish	x	1	1	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

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1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Yelloweye Rockfish

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: EFH for larval yelloweye rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-29, General Distribution of Rockfish Larvae.

Early Juveniles: EFH for early juvenile Yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure E-34.

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Late Juveniles: EFH for late juvenile Yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure E-34.

Adults: EFH for adult Yelloweye rockfish is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner shelf (0 to 50 m), middle shelf (50 to 100 m), outer shelf (100 to 200 m) and upper slope (200 to 500 m) throughout the GOA wherever there are substrates of rock and in areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges, as depicted in Figure E-34.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA yelloweye rockfish

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Yelloweye Rockfish	M					x	x	x	x	x						x	x								x			
	LJ					x	x	x								x	x								x			
	EJ					x	x	x								x	x								x			
	L					x	x																	x	x	x		
	E																											

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GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Yelloweye Rockfish	M	x							x									x	x
	LJ	x																	x
	EJ	x																	x
	L	x																	x
	E																		

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA yelloweye rockfish

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Yelloweye Rockfish	M					X	x			x			x		x											
	LJ					X	x			x			x		x											
	EJ					X	x			x			x		x											
	L					X	x			x																
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Yelloweye Rockfish	M	22		18			x		x											x	x	x	x					

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA yelloweye rockfish

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock
Yelloweye Rockfish	M																	X		X	X		X				X			
	LJ																													
	EJ										X																			
	L																													
	E																													

GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrestrial Mammals
Yelloweye Rockfish	M						X			X	X					X														
	LJ						X			X	X					X														
	EJ																													
	L																													
	E																													

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1.2 Yelloweye rockfish *(Sebastes ruberrimus)* and other demersal rockfishes

Yelloweye rockfish (primary, described below), *Sebastes ruberrimus*

Quillback rockfish, *Sebastes maliger*

Rosethorn rockfish, *Sebastes helvomaculatus*

Tiger rockfish, *Sebastes nigrocinctus*

Canary rockfish, *Sebastes pinniger*

China rockfish, *Sebastes nebulosus*

Copper rockfish, *Sebastes caurinus*

1.2.1 Life History and General Distribution

These species are distributed from Ensendada, northern Baja California to Umnak Island and Unalaska Island, Aleutians in depths from 60 to 1,800 feet but commonly in 300 to 600 feet in rocky, rugged habitat (Allen and Smith 1988, Eschmeyer et al. 1983). Little is known about the young of the year and settlement. Young juveniles between 2.5 and 10 cm have been observed in areas of high and steep relief, in depths deeper than 15 m. Subadult and adult fish are generally solitary, occurring in rocky areas and high relief with refuge space, particularly overhangs, caves and crevices (O'Connell and Carlile 1993). Yelloweye are ovoviviparous. Parturition occurs in southeast Alaska between April and July with a peak in May (O'Connell 1987). Fecundity ranges from 1,200,000 to 2,700,000 eggs per season (Hart 1942, O'Connell unpublished data). Yelloweye feed on a variety of prey, primarily fishes (including other rockfishes, herring, and sandlance) as well as caridean shrimp and small crabs. Yelloweye are a K-selected species with late maturation, slow growth, extreme longevity, and low natural mortality. They reach a maximum length of about 91 cm and growth slows considerably after age 30. Approximately 50 percent of females are mature at 45 cm and 22 years. Age of 50 percent maturity for males is 18 years and length is 43 cm . Natural mortality (M) is estimated to be 0.02, and maximum age published is 118 years (O'Connell and Fujioka 1991, O'Connell and Funk 1987). However a 121 year old specimen was harvested in the commercial fishery off Southeast Alaska in 2000 (Southeast Alaska Groundfish Project , Alaska Department of Fish and Game, unpublished data).

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1.2.2 Fishery

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Demersal shelf rockfish are the target of a directed longline fishery and are the primary bycatch species in the longline fishery for Pacific halibut. They recruit into the fishery at about age 18 to 20 at a length between 45 and 50 cm. The commercial fishery grounds are usually areas of rocky bottom with varying degrees of vertical relief in water depths between 20 and 100 fm. The directed fishery now occurs between November and March both because of higher winter prices and limitations imposed due to the halibut IFQ regulations.

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1.2.3 Relevant Trophic Information

Yelloweye rockfish eat a large variety of organisms, primarily fishes included small rockfishes, herring and sandlance as well as caridean shrimp and small crabs (Rosenthal et al 1988). They also opportunistically consume lingcod eggs. Young rockfishes are in turn eaten by a variety of predators including lingcod, large rockfish, salmon, and halibut.

1.2.4 Habitat and Biological Associations

Young juveniles between 2.5 (1 inch) and 10 cm (4 inches) have been observed in areas of high relief. This relief can be provided by the geology of an area such as vertical walls, fjord-like areas, and pinnacles, or by large invertebrates such as cloud sponges, *Farrea occa*, *Metridium farcimen* and *Primnoa* coral. These observations were made in depths deeper than 13 m during the course of submersible research in the Eastern Gulf of Alaska (Southeast Alaska Groundfish Project , Alaska Department of Fish and Game, unpublished data). Subadult (late juveniles) and adult fish are generally solitary, occurring in rocky areas and high relief with refuge spaces particularly overhangs, caves and crevices (O'Connell and Carlile 1993), and can co-occur with gorgonian corals (Krieger and Wing 2002). Not infrequently an adult yelloweye rockfish will cohabitate a cave or refuge space with a tiger rockfish. Habitat specific density data shows an increasing density with increasing habitat complexity: deep water boulder fields consisting of very large boulders have significantly higher densities than other rock habitats (O'Connell and Carlile 1993, O'Connell et al 2007). Although yelloweye do occur over cobble and sand bottoms, generally this is when foraging and often these areas directly interface with a rock wall or outcrop.

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Habitat and Biological Associations: Yelloweye Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	na							
Larvae	<6 mo	Copepod	Spring/ Summer	U	N?	U	U	
Early Juveniles	to 10 years	U		ICS, MCS, OCS, BAY, IP	D	R, C	U	
Late Juveniles	10 to 18 years	U		ICS, MCS, OCS, BAY, IP	D	R, C	U	
Adults	At least 118 years	Fish, shrimp, crab	Parturition: Apr-Jul	ICS, MCS, OCS, USP, BAY, IP	D	R, C, CB	U	

Habitat and Biological Associations: Other Rockfishes.

Species	Range/Depth	Maximum Age	Trophic	Parurition	Known Habitat
Quillback	Kodiak Island to San Miguel Island, CA To 274 m (commonly 12-76 m)	At least 32 50 percent SM=30 cm	Main prey = crustaceans, herring, Sandlance	Spring (Mar-Jun)	Juveniles have been observed at the margins of kelp beds, adults occur over rock bottom, or over cobble/sand next to reefs
Copper	Shelikof St to central Baja, CA Shallow to 183 m (commonly to 122 m)	At least 31 years 50 percent SM=5 yr	Crustaceans Octopi Small fishes	Mar-Jul	Juveniles have been observed near eelgrass beds and in kelp, in areas of mixed sand and rock. Adults are in rocky bays and shallow coastal areas, generally less exposed than the other DSR
Tiger	Kodiak Is and Prince William Sound to Tanner-Cortes Banks, CA From 33 to 183 m	To 116 years	Invertebrates, primarily crustaceans	Early spring	Juveniles and adults in rocky areas: most frequently observed in boulder areas, generally under overhangs.
China	Kachemak Bay to San Miguel Island, CA To 128 m	To 72 years	Invertebrates, Brittle stars are significant component of diet	Apr-Jun	Juveniles have been observed in shallow kelp beds, adults in rocky reefs and boulder fields. Some indications that adults have a homesite.
Rosethorn	Kodiak Is to Guadalupe Is, Baja, CA To 25 m to 549 m	To 87 years Mature 7-10 years		Feb-Sept (May)	Observed over rocky habitats and in rock pavement areas with large sponge cover
Canary	Shelikof St to Cape Colnett, Baja, CA To 424 m (commonly to 137 m)	To 75 years 50 percent sm = 9	Macroplankton and small fishes		Occur over rocky and sand/cobble bottoms, often hovering in loose schools over soft bottom near rock outcrops. Schools often associate with schools of yellowtail and silvergrey.

1.2.5 Additional Sources of Information

NMFS, Alaska Fisheries Science Center.

1.2.6 Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and Northeast pacific. NOAA Tech. Rep. NMFS 66. Seattle.

Eschmeyer, W.N., E.S. Herald, and H. Hammann. 1983. A field guide to Pacific fishes of North America from the Gulf of Alaska to Baja California. Boston: Houghton Mifflin.

Hart, J.L. 1942. New Item. Red snapper fecundity. Fish. Res. Board. Can. Pac. Progr. Rep. 52: 18.

Krieger, K.J. and B.L. Wing. 2002. Megafauna associations with deepwater corals (Primnoa spp.) in the Gulf of Alaska. Hydrobiologia. Vol. 471 (1-3): 83-90.

O'Connell, V.M. 1987. Reproductive seasons for some Sebastes species in southeast Alaska. Alaska Department of Fish and Game Information Leaflet No. 263. Juneau, AK.

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O'Connell, V.M., and D.C Carlile. 1993. Habitat-specific density of adult yelloweye rockfish Sebastes ruberrimus in the eastern GOA. Fishery Bull. 91:304-309.

O'Connell, V.M., and J.T. Fujioka. 1991. Demersal Shelf Rockfishes. In Loh-Lee Low (ed.), Status of living marine resources off Alaska as assessed in 1991, p. 46-47. NOAA Tech. Memo. NMFS F/NWC-211, Northwest Fish. Sci. Cent., Auke Bay AK 95 P.

O'Connell, V.M., and F.C. Funk. 1987. Age and growth of yelloweye rockfish (Sebastes ruberrimus) landed in southeast Alaska. In B.R. Melteff (ed.), Proceedings of the International Rockfish Symposium. p 171-185. Alaska Sea Grant Report No. 87-2.

O'Connell, V.M., C.K. Brylinsky, and H.G. Greene. 2007. The use of geophysical survey data in fisheries management: a case history from Southeast Alaska. In Mapping the Seafloor for Habitat Characterization. p 319-328. Geological Association of Canada Special paper 47.

Rosenthal, R.J., V. Moran-O'Connell, and M.C. Murphy. 1988. Feeding ecology of ten species of rockfishes (Scorpaenidae) from the GOA. Calif. Fish and Game 74(1):16-37.

[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] **GOA yelloweye rockfish**

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-29 and E-34 Yelloweye rockfish (larvae, late juveniles, early juveniles and adults)

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Figure E-29
GOA Rockfish Larval Presence

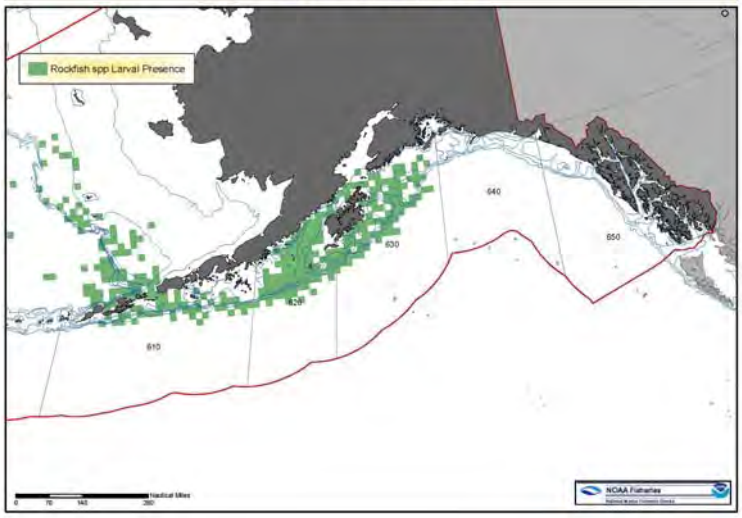
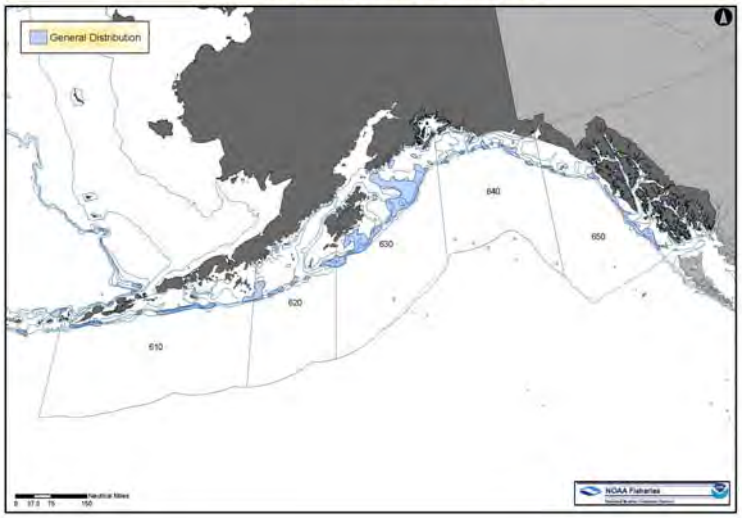


Figure E-34
GOA Yelloweye Rockfish Late Juveniles/Adults



[Pulled from Appendix F.1.5, GOA Groundfish FMP, effects on EFH] GOA yelloweye rockfish

1.2.7 Evaluation of Effects on EFH of Groundfish Species

[NOTE: There is no entry in this section of the GOA FMP for yelloweye rockfish or demersal shelf rockfish. Such an entry may need to be created. The entry for GOA PSR is included as an example only.]

Pelagic Shelf Rockfish (GOA)

Issue	Evaluation
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Growth to Maturity	U (Unknown effect)
Feeding	MT (Minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of dusky rockfish are either unknown or negligible; however, caution is warranted. There is some information to suggest that bottom trawling may have a negative impact on the benthic habitat, especially corals and sponges. The LEI analysis indicates that there is a potential for large reductions in living substrates and hard coral habitats that dusky rockfish inhabit. The potential loss of these habitats would likely not have an effect on spawning/breeding of dusky rockfish or their feeding behavior. Very little information is available on these aspects of their life history, however, and further investigation may prove otherwise. A reduction in living structure and hard corals may impede these fishes' ability to reach growth to maturity. Several observations have shown rockfish to be associated with sponges and coral. The extent of this association is largely unknown, though, but may be of significance if these substrates increase survival rates by acting as refugia to juveniles or adults. An age-structured model has recently been developed for dusky rockfish and indicates no obvious trends in recruitment or spawning biomass. Data for this model are limited, however, and recruitment in the years prior to 1977 is not known, making long-term effects difficult to detect.

Worksheet – species-specific determinations on whether EFH needs to be changed

GOA Thornyheads

1. EFH Description Update

Does new information warrant change to the EFH text description **Y** (Y or N) or the EFH distribution maps by life stage? **N** Y or N If yes, explain. **There is updated information from recently published studies.**

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Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2*)? **Yes, early juveniles from "x" to "1".**

Comment [sl1]: The table in the text does not utilize the 4 information levels listed in the footnote. It only uses an "x" for insufficient or "1" for sufficient information to describe EFH.

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here. **N**

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.
Highest research priority is age and growth studies

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. **N** See item #4 in section B of instructions. **. The text and conclusions are still appropriate.**

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list. **N**

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain. **N**

* EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Thornyhead rockfish	x	1	1	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

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1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Thornyhead Rockfish

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: EFH for larval thornyhead rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-29, General Distribution of Rockfish Larvae.

Early Juveniles: EFH for early juvenile thornyhead rockfish is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA, as depicted in Figure E-29, General Distribution of Rockfish Larvae.

Deleted: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile thornyhead rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) throughout the GOA wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure E-33.

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Adults: EFH for adult Thornyhead rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the middle and outer shelf (50 to 200 m) and upper to lower slope (200 to 1,000 m) throughout the GOA wherever there are substrates of mud, sand, rock, sandy mud, muddy sand, cobble, and gravel, as depicted in Figure E-33.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA thornyheads

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Thornyhead Rockfish	M								x	x	x	x	x												x			
	LJ						x	x	x																x			
	EJ																									x		
	L																									x		
	E																									x		

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Thornyhead Rockfish	M							x		x								x	x
	LJ							x		x									x
	EJ																		
	L																		
	E																		

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA thornyheads

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
bThornyhead Rockfish	M							x																		
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Thornyhead Rockfish	M	21.5 cm							x		x									x	x	x	x					

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA thornyheads

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock
Thornyhead Rockfish	M				X					X								X		X										
	LJ				X					X								X		X										
	EJ																													
	L																													
	E																													

Deleted: x

GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Thornyhead Rockfish	M														X															
	LJ														X															
	EJ																													
	L																													
	E																													

1.2 Thornyhead Rockfish *(Sebastolobus spp.)*

1.2.1 Life History and General Distribution

Thornyheads of the northeastern Pacific Ocean comprise two species, the shortspine thornyhead (*Sebastolobus alascanus*) and the longspine thornyhead (*S. altivelis*). The longspine thornyhead is not common in the GOA. The shortspine thornyhead is a demersal species which inhabits deep waters from 17 to 1,524 m along the Pacific rim from the Seas of Okhotsk and Japan in the western north Pacific, throughout the Aleutian Islands, Bering Sea slope and Gulf of Alaska, and south to Baja California. This species is common throughout the GOA, EBS and AI. The population structure of shortspine thornyheads, however, is not well defined. Thornyheads are slow-growing and long-lived with maximum age in excess of 50 years and maximum size greater than 75 cm and 2 kg. Shortspine thornyhead spawning takes place in the late spring and early summer, between April and July in the Gulf of Alaska Thornyheads spawn a bi-lobed mass of fertilized eggs which floats in the water column. Juvenile shortspine thornyheads have an extended pelagic period of about 14 to 15 months and settle out at about 22 to 27 mm into relatively shallow benthic habitats between 100 and 600 m and then migrate deeper as they grow. Fifty percent of female shortspine thornyheads are sexually mature at about 21.5 cm.

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Deleted: Thornyheads spawn buoyant masses of eggs during the late winter and early spring that resemble bilobate "balloons" which float to the surface.

Deleted: and 12 to 13 years of age.¶ Female shortspine thornyheads appear to be mature at about 21 to 22 cm.

1.2.2 Fishery

Trawl and longline gear are the primary methods of harvest. The bulk of the fishery occurs in late winter or early spring through the summer. In the past, this species was seldom the target of a directed fishery. Today thornyheads are one of the most valuable of the rockfish species, with most of the domestic harvest exported to Japan. Despite their high value, they are still managed using a "bycatch only" fishery status in the Gulf of Alaska because they are nearly always taken in fisheries directed at sablefish (*Anoplopma fimbria*) and other rockfish (*Sebastes* spp.). The incidental catch of shortspine thornyheads in these fisheries has been sufficient to capture a substantial portion of the thornyhead quota established in recent years, so directed fishing on shortspine thornyheads exclusively is not permitted. Although the thornyhead fishery is conducted operationally as a "bycatch" fishery, the high value and desirability of shortspine thornyheads means they are still considered a "target" species for the purposes of management.

Deleted: Thornyheads are taken with some frequency in the longline fishery for sablefish and cod and is often part of the bycatch of trawlers concentrating on pollock and Pacific ocean perch.

1.2.3 Relevant Trophic Information

Shortspine thornyheads prey mainly on epibenthic shrimp and fish. Yang (1993, 1996) showed that shrimp were the top prey item for shortspine thornyheads in the GOA; whereas, cottids were the most important prey item in the AI region. Differences in abundance of the main prey between the two areas might be the main reason for the observed diet differences. Shortspine thornyheads are consumed by a variety of piscivores, including arrowtooth flounder, sablefish, "toothed whales" (sperm whales), and sharks. Juvenile shortspine thornyheads are thought to be consumed almost exclusively by adult thornyheads.

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Deleted: Predator size might by another reason for the difference since the average shortspine thornyhead in the AI area was larger than that in the GOA (33.4 cm vs 29.7 cm).

1.2.4 Habitat and Biological Associations

Egg/Spawning: Eggs float in masses of various sizes and shapes. Frequently the masses are bilobed with the lobes 15 cm to 61 cm in length, consisting of hollow conical sheaths containing a single layer of eggs in a gelatinous matrix. The masses are transparent and not readily observed in the daylight. Eggs are 1.2 to 1.4 mm in diameter with a 0.2 mm oil globule. They move freely in the matrix. Complete hatching time is unknown but is probably more than 10 days.

Larvae: Three day-old larvae are about 3 mm long and apparently float to the surface.

Deleted: It is believed that the larvae remain in the water column for about 14 to 15 months before settling to the bottom.

Juveniles: Juvenile shortspine thornyheads have an extended pelagic period of about 14 to 15 months and settle out at about 22 to 27 mm into relatively shallow benthic habitats between 100 and 600 m and then migrate deeper as they grow.

Deleted: Very little information is available regarding the habitats and biological associations of juvenile shortspine thornyheads

Adults: Adults are demersal and can be found at depths ranging from about 90 to 1,500 m. Once in benthic habitats thornyheads associate with muddy substrates, sometimes near rocks or gravel, and distribute themselves evenly across this habitat, appearing to prefer minimal interactions with individuals of the same species. They have very sedentary habits and are most often observed resting on the bottom in small depressions. Groundfish species commonly associated with thornyheads include: arrowtooth flounder (Atheresthes stomias), Pacific ocean perch (Sebastes alutus), sablefish (Anoplopoma fimbria), rex sole (Glyptocephalus zachirus), Dover sole (Microstomus pacificus), shortraker rockfish (Sebastes borealis), rougheye rockfish (Sebastes aleutianus), and grenadiers (family Macrouridae).

Deleted: Two congeneric thornyhead species, the longspine thornyhead (Sebastolobus altivelis) and a species common off of Japan, S. Macrochir, are infrequently encountered in the GOA.

Habitat and Biological Associations: Thornyhead Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	U	Spawning: Late winter and early spring	U	P	U	U	
Larvae	<15 Months	U	Early spring through summer	U	P	U	U	
Juveniles	14-15 months in pelagic phase > 15 months when settling to bottom occurs (?)	U Shrimp, Amphipods, Mysids, Euphausiids?	U	MCS, OCS, USP	D	M, S, R, SM, CB, MS, G	U	
Adults	U	Shrimp Fish (cottids), Small crabs	Year-round	MCS, OCS, USP, LSP	D	M, S, R, SM, CB, MS, G	U	

Deleted: MCS, OCS, USP, LSP

Deleted: M, S, R, SM, CB, MS, GU

Deleted: Year-round?

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1.2.5 Additional Sources of Information

NMFS, Alaska Fisheries Science Center.

1.2.6 Literature

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Archibald, C.P., W. Shaw, and B.M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B.C. coastal waters, 1977-79. Can. Tech. Rep. Fish. Aquat. Sci. 1048, 57 p.

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Cooper, D.W., K.E. Pearson, and D.R. Gunderson. 2005. Fecundity of shortspine thornyhead (*Sebastolobus alascanus*) and longspine thornyhead (*S. altivelis*) (Scorpaenidae) from the northeastern Pacific Ocean, determined by stereological and gravimetric techniques. Fish Bull 103: 15-22.

Gunderson, D.R. 1997. Trade-off between reproductive effort and adult survival in oviparous and viviparous fishes. Canadian Journal of Fisheries and Aquatic Science 54: 990-998.

Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1996. Slope rockfish. In Stock assessment and fishery evaluation report for the groundfish resources of the GOA, p. 230-270. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Ianelli, J.N., D.H. Ito, and M. Martin. 1996. Thornyheads (Sebastolobus sp.). In Stock Assessment and fishery evaluation report for the groundfish resources of the GOA, p. 303-330. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Jacobson, L.D. 1993. Thornyheads. In Status of living marine resources off the Pacific coast of the United States for 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-26, 35-37 p.

Kastelle, C.R., D.K. Kimura, and S.R. Jay. 2000. Using 210Pb/226Ra disequilibrium to validate conventional ages in Scorpaenids (genera Sebastes and Sebastolobus). Fisheries Research 46: 299-312.

Kline, D.E. 1996. Radiochemical age verification for two deep-sea rockfishes Sebastolobus altivelis and S. alascanus. M.S. Thesis, San Jose State University, San Jose CA, 124 pp.

Kramer, D.E., and V.M. O'Connell. 1986. Guide to northeast Pacific rockfishes, Genera Sebastes and Sebastolobus. Marine Advisory Bulletin No. 25: 1-78. Alaska Sea Grant College Program, University of Alaska.

Low, L.L. 1994. Thornyheads. In Status of living marine resources off Alaska, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-27, 56-57 p.

Love, M.S., M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the northeast Pacific. University of California Press, Berkeley CA, 405 p.

Love, M.S., C.W. Mecklenberg, T.A. Mecklenberg, and L.K. Thorsteinson. 2005. Resource inventory of marine and estuarine fishes of the West Coast and Alaska: a checklist of north Pacific and Arctic Ocean species from Baja California to the Alaska-Yukon Border. U.S. Department of the Interior, U.S. Geological Survey, Biological Resources Division, Seattle, Washington, 98104, OCS Study MMS 2005-030 and USGS/NBII 2005-001.

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Pearson, K.E., and D.R. Gunderson, 2003. Reproductive biology and ecology of shortspine thornyhead rockfish (*Sebastolobus alascanus*) and longspine thornyhead rockfish (*S. altivelis*) from the northeastern Pacific Ocean. Environ. Biol. Fishes 67:11-136.Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on

research survey and commercial catch data, 1912-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M-S. 1996. Diets of the important groundfishes in the AI in summer 1991. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-29 and E-33 Thornyhead rockfish (larvae, late juveniles/adults)

Figure E-29
GOA Rockfish Larval Presence

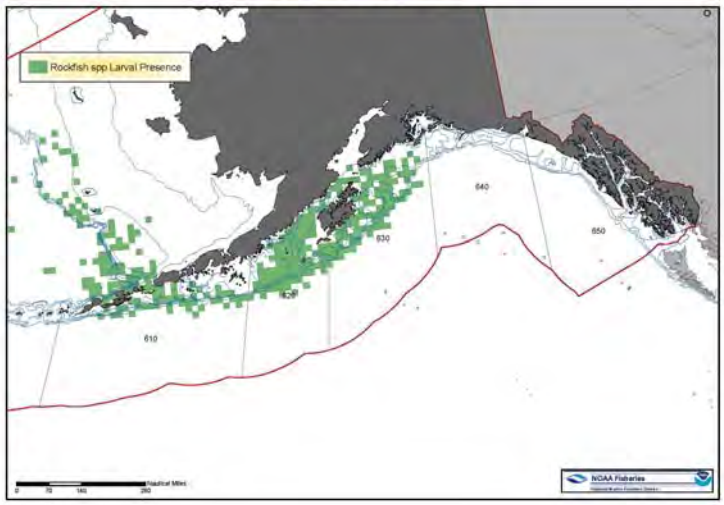
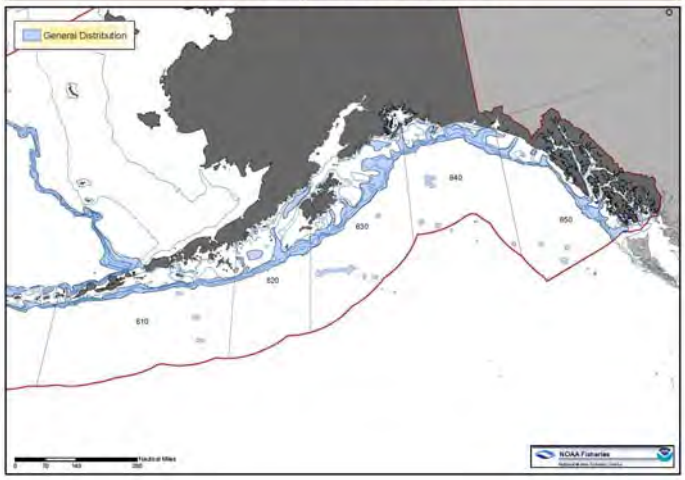


Figure E-33
GOA Thornyhead Rockfish Late Juveniles/Adults



1.2.7 Evaluation of Effects on EFH of Groundfish Species

Thornyhead Rockfish (GOA)

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)

GOA thornyhead eggs are presumed to be associated with pelagic habitats based on observations off the West Coast. GOA juveniles and adults are also associated with benthic habitats; specifically, on the deep shelf and slope in any type of non-living substrate, but they may prefer hard, non-living substrate according to limited studies in the eastern GOA. Overall, the GOA deep shelf and slope habitats comprise 33 and 22 percent, respectively, of the area designated as the thornyhead concentration distribution within the GOA (Table B.3-3 of the EFH EIS). Of this 33 and 22 percent, 1 percent of the non-living substrate within the deep shelf and slope GOA habitat is projected to be reduced under status quo (Table B.3-3 of the EFH EIS). It is assumed that this would have a negligible impact. Therefore, the ratings for the effects of spawning/breeding and growth to maturity for GOA thornyheads are no effect. The adults feed mainly on epibenthic shrimp and other benthic organisms which are included in epifaunal and infaunal features and are projected to be reduced by 1 percent in each habitat. It is assumed that the 1 percent reduction of epifauna and infauna within the GOA shallow and deep shelf habitats occupied by thornyheads would not have an impact and the rating for feeding is also no effect.

Worksheet – species-specific determinations on whether EFH needs to be changed

GOA Atka mackerel

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) **Y** or the EFH distribution maps by life stage? **N** Y or N If yes, explain. **There is updated information from several studies recently published.**

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2*)? **Yes, eggs from "x" to "1".**

Comment [sl1]: The table in the text does not utilize the 4 information levels listed in the footnote. It only uses an "x" for insufficient or "1" for sufficient information to describe EFH.

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here. **N**

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

- Studies to determine whether there have been any changes in life history parameters over time (e.g. maturity-at-age, fecundity, weight- and length-at-age)
- Studies to determine the impacts of environmental indicators such as temperature regime on Atka mackerel
- Information on Atka mackerel habitat preferences is needed to improve our understanding of Essential Fish Habitat (EFH), and improve our assessment of the impacts to habitat due to fishing
- Better habitat mapping of the Gulf of Alaska would provide information for survey stratification and the extent of trawlable and untrawlable habitat.
- Regional and seasonal food habits data for Gulf of Alaska Atka mackerel

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4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? **N** Explain. **The text and conclusions are still appropriate.** See item #4 in section B of instructions.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? **N** Y or N. If yes, list.

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? **N** Explain.

* EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Atka mackerel	1	1	x	x	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

Deleted: x

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Atka Mackerel

Eggs: Some nesting sites in the GOA have been identified. There is general distribution data available, but it is not complete for the entire GOA.

Deleted: No EFH Description Determined. Insufficient information is available

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Larvae: EFH for larval atka mackerel is the general distribution area for this life stage, located in epipelagic waters along the shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the GOA, as depicted in Figure E-36.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: No EFH Description Determined. Insufficient information is available.

Adults: EFH for adult Atka mackerel is the general distribution area for this life stage, located in the entire water column, from sea surface to the sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the GOA wherever there are substrates of gravel and rock and in vegetated areas of kelp, as depicted in Figure E-37.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Atka mackerel**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Atka Mackerel	M					x	x	x	x							x							x	x	x			
	J																					x	x					
	L																					x	x					
	E					x	x	x								x									x			

GOA Groundfish	Physical Oceanography					Substrate												
Species	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
Atka Mackerel	x			x	x			x	x								x	x
									x								x	x

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Atka mackerel**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Atka Mackerel	M								x							x			x					3-5	>17	
	J																							3-12		
	L																							2-12		
	E																		x					3-10		

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Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																										
		Age at Maturity (unless otherwise noted)				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
Atka Mackerel	M	3.6		3.6		x					x			x	x							x	x	x	x	x		

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA Atka mackerel**

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Atka Mackerel	M							X			X													X							
	J							X			X																				
	L										X																				
	E																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Atka Mackerel	M								X						X	X		X	X	X	X			X						
	J																	X		X						X	X			
	L																													
	E																													

1.2 Atka mackerel

1.2.1 Life History and General Distribution

Atka mackerel are distributed from the GOA to the Kamchatka Peninsula, and they are most abundant along the Aleutians. Adult Atka mackerel occur in large localized aggregations usually at depths less than 200 m and generally over rough, rocky, and uneven bottom near areas where tidal currents are swift. Associations with corals and sponges have been observed for AI Atka mackerel. Adults are semi-demersal, displaying strong diel behavior with vertical movements away from the bottom occurring almost exclusively during the daylight hours, presumably for feeding, and little to no movement at night. Spawning is demersal in moderately shallow waters (down to bottom depths of 144 m) and peaks in June through September, but may occur intermittently throughout the year. Female Atka mackerel deposit eggs in nests built and guarded by males on rocky substrates or on kelp in shallow water. Eggs develop and hatch at depth in 40 to 45 days, releasing planktonic larvae that have been found up to 800 km from shore. Little is known of the distribution of young Atka mackerel before their appearance in trawl surveys and the fishery at about age 2 to 3 years. R-traits are as follows: young age at maturity (approximately 50 percent are mature at age 3.6), fast growth rates, high natural mortality (M=0.3), and young average and maximum ages (about 5 and 14 years, respectively). K-selected traits indicate low fecundity (only about 30,000 eggs/female/year, large egg diameters (1 to 2 mm) and male nest-guarding behavior).

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The approximate upper size limit of juvenile fish is estimated at 35 cm.

1.2.2 Fishery

The directed fishery is conducted with bottom trawls in the Aleutian Islands, at depths between about 70 to 300 m, in trawlable areas on rocky, uneven bottom, along edges, and in the lee of submerged hills during periods of high current. The fishery generally catches fish ages 3-11 years old. Currently, the fishery occurs on reefs west of Kiska Island, south and west of Amchitka Island, in Tanaga Pass and near the Delarof Islands, and south of Seguam and Umnak Islands. Historically the fishery occurred east into the GOA as far as Kodiak Island (through the mid-1980s), but is no longer conducted there. Directed fishing for Atka mackerel in the Gulf of Alaska is prohibited by Steller sea lion protection measures. Atka mackerel are taken as bycatch in the in the Shumagin (610) and Kodiak (620) areas in the rockfish fisheries.

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1.2.3 Relevant Trophic Information

Atka mackerel are important food for Steller sea lions in the AI, particularly during summer, and for other marine mammals (minke whales, Dall's porpoise, and northern fur seals). Juveniles are eaten by thick billed murres, tufted puffins, and short-tailed shearwaters. The main groundfish predators are Pacific halibut, arrowtooth flounder, and Pacific cod. Adult Atka mackerel consume a variety of prey, but principally calanoid copepods and euphausiids. Predation on Atka mackerel eggs by cottids and other hexagrammids is prevalent during the spawning season as is cannibalism by other Atka mackerel.

1.2.4 Habitat and Biological Associations

Egg/Spawning: Adhesive eggs are deposited in nests built and guarded by males on rocky substrates or on kelp in moderately shallow water.

Larvae/Juveniles: Planktonic larvae have been found up to 800 km from shore, usually in the upper water column (neuston), but little is known of the distribution of Atka mackerel until they are about 2 years old and start to appear in the fishery and surveys.

Adults: Adults occur in localized aggregations usually at depths less than 200 m and generally over rough, rocky, and uneven bottom near areas where tidal currents are swift. Associations with corals and sponges have been observed for AI Atka mackerel. Adults are semi-demersal/pelagic during much of the year, but the males become demersal during spawning; females move between nesting and offshore feeding areas.

Deleted: they migrate annually to moderately shallow waters where

Habitat and Biological Associations: Atka mackerel

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	40 to 45 days	NA	summer	IP,ICS, MCS	D	G,R,K, CB	U	develop 3-15°C optimum 3.9-10.5°C
Larvae	up to 6 mos	U copepods?	fall-winter	U	U N?	U	U	2-12°C optimum 5-7°C
Juveniles	½ to 2 years of age	U copepods & euphausiids?	all year	U	N	U	U	3-5°C
Adults	3+ years of age	copepods euphausiids meso-pelagic fish (myctophids)	Spawning (June-Oct) non-spawning (Nov-May) tidal/diurnal, year-round?	ICS, and MCS, IP MCS and OCS, IP ICS,MCS, OCS,IP	D (males) SD females SD/D all sexes D when currents high/day SD slack tides/night	G,R,CB ,K	F,E	3-5°C all stages ≥17 ppt only

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Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figures E-36 to E-37 Atka mackerel (larvae, adults)

Figure E-36
GOA Atka Mackerel Larval Presence

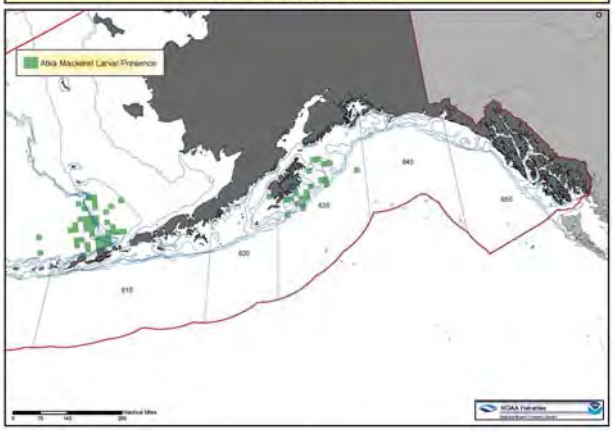
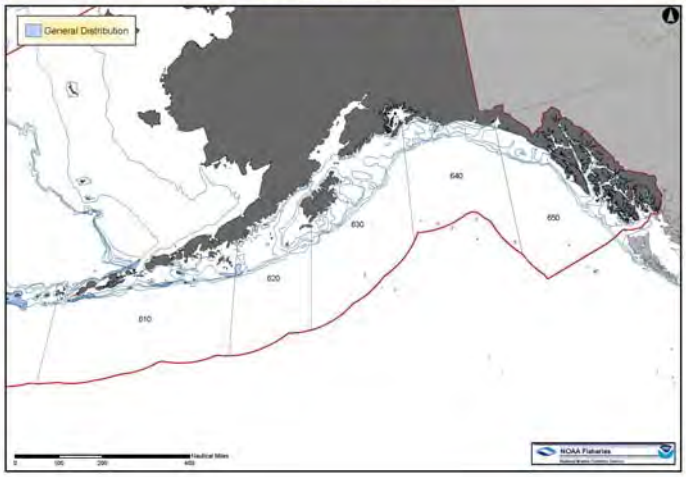


Figure E-37
GOA Atka Mackerel Adults



1.2.7 Evaluation of Effects on EFH of Groundfish Species

Atka Mackerel (BSAI and GOA)

Issue	Evaluation
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Growth to Maturity	MT (Minimal, temporary, or no effect)
Feeding	MT (Minimal, temporary, or no effect)

Summary of Effects—The effects of fishing on the habitat of Atka mackerel are considered to be minimal and temporary or negligible. Affected habitat areas may impact Atka mackerel, but environmental conditions may be the dominant factor affecting the Atka mackerel population, given the moderate exploitation levels since 1977. Environmental conditions since 1977 may favor Atka mackerel and override impacts of fishing on habitat features important to the species. Some information, however, suggests that bottom trawling may have a negative effect on the benthic habitat, especially corals and sponges. The LEI analysis indicates that there is a potential for large reductions in hard coral habitats, which intersect with Atka mackerel habitat, and Atka mackerel have been observed in association with sponges and corals. The extent and nature of the associations between AI Atka mackerel and living and non-living substrate and hard corals are largely unknown. If these are desirable habitat features for Atka mackerel, however, and there is a significant dependence on these features, the potential large reduction (more than 50 percent) in hard corals in many areas of the AI could be of concern. Overall the Atka mackerel stock is in relatively good condition and is currently at a high abundance level. There are no indications that the affected habitat areas that overlap with the distribution of Atka mackerel would impair the ability of the stock to produce MSY over the long term.

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There is some presumed overlap of the fishery with the distribution of Atka mackerel nesting sites, but the extent of the overlap with the spatial distribution of fishing impacted areas is likely to be low due a variety of factors. These factors include Steller Sea Lion protection measures, which likely afford protection to several Atka mackerel spawning grounds. Other spawning grounds that are not in closed areas, but that occur in untrawlable habitat, are also afforded protection. Summer resource assessment trawl surveys conducted biennially in the AI at the time of spawning provide a relative measure of abundance of the spawning biomass and have not detected a shift in the spatial distribution of biomass. To date, there is no evidence to suggest a link between habitat disturbance and the spawning/breeding success of AI Atka mackerel. There is also no evidence to suggest that habitat disturbance impairs the stock's ability to produce MSY over the long term through impacts on spawning/breeding success. Therefore, the impact of habitat disturbance on the spawning/breeding success of Atka mackerel is minimal and temporary.

There is no evidence to suggest a link between habitat disturbance and growth to maturity of AI Atka mackerel. There is also no evidence to suggest that habitat disturbance impairs the stock's ability to produce MSY over the long term through impacts on growth to maturity. Analyses of growth data do not indicate any detectable adverse impacts on the growth to maturity for Atka mackerel due to habitat disturbance. Therefore, the impact of habitat disturbance on the growth to maturity of Atka mackerel is minimal and temporary.

The adults feed mainly on pelagic euphausiids followed by calanoid copepods, which are not one of the affected habitat features. As euphausiids and copepods are pelagic rather than benthic in their distribution and are too small to be retained by any fishing gear, fishing probably has a minimal and/or temporary effect on the availability of prey to Atka mackerel. There is no evidence to suggest that the diet or feeding distributions of Atka mackerel have changed. Overall, there is no evidence that habitat

disturbance has affected feeding success of Atka mackerel. Therefore, the impact of habitat disturbance on the feeding success of Atka mackerel is minimal and temporary.

Stock assessment data do not show a negative trend in spawning biomass and recruitment or evidence of chronic low abundance and recruitment. There is no evidence that the cumulative effects of fishing activities on habitat have impaired the stock's ability to produce MSY since 1977. Spawning biomass is at a relatively high level. The stock has produced several years of above average recruitment since 1977, and recent recruitment has been strong.

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Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? **N**

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2*)?

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.

I added some background information, most of which is contained in the following SAFE document (I added it to the literature section).

Ormseth, O.A. and B. Matta. 2009. Gulf of Alaska Skates. In: Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska Region. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

Habitat needs for GOA skates have not been studied. In particular, it would be valuable to know whether there are nursery sites (where egg cases are deposited) similar to those that have been found in the BSAI. Also, we know nothing about movement of skates throughout the GOA.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions. **N**

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list. **N**

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain. **N**

* EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Skates	x	x	x	x	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Skates

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: No EFH Description Determined. Insufficient information is available.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: No EFH Description Determined. Insufficient information is available.

Adults: EFH for adult skates is the general distribution area for this life stage, located in the lower portion of the water column on the shelf (0 to 200 m) and the upper slope (200 to 500 m) throughout the GOA wherever there are of substrates of mud, sand, gravel, and rock, as depicted in Figure E-39.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA skates**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Skates	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x			
	LJ																											
	EJ																											
	L																											
	E																											

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Skates	M																		
	LJ																		
	EJ																		
	L																		
	E																		

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA skates**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Skates	M																									
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Skates	M						x	x					x															

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA skates

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Skates	M								X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	LJ																														
	EJ																														
	L																														
	E																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Skates	M																		X											
	LJ																													
	EJ																													
	L																													
	E																													

1.2 Skates (Rajidae)

The species representatives for skates are:

Alaska skate (*Bathyraja parmifera)*

Aleutian skate (*Bathyraja aleutica)*

Bering skate (*Bathyraja interrupta)*

1.2.1 Life History and General Distribution:

Skates (Rajidae) that occur in the BSAI and GOA are grouped into two genera: Bathyraja sp., or soft-nosed species (rostral cartilage slender and snout soft and flexible), and Raja sp., or hard-nosed species (rostral cartilage is thick making the snout rigid). Skates are oviparous; fertilization is internal, and eggs (one to five or more in each case) are deposited in horny cases for incubation. Adults and juveniles are demersal and feed on bottom invertebrates and fish. Big skates (Raja binoculata) and longnose skates (Raja rhina) are the most abundant skates in the GOA. Most of the biomass for these two species is located in the Central GOA (NMFS statistical areas 620 & 630). Their depth distributions from surveys are : big skates, primarily 0-100 m; longnose skates, primarily 100-200m although they are found at all depths shallower than 300m. Below 200 m depth, Bathyraja sp. Skates are dominant. Little is known of their habitat requirements for growth or reproduction, nor of any seasonal movements. BSAI skate biomass estimate more than doubled between 1982 to 1996 from bottom trawl survey; it may have decreased in the GOA and remained stable in the AI in the 1980s.

Approximate upper size limit of juvenile fish is unknown.

1.2.2 Fishery

Until 2003, skates were not a target of groundfish fisheries of BSAI or GOA, but were caught as bycatch (13,000 to 17,000 mt per year in the BSAI from 1992 to 1995; 1,000 to 2,000 mt per year in the GOA) principally by the longline Pacific cod and bottom trawl pollock and flatfish fisheries; almost all were discarded. Skate bycatches in the EBS groundfisheries ranged between 1 and 4 percent of the annual EBS trawl survey biomass estimates from 1992 to 1995.

Starting in 2003, a directed fishery for skates developed in the GOA centered around Kodiak Island. It is prosecuted primarily on longline vessels less than 60 feet long, with some additional targeting by trawlers using large mesh nets. The primary target species appeared to be *R. binoculata*, followed by *R. rhina*, but this is difficult to determine given that there is almost no observer coverage of the fishery. Directed fishing for skates has been prohibited in the GOA since 2005. There continues to be substantial incidental catch; the official 2008 estimate for all skates gulfwide was 2,351 t. There is also undocumented catch in the IFQ halibut fisheries.

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1.2.3 Relevant Trophic Information

Skates feed on bottom invertebrates (crustaceans, molluscs, and polychaetes) and fish.

1.2.4 Habitat and Biological Associations

Egg/Spawning: Skates deposit eggs in horny cases on shelf and slope.

Juveniles and Adults: After hatching, juveniles probably remain in shelf and slope waters, but distribution is unknown. Adults found across wide areas of shelf and slope; surveys found most skates at depths <500 m in the GOA and EBS, but >500 m in the AI. In the GOA, most skates found between 4-7°C, but data are limited.

Habitat and Biological Associations: Skates

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	na	U	MCS,OCS,USP	D	U	U	
Larvae	na	na	na	na	na	na	na	
Juveniles	U	Invertebrates small fish all year	MCS,OCS, USP	D	U	U		
Adults	U	Invertebrates small fish	all year	MCS,OCS,USP	D	U	U	

Deleted: Invertebrates¶ small fish

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1.2.5 Additional sources of information

NMFS, Alaska Fisheries Science Center, Olav A. Ormseth

1.2.6 Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the BS and Northeastern Pacific. U.S. Dep. Commerce., NOAA Tech. Rept. NMFS 66, 151 p.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

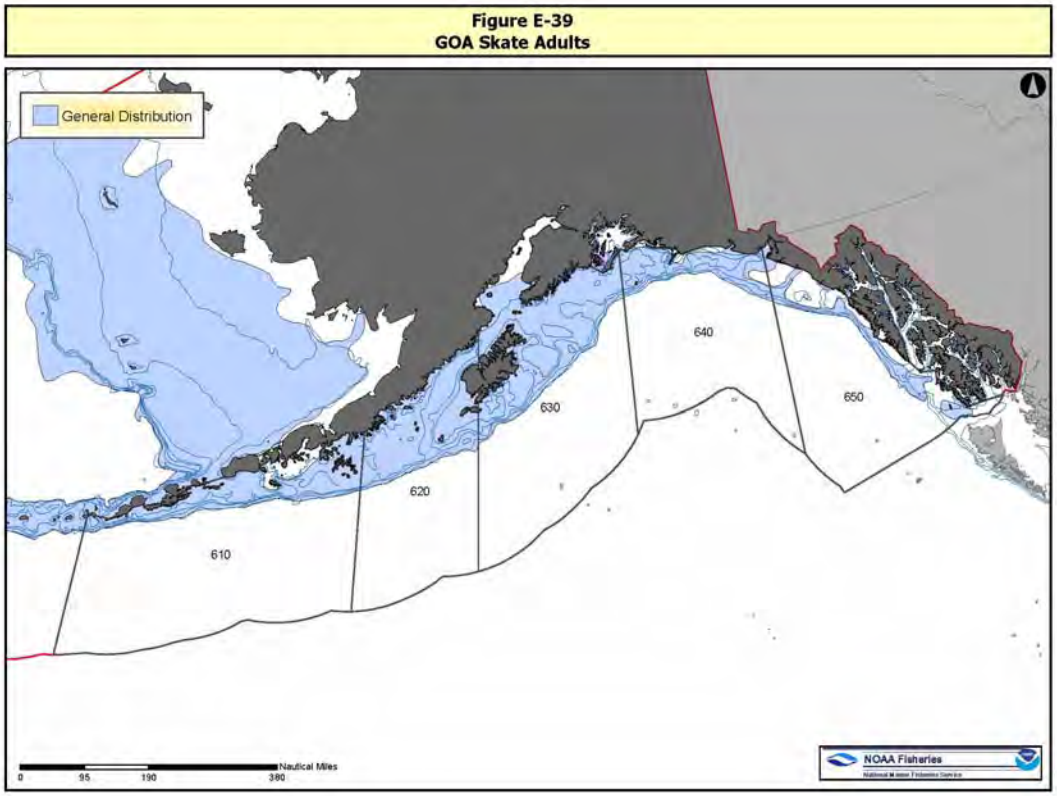
Ormseth, O.A. and B. Matta. 2009. Gulf of Alaska Skates. In: Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska Region. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Deleted:

Teshima, K., and T.K. Wilderbuer. 1990. Distribution and abundance of skates in the EBS, AI region, and the GOA. Pp. 257-267 *in* H.L. Pratt, Jr., S.H. Gruber, and T. Taniuchi (eds.)., Elasmobranchs as living resources: advances in the biology, ecology, systematics and the status of the fisheries. U.S. Dep. Commerce., NOAA Technical Report 90.

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figure E-39 Skates species (adults)



1.2.7 Evaluation of Effects on EFH of Groundfish Species

Squid and Other Species

While there was considerable new information to evaluate habitat effects for the major target groundfish species in Alaska, there were some species where information was either too sparse to evaluate, or simply did not exist. For other species, especially nontarget species such as skates, sculpins, sharks, squids, and octopi, growth information has not been collected historically, and species-specific catch per unit effort information may be unreliable. Information on nontarget species is improving, but it is currently insufficient to evaluate habitat specific impacts. For these reasons, the original evaluations for the following species groups presented in the DEIS still represent the best available information, despite extensive inquiry to improve upon it.

GOA Skates (two Raja species, Big and longnose skate, and 8-15 Bathyraja species)

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the GOA to determine whether fishing activities have an effect on the habitat of skates. Skates are benthic dwellers. The big skate, a new commercial species in the GOA, comprises just under half of the skate complex biomass in the GOA and is distributed mainly on the upper continental shelf. However, other skate species are found throughout that habitat as well. The diversity of the group increases with depth in the gullies within the continental shelf and along the outer continental shelf and slope. Therefore, any adverse affects to the shallow shelf habitat may influence the health of the big skate populations as well as other skate species, while any adverse affects to outer continental shelf and slope habitats may influence the health of multiple species of skates.

Worksheet – species-specific determinations on whether EFH needs to be changed (BSAI and) GOA Octopus

1. EFH Description Update

Does new information warrant change to the EFH text description or the EFH distribution maps by life stage?

No. There is still insufficient information to determine the general distribution of octopus species in the BSAI and GOA. A map of occurrence of octopus in observed hauls is provided in the stock assessment for informational purposes, but this map does not represent the general distribution of any species of octopus. A new "Field Guide to Squids and Octopods of the Eastern North Pacific and Bering Sea" by Elaina Jorgensen was published in August 2009. This volume has species-specific information and general distribution maps for individual species, but the scale of these maps is not sufficient for determination of EFH.

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2[*])? **No**

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.

Elaina W. Jorgensen. 2009. Field Guide to Squids and Octopods of the Eastern North Pacific and Bering Sea. Alaska Sea Grant SG-ED-65. 100 pp.

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

E; Jorgensen doctoral research with E. dofleini growth and development.

NPRB project 920 Conners, Conrath, & Brewer. Field studies to document reproductive seasons of E dofleini in Alaska and to develop octopus pot gear and tagging methods.

Ongoing observer program special project to collect individual weights and sex of octopus; for 2009, will also be testing vitality key for possible discard mortality,

Proposed research:

M.E. Conners & C. Conrath, Developing Octopus field Gear (NOAA CR)

D. Scheel, Discard mortality studies of pot-caught octopus (NOAA SK)

D. Scheel, Population genetics of *Enteroctopus dofleini* (NPRB)

B. Norcross, R. Brwer, and M.E. Conners, Octopus Tagging studies (NPRB)

3. Research and Information Needs

[*] EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

Is research needed or do data gaps exist? **Yes** Briefly explain and list in order of priority.

1) Life history: Because octopuses are semelparous, a better understanding of reproductive seasons and habits is needed to determine the best strategies for protecting reproductive output. Reproductive seasons and spawning habitat of *E dofleini* need to be identified for Alaskan waters. Life histories of other species need more information.

2) Seasonal movement: *E. dofleini* in Japan and off the US west coast reportedly undergo seasonal movements, but the timing and extent of migrations in Alaska is unknown. While many octopus move into shallower coastal waters for egg-laying, it is probable that at least some octopus reproduction occurs within federal waters.

3) State/Federal: The distribution of octopus biomass and extent of movement between federal and state waters is unknown and could become important if a directed state fishery develops. Tagging studies to determine seasonal and reproductive movements of octopus in Alaska would add greatly to our ability to appropriately manage commercial harvest.

4) Biomass Estimation: Fishery-independent methods for assessing biomass of the harvested size group of octopus are feasible, but would be species-specific and could not be carried out as part of existing multi-species surveys. Pot surveys are effective both for collecting biological and distribution data and as an index of abundance; mark-recapture methods have been used with octopus both to document seasonal movements and to estimate biomass and mortality rates. These methods would require either extensive industry cooperation or funding for directed field research. Factors determining year-to year patterns in octopus abundance are poorly understood. Octopus abundance is probably controlled primarily by survival at the larval stage; substantial year-to-year variations in abundance due to climate and oceanographic factors are expected. The high variability in trawl survey estimates of octopus biomass make it difficult to depend on these estimates for time-series trends; trends in CPUE from observed cod fisheries may be more useful.

5) Natural Mortality: Estimates of natural mortality rates for octopus would require species and region-specific field studies. Any stock assessment calculations would need to be based on natural mortality rates for adult octopus prior to spawning. Development of octopus-specific survey gear or tagging would be needed to perform such studies.

6) Growth: Field and laboratory studies to determine growth rates, age at maturity, and fecundity.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions.

No. There is still insufficient information to describe EFH and determine fishing effects.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list.

In BSAI, octopus appear as a significant component in the Ecopath model diet of Steller sea lions. Most retention of incidentally-caught octopus occurs in cod pot fisheries, which are often located in no-trawl zones to avoid gear conflicts. The SSL no-trawl zones around the north side of Akun Island, in particular, are a known area of intensive cod pot fishing and octopus bycatch, so have some potential for interaction of fisheries with SSLs. There is no evidence to suggest this area is particularly essential or ecologically important to octopus, it is more heavily fished than other areas primarily for reasons of proximity to processors. In the GOA, octopus show up in Ecopath models as important to the diet of some seals but not to SSL.

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain.

E. dofleini is widely spread throughout the BSAI and GOA and has pelagic larvae, and so are not likely to be sensitive to any localized fishing effects. The demersal larvae of other octopus species may be more sensitive but may occur primarily in deeper waters. At present there is not enough information to evaluate EFH for octopus.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Octopus	x	x	x	x	x

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Octopus

Eggs: No EFH Description Determined. Insufficient information is available.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: No EFH Description Determined. Insufficient information is available.

Adults: No EFH Description Determined. Insufficient information is available.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA octopus**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Octopus	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x				x	x	x	
	LJ																											
	EJ																											
	L																											
	E																											

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Octopus	M																		
	LJ																		
	EJ																		
	L																		
	E																		

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA octopus**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Octopus	M																									
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Octopus	M						x				x			x	x													

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA octopus**

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Octopus	M															X	X	X	X	X	X				X		X		X		X
	LJ																														
	EJ																														
	L																														
	E																														

GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Octopus	M							X	X	X	X					X	X	X	X	X		X								
	LJ																													
	EJ																													
	L																													
	E																													

1.2 Octopus

There are at least seven species of octopus currently identified from the Gulf of Alaska, including one species of genus *Octopus* that has not been fully described (*Octopus* sp. A, Jorgensen). The species most abundant at depths less than 200m is the giant Pacific octopus *Enteroctopus dofleini* (formerly *Octopus dofleini*). Several species are found primarily in deeper waters along the shelf break and slope, including, *Benthoctopus leioderma* and the cirrate octopus *Opisthoteuthis* cf *californiana*. ***Octopus californicus*** is reported from the eastern GOA at depths ranging from 100 to 1000m. *Japetella diaphana* and bathypelagic finned species ***Vampyroteuthis infernalis*** are found in pelagic waters of the Gulf of Alaska. Preliminary evidence (Jorgensen 2007, Conners et al 2004) indicates that octopus taken as incidental catch in groundfish fisheries are primarily *Enteroctopus dofleini*. This species has been extensively studied in British Columbia and Japan, and is used as the primary indicator for the assemblage. Species idendification of octopuses in the Bering Sea and Gulf of Alaska has changed since the previous EFH review and is still developing. The state of knowledge of octopuses in the GOA, including the true species composition, is very limited.

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1.2.1 Life History and General Distribution

Deleted: The species representatives for octopus are:¶
. Octopoda: . Octopus *(Octopus gilbertianus; O. dofleini*)¶
. Vampyromorpha: . Pelagic octopus (*Vampyroteuthis infernalis*) ¶

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Octopus are members of the molluscan class Cephalopoda, along with squid, cuttlefish and nautiloids. The octopuses (order Octopoda) have only eight appendages or arms and unlike other cephalopods, they lack shells, pens, and tentacles. There are two groups of Octopoda, the cirrate and the incirrate. The cirrate have cirri and are by far less common than the incirrate which contain the more traditional forms of octopus. Octopuses are found in every ocean in the world and range in size from less than 20 cm (total length) to over 3 m (total length); the latter is a record held by *Enteroctopus dofleini* (Wülker, 1910).

In the GOA octopuses are found from subtidal waters to deep areas near the outer slope. The highest diversity is along the shelf break region of the Gulf of Alaska, although, unlike the Bering Sea, there is a high abundance of octopuses on the shelf. While octopuses were observed throughout the GOA, they are more commonly observed in the Central and Western GOA (stat areas 610-630) than in the Eastern GOA. The greatest number of observations is clustered around the Shumagin Islands and Kodiak Island. These spatial patterns are influenced by the distribution of fishing effort. AFSC Survey data also show the presence of octopus throughout the GOA but also indicate highest biomass in areas 610 and 630. Octopuses were caught at all depths ranging from shallow inshore areas (mostly pot catches) to trawl and longline catches on the continental slope at depths to nearly 1000 meters. The majority of octopus caught with pots in the GOA came from 40-60 fathoms (70-110 meters); catches from longline vessels tended to be in deeper waters of 200-400 fathoms (360-730 meters). The distribution of octopuses between state waters (within three miles of shore) and federal waters remains unknown. *Enteroctopus dofleini* in Japan undergo seasonal depth migrations associated with spawning; it is unknown whether similar migrations occur in Alaskan waters.

In general, octopus life spans are either 1-2 years or 3-5 years depending on species. Life histories of six of the seven species in the Bering Sea are largely unknown. *Enteroctopus dofleini* has been studied in waters of northern Japan and western Canada, but reproductive seasons and age/size at maturity in Alaskan waters are still undocumented. General life histories of the other six species are inferred from what is known about other members of the genus.

E. dofleini is sexually mature after approximately three years. In Japan, females weigh between 10 – 15 kg at maturity while males are 7 – 17 kg (Kanamaru and Yamashita, 1967). *E. dofleini* in the Bering Sea may mature at larger sizes given the more productive waters in the Bering Sea. *E. dofleini* in Japan move to deeper waters to mate during July – October and move to shallower waters to spawn during October –

January. There is a two-month lag time between mating and spawning. This time may be necessary for the females to consume extra food to last the seven months required for hatching of the eggs, during which time the female guards and cleans the eggs but does not feed. *E. dofleini* is a terminal spawner, females die after the eggs hatch while males die shortly after mating. While females may have 60,000 - 100,000 eggs in their ovaries, only an average of 50,000 eggs are laid (Kanamaru, 1964). Hatchlings are approximately 3.5 mm. Mottet (1975) estimated survival to 6 mm at 4%, while survival to 10 mm was estimated to be 1%; mortality at the 1 – 2 year stage was also estimated to be high (Hartwick, 1983). Since the highest mortality occurs during the larval stage it is likely that ocean conditions have the largest effect on the number of *E. dofleini* in the Bering Sea and large fluctuations in numbers of *E. dofleini* should be expected.

Octopus californicus is a medium-sized octopus, maximum total length of approximately 40 cm. Very little is known about this species of octopus. It is collected between 100-1000 m. It is believed to spawn 100-500 eggs. Hatchlings are likely benthic; hatchling size is unknown. The female likely broods the eggs and dies after hatching.

Octopus sp. A is a small-sized species, maximum total length < 10 cm. This species has only recently been identified in the GOA and its full taxonomy has not been determined. *Octopus sp. A* is likely a terminal spawner with a life-span of 12-18 months. The eggs of *Octopus sp. A* are likely much larger than those of *O. rubescens*, as benthic larvae are often bigger; they could take up to six months or more to hatch. Females have 80-90 eggs.

Benthoctopus leioderma is a medium-sized species, maximum total length ~ 60 cm. Its life span is unknown. It occurs from 250 – 1400 m and is found throughout the shelf break region. It is a common octopus and often occurs in the same areas where E. dofleini are found. The eggs are brooded by the female but mating and spawning times are unknown. They are thought to spawn under rock ledges and crevices. The hatchlings are benthic.

Opisthoteuthis californiana is a cirrate octopus, it has fins and cirri (on the arms). It is common in the Gulf of Alaska but would not be confused with E. dofleini. It is found from 300 – 1100 m and likely common over the abyssal plain. Other details of its life history remain unknown.

Japetella diaphana is a small pelagic octopus. Little is known about members of this family. This is not a common octopus in the Gulf of Alaska and would not be confused with E. dofleini.

V. infernalis is a relatively small (up to about 40 cm total length) bathypelagic species, living at depths well below the thermocline; they may be most commonly found at 700 to 1,500 m. They are found throughout the world's oceans. Eggs are large (3 to 4 mm in diameter) and are shed singly into the water. Hatched juveniles resemble adults, but with different fin arrangements, which change to the adult form with development. Little is known of their food habits, longevity, or abundance.

1.2.2 Fishery

There is no federally-managed directed fishery for octopus in the GOA. The State of Alaska allows directed fishing for octopus in state waters under a commissioner's permit. One processor in Kodiak purchases incidentally-caught octopus, primarily for halibut bait Recent increases in market value have increased retention of incidentally-caught octopus in the GOA). Catches in federal waters are incidental, chiefly in the pot fishery for Pacific cod and bottom trawl fisheries for cod and flatfish, but sometimes in the pelagic trawl pollock fishery. Total incidental catch has ranged between an estimated 200-400 mt in the BSAI and 80-300 mt in the GOA. Most of the bycatch occurs on the outer continental shelf (100-200 m depth), chiefly in the western GOA around Kodiak Island and south of the Alaska peninsula in the

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O. gilbertianus is a medium-size octopus (up to 2 m in total length) distributed across the shelf (to 500 m depth) in the eastern and western BS (where it is the most common octopus), AI, and GOA (endemic to the North Pacific). Little is known of its reproductive or trophic ecology, but eggs are laid on the bottom and tended by females. It lives ma ... [1]

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Sanak-Shumagin region. The North Pacific Fisheries Management Council is currently considering dividing the GOA "other species" category into several subgroups for separate management; one of these subgroups would be octopus (all species).

1.2.3 Relevant Trophic Information

Octopus are eaten by pinnipeds (principally Steller sea lions, and spotted, bearded, and harbor seals) and a variety of fishes, including Pacific halibut and Pacific cod (Yang 1993). When small, octopods eat planktonic and small benthic crustaceans (mysids, amphipods, copepods). As adults, octopus eat benthic crustaceans (crabs) and molluscs (clams). Large octopus are also able to catch and eat benthic fishes; the Seattle aquarium has documented a giant Pacific octopus preying on a four-foot dogfish.

1.2.4 Habitat and Biological Associations

Egg/Spawning: Occurs on shelf; E. dofleini lays strings of eggs in cave or den in boulders or rubble, which are guarded by the female until hatching. The exact habitat needs and preferences for denning are unknown,

**Larvae:* pelagic for *Enteroctopus dofleini*, demersal for other octopus species.

Young Juveniles: Are semi-demersal; are widely dispersed on shelf, upper slope.

Old Juveniles and Adults: Are demersal; are widely dispersed on shelf and upper slope, preferentially among rocks, cobble, but also on sand/mud.

Habitat and Biological Associations: *Octopus dofleini*, *O. gilbertianus*

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U (1 to 2 months?)	NA	spring-summer?	U (IS, MS?)	D, P*	R, G?	U	Euhaline waters
Young juveniles	U	zooplankton	summer-fall	U (IS, MS, OS, USL?)	D,SD	U	U	Euhaline waters
Older Juveniles and Adults	U (3-5 yrs for *E.dofleini*, 1-2 yrs for other species?)	crustaceans, mollusks, fish	all year	IS, MS, OS, USL	D?	R, G, S, MS	U	Euhaline waters

1.2.5 Additional sources of information

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1.2.6 Literature

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Deleted: on the outer continental shelf (100 to 200 m depth), chiefly north of the Alaska Peninsula from Unimak Island to Port Moller and northwest to the Pribilof Islands; also around Kodiak Island and many of the AI.

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Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

[NOTE: No EFH distribution maps included in the FMP for octopus]

1.2.7 Evaluation of Effects on EFH of Groundfish Species

Squid and Other Species

While there was considerable new information to evaluate habitat effects for the major target groundfish species in Alaska, there were some species where information was either too sparse to evaluate, or simply did not exist. For other species, especially nontarget species such as skates, sculpins, sharks, squids, and octopi, growth information has not been collected historically, and species-specific catch per unit effort information may be unreliable. Information on nontarget species is improving, but it is currently insufficient to evaluate habitat specific impacts. For these reasons, the original evaluations for the following species groups presented in the DEIS still represent the best available information, despite extensive inquiry to improve upon it.

GOA Octopuses (7 or more species)

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Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the GOA to determine whether fishing activities have an effect on the habitat of octopus. Octopuses occupy all types of benthic habitats, extending from very shallow subtidal areas to deep slope habitats; thus, any adverse effects to this habitat may influence the health of octopus populations. Knowledge of octopus distributions are insufficient to allow comparison with fishing effects.

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Octopus are members of the molluscan class Cephalopoda, along with squid, cuttlefish, and nautiloids. In the BSAI and GOA, the most commonly encountered octopods are the shelf demersal species *O. gilbertianus* and *O. dofleini*, and the bathypelagic finned species, *V. infernalis*. Octopods, like other cephalopods are dioecious, with fertilization of eggs (usually within the mantle cavity of the female) requiring transfer of spermatophores during copulation. Octopods probably do not live longer than about 2 to 4 years, and females of some species (e.g., *O. vulgaris*) die after brooding their eggs on the bottom.

O. gilbertianus is a medium-size octopus (up to 2 m in total length) distributed across the shelf (to 500 m depth) in the eastern and western BS (where it is the most common octopus), AI, and GOA (endemic to the North Pacific). Little is known of its reproductive or trophic ecology, but eggs are laid on the bottom and tended by females. It lives mainly among rocks and stones.

O. dofleini is a giant octopus (up to 10 m in total length, though mostly about 3 to 5 m) distributed in the southern boreal region from Japan and Korea, through the AI, GOA, and south along the Pacific coast of North America to California. Inhabits the sublittoral to upper slope. Egg length is 6 to 8 mm, and they are laid on the bottom. Copulation may occur in late fall and winter, but oviposition is the following spring; each female lays several hundred eggs.

Page 6: [2] Deleted **lconners** **9/2/2009 9:33:00 AM**

Octopus are not currently a target of groundfish fisheries of BSAI or GOA. Bycatch has ranged between 200 to 1,000 mt in the BSAI and 40 to 100 mt in the GOA, chiefly in the pot fishery for Pacific cod and bottom trawl fisheries for cod and flatfish, but sometimes in the pelagic trawl pollock fishery. Directed octopus landings have been less than 8 mt/year from 1988 to 1995. Age/size at 50 percent recruitment is unknown. Most of the bycatch occurs

Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? Y or N If yes, explain.
NO
Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2*)?
NO

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.

Yes, depth range has been expanded, age at 50% maturity, maximum age and spawning season are included. Predator and prey species have been expanded.

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

Habitat use of spiny dogfish from satellite tagging data.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.
Estimates of bycatch from unobserved fisheries, including halibut IFQ and salmon.
Identification of nursery areas and juvenile habitat use.
Investigation of fishing effects on the species, such as fecundity and survival.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions.
NO

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list.
NO

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain.
NO

* EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Sharks	x	x	x	x	x

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Sharks

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: No EFH Description Determined. Insufficient information is available.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: No EFH Description Determined. Insufficient information is available.

Adults: No EFH Description Determined. Insufficient information is available.

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA sharks**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Sharks	M			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	LJ																											
	EJ																											
	L																											
	E																											

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Sharks	M																		
	LJ																		
	EJ																		
	L																		
	E																		

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA sharks**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Sharks	M																									
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																										
		Age at Maturity (unless otherwise noted)				Fertilization/Egg Development					Spawning Behavior						Spawning Season											
		Female		Male																								
Species	Life Stage	50%	100%	50%	100%	External	Internal	Oviparous	Aplacental viviparous	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
Sharks	M	35		21			x	x	x	x			x			x	x	x	x						x	x	x	x

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[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA sharks

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Sharks	M						X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	LJ																														
	EJ																														
	L																														
	E																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Sharks	M									X						X	X													
	LJ																													
	EJ																													
	L																													
	E																													

1.2 Sharks

The species representatives for sharks are:

Lamnidae:	Salmon shark (*Lamna ditropis*)
Squalidae:	Sleeper shark (*Somniosus pacificus*)
	Spiny dogfish (*Squalus acanthias*)

1.2.1 Life History and General Distribution

Sharks of the order Squaliformes (which includes the two families Lamnidae and Squalidae) are the higher sharks with five gill slits and two dorsal fins. The Lamnidae are large, aplacental viviparous (with small litters, 1 to 4; embryos nourished by yolk sac, oophagy and/or intrauterine cannibalism), widely migrating sharks which are highly aggressive predators (salmon and white sharks). The Lamnidae are partly warm-blooded; the heavy trunk muscles are warmer than water for greater power and efficiency. Salmon sharks are distributed epipelagically along the shelf (can be found in shallow waters) from California through the GOA (where they occur all year and are probably most abundant in Alaska waters), the BS, and off Japan. In groundfish fishery and survey data, they occur chiefly on outer shelf/upper slope areas in the BS, but near the coast to the outer shelf in the GOA, particularly near Kodiak Island. They are not commonly seen in AI. They are believed to eat primarily fish, including salmon, sculpins, and gadids and can be up to 3 m in length.

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The Pacific sleeper shark is distributed from California around the Pacific rim to Japan and in the BS principally on the outer shelf and upper slope (but has been observed nearshore), generally demersal (but also seen near surface). Other members of the Squalidae are aplacental viviparous, but fertilization and development of sleeper sharks are not known; adults are up to 8 m in length. They are omnivorous predators of flatfish, cephalopods, rockfish, crabs, seals, and salmon; they may also prey on pinnipeds. In groundfish fishery and survey data, they occur chiefly on outer shelf/upper slope areas in the BS, but near coast to the outer shelf in the GOA, particularly near Kodiak Island.

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Spiny dogfish are widely distributed through the Atlantic, Pacific, and Indian Oceans. In the north Pacific, they may be most abundant in the GOA, but also occur in the BS. They are pelagic species and are found at surface and to depths of 700 m; they are mostly found at 200 m or less on shelf and neritic; they are often found in aggregations. They are aplacental viviparous, with litter size proportional to the size of the female, range from 2 to 23, average 10; gestation may be 22 to 24 months. Young are 24 to 30 cm at birth, with growth initially rapid, then it slows dramatically. Maximum adult size is about 1.6 m and 10 kg; maximum age is 80+ years. Fifty percent of females are mature at 97 cm and 35 years old; males are mature at 74 cm and 21 years old. Females give birth in shallow coastal waters, usually from September to January. Dogfish eat a wide variety of foods, including fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus). Tagging experiments indicate local indigenous populations in some areas and widely migrating groups in others. They may move inshore in summer and offshore in winter.

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The approximate upper size limit of juvenile fish is unknown for salmon sharks and sleeper sharks; for spiny dogfish, it is 94 cm for females, and 72cm for males.

1.2.2 Fishery

Sharks are not a target of groundfish fisheries of BSAI or GOA, but shark bycatch has ranged from 187 to 1,603 mt per year in the BSAI from 1997 to 2008; 409 to 1,603 mt per year in the GOA principally by pelagic trawl fishery for pollock, longline fisheries for Pacific cod and sablefish, and bottom trawl

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fisheries for pollock, flatfish, and cod; almost all are discarded. Little is known of shark biomass in BSAI or GOA.

1.2.3 Relevant Trophic Information

Sharks are top level predators in the Gulf of Alaska, the only likely predator would be larger fish preying on young/small spiny dogfish. Spiny dogfish tend be opportunistic and generalist feeders (Tribuzio et al. in review), feeding more on invertebrates (such as shrimp and hermit crabs) when young and having a more varied diet when older, including fish species (forage fish, rockfish and some salmon). Salmon shark feed primarily on squid and larger fish species (e.g. pollock and salmon). Pacific sleeper shark diet is less well known, a study by Sigler et al. (2006) found squid to be a major component, but also found flesh from grey whale and harbor seal in the stomachs. However, results were inconclusive as to whether the prey was scavenged or hunted.

1.2.4 Habitat and Biological Associations

Egg/Spawning: Salmon sharks and spiny dogfish are aplacental viviparous; reproductive strategy of sleeper sharks is not known. Spiny dogfish give birth in shallow coastal waters, while salmon sharks probably give birth offshore and pelagic.

Juveniles and Adults: Spiny dogfish are widely dispersed throughout the water column on shelf in the GOA, and along outer shelf in the EBS; apparently they are not as commonly found in the AI and are not commonly found at depths >200 m.

Salmon sharks are found throughout the GOA, but are less common in the EBS and AI; they are epipelagic and are found primarily over shelf/slope waters in the GOA and on the outer shelf in the EBS.

Sleeper sharks are widely dispersed on shelf/upper slope in the GOA and along the outer shelf/upper slope only in the EBS; they are generally demersal and may be less commonly found in the AI.

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Habitat and Biological Associations: Sharks

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs and Larvae								
Juveniles and Adults								
Salmon shark	U	fish (salmon, sculpins and gadids)	all year	ICS, MSC. OCS, US in GOA; OCS, US in BSAI	P	NA	U	
Sleeper shark	U	omnivorous; flatfish, cephalopods, rockfish, crabs, seals, salmon, pinnipeds	all year	ICS, MSC, OCS, US in GOA; OCS, US in BSAI	D	U	U	
Spiny dogfish	80+ years	fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus)	all year	ICS, MSC, OCS in GOA; OCS in BSAI give birth ICS in fall/winter?	P	U	U	Euhaline 4-16°C

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1.2.5 Additional sources of information

NMFS, Alaska Fisheries Science Center, Sarah Gaichas.

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1.2.6 Literature

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Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Tribuzio, C.A., C. Rodgveller, J. Heifetz, D. Courtney, and K.J. Goldman. 2008. Assessment of the shark stocks in the Gulf of Alaska. *In* Stock Assessment and Fishery Evaluation Report for the groundfish resources of the Gulf of Alaska. Compiled by the Plan Team for the fishery resources of the Gulf of Alaska. North Pacific Fisheries Management Council, Anchorage, AK.

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

[NOTE: No EFH distribution maps included in the FMP for sharks]

1.2.7 Evaluation of Effects on EFH of Groundfish Species

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Squid and Other Species

While there was considerable new information to evaluate habitat effects for the major target groundfish species in Alaska, there were some species where information was either too sparse to evaluate, or simply did not exist. For other species, especially nontarget species such as skates, sculpins, sharks, squids, and octopi, growth information has not been collected historically, and species-specific catch per unit effort information may be unreliable. Information on nontarget species is improving, but it is currently insufficient to evaluate habitat specific impacts. For these reasons, the original evaluations for the following species groups presented in the DEIS still represent the best available information, despite extensive inquiry to improve upon it.

GOA Sharks (dogfish, sleeper sharks, and salmon sharks)

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the GOA to determine whether fishing activities have an effect on the habitat of dogfish, sleeper sharks, or salmon sharks. Dogfish are thought to occur in the middle and lower portions of the water column and appear to concentrate in gullies along the continental shelf in the GOA. Sleeper sharks are thought to occur mainly in the middle and lower portions of the water column along the outer continental shelf and upper slope region, as well as in similar depths in Shelikof Strait and other gully habitats. Salmon sharks are pelagic throughout the GOA and appear to concentrate in Prince William Sound as well as in Shelikof Strait. Thus, any adverse affects to these habitat types may influence the health of GOA shark populations.

Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? Y or N If yes, explain.

No

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2[1])?

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.

No

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

Yes, there is a need for research on sculpin habitat utilization throughout their life history. This basic information is not known. It is also not known whether bottom trawling negatively impacts the habitat of adult sculpins. It would be first priority to find out what types of habitat are utilized by sculpins throughout their life history and then determine whether fishing activities negatively impact those habitats.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. No, these species are assessed on a yearly basis and are managed using catch limits. This is a satisfactory method to determine adverse impacts of fishing effort to the sculpin population.

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list.

No

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain.

No

[1] EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Sculpins	x	x	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Sculpins

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: No EFH Description Determined. Insufficient information is available.

Juveniles: EFH for juvenile sculpins is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) throughout the GOA wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure E-38.

Adults: EFH for adult sculpins is the general distribution area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m), middle (50 to 100 m), outer shelf (100 to 200 m) and portions of the upper slope (200 to 500 m) throughout the GOA wherever there are substrates of rock, sand, mud, cobble, and sandy mud, as depicted in Figure E-38.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA sculpins**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin											Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Sculpins	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x			
	LJ																											
	EJ																											
	L																											
	E																											

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Sculpins	M																		
	LJ																		
	EJ																		
	L																		
	E																		

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA sculpins**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Sculpins	M							x																		
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Sculpins	M					x									x													

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA sculpins

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Sculpins	M				X			X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X			X	X	
	LJ																														
	EJ																														
	L																														
	E																														

GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Sculpins	M							X	X		X	X	X		X	X	X	X	X	X	X									
	LJ																													
	EJ																													
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	E																													

1.2 Sculpins

The species representatives for sculpins are:

Yellow Irish lord (*Hemilepidotus jordani)*

Red Irish lord (*Hemilepidotus hemilepidotus*)

Butterfly sculpin (*Hemilepidotus papilio*)

Bigmouth sculpin (*Hemitripterus bolini*)

Great sculpin (*Myoxocephalus polyacanthocephalus*)

Plain sculpin (*Myoxocephalus jaok*)

1.2.1 Life History and General Distribution

Cottidae (sculpins) is a large circumboreal family of demersal fishes inhabiting a wide range of habitats in the north Pacific Ocean and BS. Most species live in shallow water or in tidepools, but some inhabit the deeper waters (to 1,000 m) of the continental shelf and slope. Most species do not attain a large size (generally 10 to 15 cm), but those that live on the continental shelf and are caught by fisheries can be 30 to 50 cm; the cabezon is the largest sculpin and can be as long as 100 cm. Most sculpins spawn in the winter. All species lay eggs, but in some genera, fertilization is internal. The female commonly lays demersal eggs amongst rocks where they are guarded by males. Egg incubation duration is unknown; larvae were found across broad areas of the shelf and slope all year-round in ichthyoplankton collections from the southeast BS and GOA. Larvae exhibit diel vertical migration (near surface at night and at depth during the day). Sculpins generally eat small invertebrates (e.g., crabs, barnacles, mussels), but fish are included in the diet of larger species; larvae eat copepods.

Yellow Irish lords: They are distributed from subtidal areas near shore to the edge of the continental shelf (down to 200 m) throughout the BS, AI, and eastward into the GOA as far as Sitka, AK; up to 40 cm in length. 12 to 26 mm larvae collected in spring on the western GOA shelf.

Red Irish lords: They are distributed from rocky, intertidal areas to about 100 m depth on the middle continental shelf (most shallower than 50 m), from California (Monterey Bay) to Kamchatka; throughout the BS and GOA; rarely over 30 cm in length. Spawns masses of pink eggs in shallow water or intertidally. Larvae were 7 to 20 mm long in spring in the western GOA.

Butterfly sculpins: They are distributed primarily in the western north Pacific and northern BS, from Hokkaido, Japan, Sea of Okhotsk, Chukchi Sea, to southeast BS and in AI; depths of 20 to 250 m, most frequent 50 to 100 m.

Bigmouth sculpin: They are distributed in deeper waters offshore, between about 100 to 300 m in the BS, AI, and throughout the GOA; up to 70 cm in length.

Great sculpin: They are distributed from the intertidal to 200 m, but may be most common on sand and muddy/sand bottoms in moderate depths (50 to 100 m); up to 80 cm in length. They are found throughout the BS, AI, and GOA, but may be less common east of Prince William Sound. *Myoxocephalus* spp. larvae ranged in length from 9 to 16 mm in spring ichthyoplankton collections in the western GOA.

Plain sculpin: They are distributed throughout the BS and GOA (not common in the AI) from intertidal areas to depths of about 100 m, but most common in shallow waters (<50 m); up to 50 cm in length. *Myoxocephalus* spp. larvae ranged in length from 9 to 16 mm in spring ichthyoplankton collections in the western GOA.

The approximate upper size limit of juvenile fish is unknown.

1.2.2 Fishery

Sculpins are not a target of groundfish fisheries of the GOA, but sculpin bycatch (which comprises 75% of the other species complex biomass) has ranged from 500 to 1,600 mt per year in the GOA. Bycatch occurs principally in bottom trawl fisheries for flatfish, Pacific cod, and rockfish, and in the Pacific cod pot fishery; in 2007 about 20% of sculpins were retained. Since 2006 sculpin bycatch has increased due to the capture of large sculpins in the shallow water flatfish fishery (Reuter and TenBrink 2008). Bycatch of sculpin species is about 5% of total sculpin biomass in the GOA.

Deleted: BSAI or

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Deleted: Annual sculpin bycatch in the BSAI ranges between 1 and 4 percent of annual survey biomass estimates; however, little is known of the species distribution of the bycatch.

1.2.3 Relevant Trophic Information

Sculpin feed on bottom invertebrates (e.g., crabs, barnacles, mussels, and other molluscs); larger species eat fish.

1.2.4 Habitat and Biological Associations

Egg/Spawning: Lay demersal eggs in nests guarded by males; many species in rocky shallow waters near shore.

Larvae: Distributed pelagically and in neuston across broad areas of shelf and slope, but predominantly on inner and middle shelf; have been found year-round.

Juveniles and Adults: Sculpins are demersal fish and live in a broad range of habitats from rocky intertidal pools to muddy bottoms of the continental shelf and in rocky, upper slope areas. Most commercial bycatch occurs on middle and outer shelf areas used by bottom trawlers for Pacific cod and flatfish.

Habitat and Biological Associations: Sculpins

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	na	winter?	BCH,ICS (MSC-OSC?)	D	R (others?)	U	
Larvae	U	copepods	all year?	ICS-MSC,OCS,US	N,P	na?	U	
Juveniles and Adults	U	bottom invertebrates (crabs, molluscs, barnacles) and small fish	all year	BCH,ICS, MSC, OSC, USP	D	R, S, M, SM	U	

1.2.5 Additional sources of information

NMFS, Alaska Fisheries Science Center, Sarah Gaichas.

1.2.6 Literature

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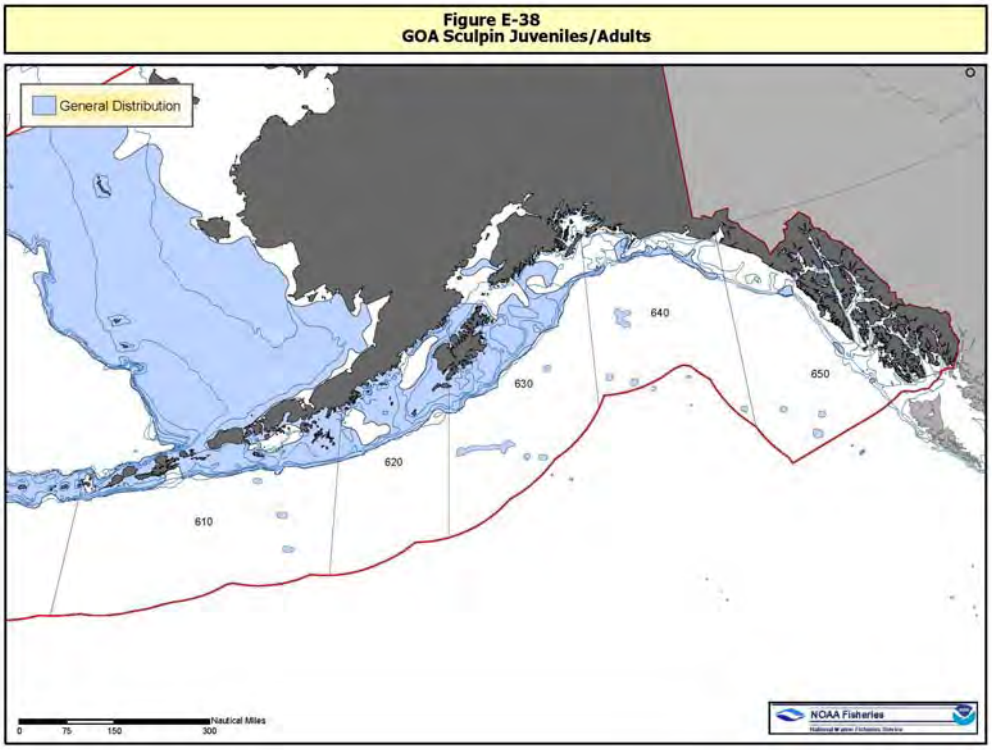
Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western GOA, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Processed Rept 90-01, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 p.

Waldron, K.D. 1978. Ichthyoplankton of the EBS, 11 February-16 March 1978. REFM Report, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 33 p.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the EBS. Final Report (RU 380), Environmental Assessment of the Alaskan continental shelf, REFM, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 88 p.

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figure E-38 Sculpin species (juveniles/adults)



1.2.7 Evaluation of Effects on EFH of Groundfish Species

Squid and Other Species

While there was considerable new information to evaluate habitat effects for the major target groundfish species in Alaska, there were some species where information was either too sparse to evaluate, or simply did not exist. For other species, especially nontarget species such as skates, sculpins, sharks, squids, and octopi, growth information has not been collected historically, and species-specific catch per unit effort information may be unreliable. Information on nontarget species is improving, but it is currently insufficient to evaluate habitat specific impacts. For these reasons, the original evaluations for the following species groups presented in the DEIS still represent the best available information, despite extensive inquiry to improve upon it.

GOA Sculpins (48 species identified in GOA trawl surveys)

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the GOA to determine whether fishing activities have an effect on the habitat of sculpins. Sculpins are benthic dwellers. Some sculpin species guard their eggs, and at least one species, the bigmouth sculpin, lays its eggs in vase sponges, although it is not known whether a particular type of sponge, or sponges in general, are essential to reproductive success. There are so many diverse species in this category that almost all benthic areas in the GOA are likely to be inhabited by at least one sculpin species. Therefore, any adverse affects to habitat may influence the health of species in the sculpin complex.

Worksheet – GOA squids

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? **N**

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2*)?

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here. **N**

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.

Squid in the GOA are very poorly understood, so any information on distribution or habitat would be helpful. Perhaps the most important question is how the distribution of squids (and the habitat needs that drive it) overlap with seabird and marine mammal predators. This would be really useful for looking at the potential impact of squid removals on other parts of the ecosystem.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions. **N**

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list. **N**

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain. **N**

* EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Squid	x	x	x	1	1

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.

Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Squid

Eggs: No EFH Description Determined. Insufficient information is available.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: EFH for older juvenile squid is the general distribution area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) throughout the GOA, as depicted in Figure E-40.

Adults: EFH for adult squid is the general distribution area for this life stage, located in the entire water column, from the sea surface to sea floor, along the inner (0 to 50 m), middle (50 to 100 m), and outer (200 to 500 m) shelf and the entire slope (500 to 1,000 m) throughout the GOA, as depicted in Figure E-40.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA squid**

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Squid	M				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	LJ																											
	EJ																											
	L																											
	E																											

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Squid	M																		
	LJ																		
	EJ																		
	L																		
	E																		

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA squid**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Squid	M							x																		
	LJ																									
	EJ																									
	L																									
	E																									

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																									
		Age at Maturity (unless otherwise noted)				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
Squid	M						x				x																	

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA squid**

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Squid	M							X			X										X	X	X	X							
	LJ																														
	EJ																														
	L																														
	E																														

GOA Groundfish		Prey of																													
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Hailbut	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Squid	M	X						X	X	X	X					X	X	X	X	X	X		X	X		X	X	X	X	
	LJ																													
	EJ																													
	L																													
	E																													

1.2 Squid

The species representatives for squid are:

Gonaditae:	Red or magistrate armhook squid (Berryteuthis magister)
Onychoteuthidae:	Boreal clubhook squid (Onychoteuthis banksii borealjaponicus)
	Giant or robust clubhook squid (Moroteuthis robusta)
Sepiolidae:	eastern Pacific bobtail squid (Rossia pacifica)

1.2.1 Life History and General Distribution:

Squid are members of the molluscan class *Cephalopoda*, along with octopus, cuttlefish, and nautiloids. In the BSAI and GOA, gonatid and onychoteuthid squids are generally the most common, along with chiroteuthids. All cephalopods are stenohaline, occurring only at salinities >30 ppt. Fertilization is internal, and development is direct ("larval" stages are only small versions of adults). The eggs of inshore neritic species are often enveloped in a gelatinous matrix attached to rocks, shells, or other hard substrates, while the eggs of some offshore oceanic species are extruded as large, sausage-shaped drifting masses. Little is known of the seasonality of reproduction, but most species probably breed in spring-early summer, with eggs hatching during the summer. Most small squid are generally thought to live only 2 to 3 years, but the giant *Moroteuthis robusta* clearly lives longer.

B magister is widely distributed in the boreal north Pacific from California, throughout the BS, to Japan in waters 30 to 1,500 m deep; adults are most often found at mesopelagic depths or near bottom on shelf, rising to the surface at night; juveniles are widely distributed across shelf, slope, and abyssal waters in meso- and epipelagic zones, and they rise to the surface at night. They migrate seasonally, moving northward and inshore in summer, and southward and offshore in winter, particularly in the western north Pacific. Maximum size for females is 50 cm mantle length (ML); for males, maximum size is 40 cm ML. Spermatophores are transferred into the mantle cavity of the female, and eggs are laid on the bottom on the upper slope (200 to 800 m). Fecundity is estimated at 10,000 eggs/female. Spawning of eggs occurs from February to March in Japan, but apparently year-round in the BS. Eggs hatch after 1 to 2 months of incubation; development is direct. Adults are gregarious prior to and most die after mating.

O. banksii borealjaponicus, an active, epipelagic species, is distributed in the north Pacific from the Sea of Japan, throughout the AI and south to California, but is absent from the Sea of Okhotsk and is not common in the BS. Juveniles can be found over shelf waters at all depths and near shore. Adults apparently prefer the upper layers over slope and abyssal waters; they are diel migrators and gregarious. Development includes a larval stage; maximum size is about 55 cm.

M. robusta, a giant squid, lives near the bottom on the slope and mesopelagically over abyssal waters; it is rare on the shelf. It is distributed in all oceans and is found in the BS, AI, and GOA. Mantle length can be up to 2.5 m long, with tentacles, at least 7 m, but most are about 2 m long.

R. pacifica is a small (maximum length with tentacles of less than 20 cm) demersal, neritic and shelf, boreal species, distributed from Japan to California in the North Pacific and in the BS in waters of about 20 to 300 m depth. Other *Rossia* spp. deposit demersal egg masses.

For *B. magister*, the approximate upper size limit of juvenile fish is 20 cm ML for males, 25 cm ML for females; both at approximately 1 year of age.

1.2.2 Fishery

Squid are not currently a target of groundfish fisheries of BSAI or GOA. A Japanese fishery catching up to 9,000 mt of squid annually existed until the early 1980s for B. magister in the BS and O. banksii

borealjaponicus in the AI. Since 1990, annual squid bycatch has been about 1,000 mt or less in the BSAI and between 30 to 150 mt in the GOA; in the BSAI, almost all squid bycatch is in the midwater pollock fishery near the continental shelf break and slope, while in the GOA, trawl fisheries for rockfish and pollock (again mostly near the edge of the shelf and on the upper slope) catch most of the squid bycatch.

1.2.3 Relevant Trophic Information

The principal prey items of squid are small forage fish pelagic crustaceans (e.g., euphausiids and shrimp) and other cephalopods; cannibalism is not uncommon. After hatching, small planktonic zooplankton (copepods) are eaten. Squid are preyed upon by marine mammals, seabirds, and, to a lesser extent by fish, and they occupy an important role in marine food webs worldwide. Perez (1990) estimated that squids comprise over 80 percent of the diets of sperm whales, bottlenose whales, and beaked whales and about half of the diet of Dall's porpoise in the EBS and AI. Seabirds (e.g., kittiwakes, puffins, murres) on island rookeries close to the shelf break (e.g., Buldir Island, Pribilof Islands) are also known to feed heavily on squid (Hatch et al. 1990, Byrd et al. 1992, Springer 1993). In the GOA, only about 5 percent or less of the diets of most groundfish consisted of squid (Yang 1993). However, squid play a larger role in the diet of salmon (Livingston and Goiney 1983).

1.2.4 Habitat and Biological Associations for B. magister

Egg/Spawning: Eggs are laid on the bottom on the upper slope (200 to 800 m); incubate for 1 to 2 months.

Young Juveniles: Distributed epipelagically (top 100 m) from the coast to open ocean.

Old Juveniles and Adults: Distributed mesopelagically (most from 150 to 500 m) on the shelf (summer only?), but mostly in outer shelf/slope waters (to lesser extent over the open ocean). They migrate to slope waters to mate and spawn demersally.

Habitat and Biological Associations: Berryteuthis magister (red squid)

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	1 to 2 months	NA	varies	USP,LSP	D	M,SM, MS	U	
Young juveniles	4 to 6 months	zooplankton		All shelf, slope, BSN	P,N	NA	UP,F?	
Older Juveniles and Adults	1 to 2 years (may be up to 4 years)	euphausiids, shrimp, small forage fish, and other cephalopods	summer	All shelf, USP,LSP,BSN	SP	UP, F?		Euhaline waters, 2-4°C
			winter	OS,USP,LSP, BSN	SPU	UP,F?	U	

1.2.5 Additional sources of information

NMFS, Alaska Fisheries Science Center, Olav A. Ormseth

NMFS, Alaska Fisheries Science Center, Beth Sinclair

1.2.6 Literature

Arkhipkin, A.I., V.A. Bizikov, V.V. Krylov, and K.N. Nesis. 1996. Distribution, stock structure, and growth of the squid *Berryteuthis magister* (Berry, 1913) (Cephalopoda, Gonatidae) during summer and fall in the western BS. Fish. Bull. 94: 1-30.

Akimushkin, I.I. 1963. Cephalopods of the seas of the U.S.S.R. Academy of Sciences of the U.S.S.R., Institute of Oceanology, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem 1965. 223 p.

Byrd, G.V., J.C. Williams, and R. Walder. 1992. Status and biology of the tufted puffin in the AI, Alaska, after a ban on salmon driftnets. U. S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, AI Unit, PSC 486, Box 5251, FPO AP 96506_5251, Adak, Alaska.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the BSAI Regions as Projected for 1997. Council, 605 West 4th Avenue, Suite 306, Anchorage, AK.

Hatch, S.A., G.V. Byrd, D.B. Irons, and G.L. Hunt, Jr. 1990. Status and ecology of kittiwakes in the North Pacific. Proc. Pacific Seabird Group Symposium, Victoria, B.C., 21-25 February 1990.

Livingston, P.A., and B.J. Goiney, Jr. 1983. Food habits literature of North Pacific marine fishes: a review and selected bibliography. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS F/NWC-54, 81 p.

Nesis, K.N. 1987. Cephalopods of the world. TFH Publications, Neptune City, NJ, USA. 351 pp.

Perez, M. 1990. Review of marine mammal population and prey information for BS ecosystem studies. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS F/NWC-186, 81 p.

Sobolevsky, Ye. I. 1996. Species composition and distribution of squids in the western BS. Pp. 135-141 *In* O.A. Mathisen and K.O. Coyle (eds.), Ecology of the BS: a review of Russian literature. Alaska Sea Grant Rept 96-01, U. Alaska, Fairbanks, AK 99775.

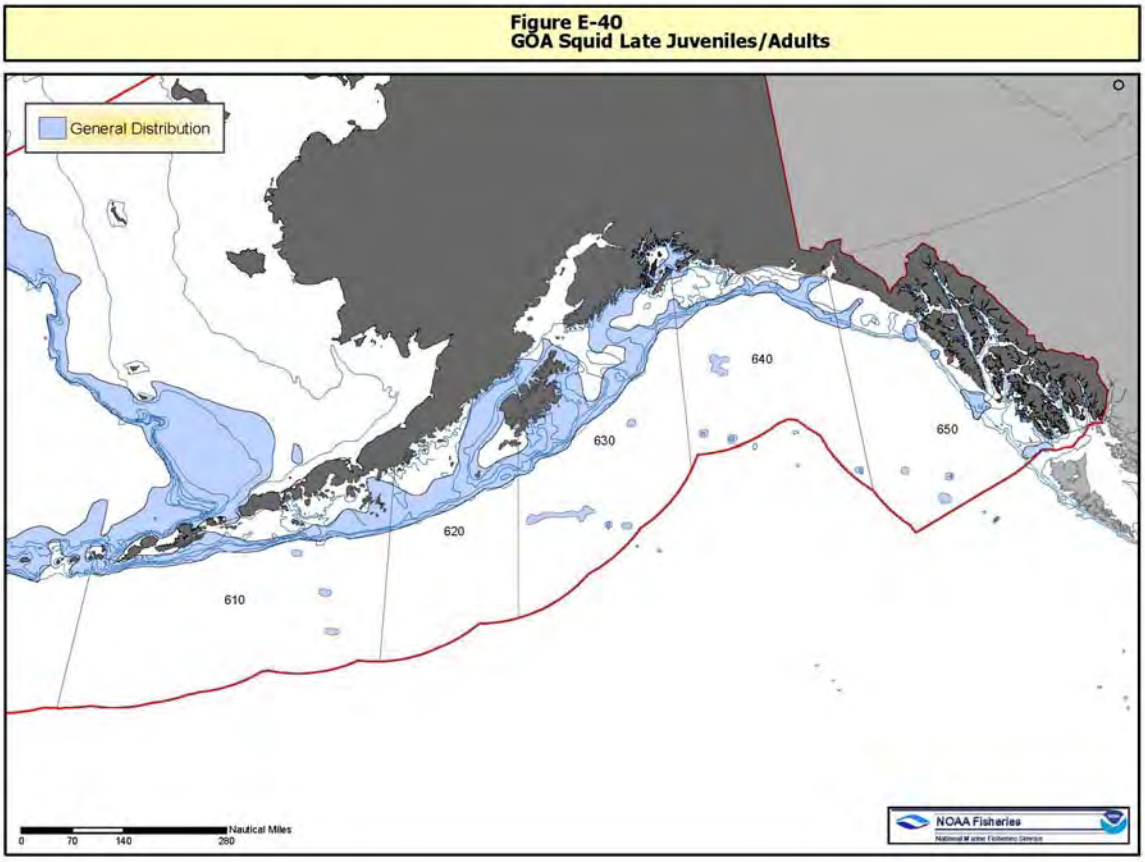
Springer, A. 1993. Report of the seabird working group. pp. 14-29 In Is it food? Addressing marine mammal and seabird declines: a workshop summary. Alaska Sea Grant Report 93-01, Univ. Alaska, Fairbanks, AK, 99775.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the GOA in 1990. U.S. Dep. Commerce., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

[Pulled from Appendix E, GOA Groundfish FMP, EFH maps] **GOA squid**

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

Figure E-40 Squid (late juveniles/adults)



1.2.7 Evaluation of Effects on EFH of Groundfish Species

Squid and Other Species

While there was considerable new information to evaluate habitat effects for the major target groundfish species in Alaska, there were some species where information was either too sparse to evaluate, or simply did not exist. For other species, especially nontarget species such as skates, sculpins, sharks, squids, and octopi, growth information has not been collected historically, and species-specific catch per unit effort information may be unreliable. Information on nontarget species is improving, but it is currently insufficient to evaluate habitat specific impacts. For these reasons, the original evaluations for the following species groups presented in the DEIS still represent the best available information, despite extensive inquiry to improve upon it.

GOA Squid (10 or more species)

Issue	Evaluation
Spawning/breeding	U (Unknown effect)
Feeding	U (Unknown effect)
Growth to maturity	U (Unknown effect)

Summary of Effects—Essential habitat requirements for species in this category are unknown. No studies have been conducted in the GOA to determine whether fishing activities have an effect on the habitat of squid. Squid are thought to occur in pelagic waters along the gullies within the continental shelf and the outer continental shelf, in the upper slope region of the GOA, and to concentrate over submarine canyons; thus, any adverse effects to this habitat may influence the health of the squid populations.

Worksheet – species-specific determinations on whether EFH needs to be changed

1. EFH Description Update

Does new information warrant change to the EFH text description (Y or N) or the EFH distribution maps by life stage? **N**

As in the BSAI (and actually moreso in the GOA) there has been some progress on forage fish distribution and habitat, but it's not enough yet to formally describe EFH for forage fishes beyond what is already contained in the document. As in the BSAI, nearshore areas in general are likely to be forage fish EFH for at least part of the year.

Does the new description, and any associated information, change the level of information known for the species life stage (e.g., not-identified to Level 1; Level 1 to 2*)?

2. New Information

Is there any new information (published or other) that you have used in the review that is not listed in the revisions to the FMP text? If so, please reference it here.

Ormseth, O.A., Conners, L., Guttormsen M., and J. Vollenweider. 2008. Forage fishes in the Gulf of Alaska. In: Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska Region. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

If appropriate, please briefly list any relevant studies that are currently underway that may be useful for EFH reviews in the future.

There is a lot of interest in GOA forage fishes. The NPRB is currently creating a GOA integrated ecosystem research project, and forage species will be a primary focus of this work. The project is slated to run from 2010-2014 and will probably yield some useful results for the next 5-year review.

3. Research and Information Needs

Is research needed or do data gaps exist? Briefly explain and list in order of priority.
There are lots of little bits of information on GOA forage fishes; what is needed is a comprehensive understanding of distribution, habitat, and movement gulfwide. Hopefully the GOA IERP will yield some of this.

4. Fishing Activities

Does new information, and any changes in the distribution of fishing intensity, suggest that the fishing effects analysis summarized in the FMP should be updated? Explain. See item #4 in section B of instructions. **N**

5. Habitat Areas of Particular Concern (HAPC)

Are there specific ecologically significant, rare, or sensitive sites, relevant to your species, that are particularly vulnerable to human perturbation, which the Council might want to consider identifying as HAPC? Y or N. If yes, list. **N**

6. Conservation recommendations

Do you have any EFH conservation recommendations that the Council may want to consider? Explain. **N**

---

* EFH Information Levels: Level 1 - Distribution (general) data available; Level 2 - Habitat-related density data available; Level 3 - Growth, reproduction, or survival rates within habitats are available; Level 4 – Production rates by habitat are available. See FMP for EFH Level specifics by life stage.

1.1.1 Essential Fish Habitat Definitions

1.1.1.1 Essential Fish Habitat Information Levels

A summary of the habitat information levels for each species is listed in Table **Error! No text of specified style in document.**-1.

Table Error! No text of specified style in document.**-1 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.**

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Forage fish complex	x	x	x	x	x

NOTES: "1" indicates indicates that there is sufficient information available to describe EFH; "x" indicates that there is insufficient information available to describe EFH.
Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

1.1.1.2 Essential Fish Habitat Text Descriptions for GOA Groundfish

1.1.1.2.1 Forage Fish Complex (Eulachon, Capelin, Sand Lance, Sand Fish, Euphausiids, Myctophids, Pholids, Gonostomatids, etc.)

Eggs: No EFH Description Determined. Insufficient information is available.

Larvae: No EFH Description Determined. Insufficient information is available.

Early Juveniles: No EFH Description Determined. Insufficient information is available.

Late Juveniles: No EFH Description Determined. Insufficient information is available.

Adults: No EFH Description Determined. Insufficient information is available.

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA forage fish

Table D.1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish		Nearshore				Shelf			Slope						Stratum Reference							Location						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin												Pelagic		
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	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Eulachon	M						X	X	X								X									X		
	LJ						X	X																		X		
	EJ					X	X																			X		
	L	X	X			X	X										X						X					
	E	X																										
Capelin	M						X	X									X									X		
	LJ						X	X																		X		
	EJ					X	X																			X		
	L		X			X	X										X						X					
	E			X											X													
Sand Lance	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		X			X									X		X					X	X			X		
	E			X													X											

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA forage fish**

GOA Groundfish		Physical Oceanography					Substrate												
Species	Life Stage	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
Eulachon	M	X			X	X													
	LJ	X			X	X													
	EJ	X			X														
	L																		
	E																		
Capelin	M	X			X	X													
	LJ	X			X	X													
	EJ	X			X														
	L																		
	E								X	X					X				
Sand Lance	M								X	X					X				
	LJ								X	X					X				
	EJ																		
	L																		
	E																		

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA forage fish**

GOA Groundfish		Structure										Community Associations												Oceanographic Properties		
Species	Life Stage	Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)
Eulachon	M																									
	LJ																									
	EJ																									
	L																									
	E																							**4-8**		
Capelin	M																							**-2-3**		
	LJ																									
	EJ																									
	L																									
	E																							**5-9**		
Sand Lance	M																									
	LJ																									
	EJ																									
	L																									
	E																									

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA forage fish

Table D.2 Summary of biological associations for GOA groundfish.

GOA Groundfish		Reproductive Traits																										
		Age at Maturity (unless otherwise noted)				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**
Eulachon	M	3	5	3	5	X		X			X									X	X	X						
Capelin	M	2	4	2	4	X		X			X										X	X	X	X				
Sand Lance	M	1	2	1	2	X		X			X						X	X									X	X

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] GOA forage fish

Table D.3 Summary of predator and prey associations for GOA groundfish.

GOA Groundfish		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	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Eulachon	M				X			X			X																				
	LJ				X			X			X																				
	EJ				X			X			X																				
	L			X	X	X		X			X																				
	E																														
Capelin	M				X			X			X		X							X											
	LJ				X			X			X																				
	EJ				X			X			X																				
	L			X	X	X		X			X																				
	E																														
Sand Lance	M				X			X		X	X																				
	LJ				X			X		X	X																				
	EJ				X			X		X	X																				
	L			X	X	X		X		X	X																				
	E																														

EFH 5-year report - Appendix 2

[Pulled from Appendix D, GOA Groundfish FMP, Tables D.1-D.3] **GOA forage fish**

GOA Groundfish		Prey of																												
Species		Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pacific cod	Ling 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	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Eulachon	M						X	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														
	L					X	X	X	X							X														
	E																													
Capelin	M						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														
	L					X	X	X	X						X	X														
	E																													
Sand Lance	M						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														
	L					X	X	X	X						X	X														
	E																													

1.2 Capelin (*osmeridae*)

The species representative for capelin is *Mallotus villosus*.

1.2.1 Life History and General Distribution

Capelin is a short-lived marine (neritic), pelagic, filter-feeding schooling fish distributed along the entire coastline of Alaska and the BS, and south along British Columbia to the Strait of Juan de Fuca; circumpolar. In the North Pacific, capelin grow to a maximum of 25 cm and 5 years of age. Spawn at ages 2 to 4 in spring and summer (May to August; earlier in south, later in north) when about 11 to 17 cm on coarse sand, fine gravel beaches, especially in Norton Sound, northern Bristol Bay, along the Alaska Peninsula and near Kodiak. Age at 50 percent maturity is 2 years. Fecundity is 10,000 to 15,000 eggs per female. Eggs hatch in 2 to 3 weeks. Most capelin die after spawning. Larvae and juveniles are distributed on inner-mid shelf in summer (rarely found in waters deeper than about 200 m), and juveniles and adults congregate in fall in mid-shelf waters east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands, and north into the Gulf of Anadyr. They are distributed along outer shelf and under ice edge in winter. Larvae, juveniles, and adults have diurnal vertical migrations following scattering layers – night near surface, at depth during the day. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

The approximate upper size limit of juvenile fish is 13cm.

1.2.2 Fishery

Capelin are not a target species in groundfish fisheries of BSAI or GOA, but are caught as bycatch (up to several hundred tons per year in the 1990s) principally during the yellowfin sole trawl fishery in Kuskokwim and Togiak Bays in spring in the BSAI; almost all are discarded. Small local coastal fisheries occur in spring and summer.

1.2.3 Relevant Trophic Information

Capelin are important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a, Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise and fin, sei, humpback, and beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987, Wespestad 1987). Smelts are also found in the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot, and salmon throughout the North Pacific Ocean and the BS (Allen 1987, Yang 1993, Livingston, in prep.).

1.2.4 Habitat and Biological Associations

Egg/Spawning: Spawn adhesive eggs (about 1 mm in diameter) on fine gravel or coarse sand (0.5 to 1 mm grain size) beaches intertidally to depths of up to 10 m in May-July in Alaska (later to the north in Norton Sound). Hatching occurs in 2 to 3 weeks. Most intense spawning when coastal water temperatures are 5 to 9ºC.

Larvae: After hatching, 4 to 5 mm larvae remain on the middle-inner shelf in summer; distributed pelagically; centers of distribution are unknown, but have been found in high concentrations north of Unimak Island, in the western GOA, and around Kodiak Island.

Juveniles: In fall, juveniles are distributed pelagically in mid-shelf waters (50 to 100 m depth; -2 to 3ºC), and have been found in highest concentrations east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

Adults: Found in pelagic schools in inner-mid shelf in spring-fall, feed along semi-permanent fronts separating inner, mid, and outer shelf regions (~50 and 100 m). In winter, found in concentrations under ice-edge and along mid-outer shelf.

Habitat and Biological Associations: Capelin

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	2 to 3 weeks to hatch	na	May-August	BCH (to 10 m)	D	S,CB		5-9°C peak spawning
Larvae	4 to 8 months?	Copepods phytoplankton	summer/fall/ winter	ICS-MCS	N,P	U NA?	U	
Juveniles	1.5+ years up to age 2	Copepods Euphausiids	all year	ICS-MCS	P	U NA?	U F? Ice edge in winter	
Adults	2 years ages 2-4+	Copepods Euphausiids polychaetes small fish	Spawning (May-August) non-spawning (Sep-Apr)	BCH (to 10 m) ICS-MCS-OCS	D,SD P	S,CB NA?	F Ice edge in winter	-2 - 3°C Peak distributions in EBS?

1.2.5 Additional Sources of Information

Olav A. Ormseth, NMFS/AFSC, 206-526-4242

Paul Anderson, NMFS/RACE, Kodiak, AK.

Jim Blackburn, ADFG, Kodiak, AK.

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1.3 Eulachon *(osmeridae)*

The species representative for eulachon is the candlefish *(Thaleichthys pacificus*).

1.3.1 Life History and General Distribution

Eulachon is a short-lived anadromous, pelagic schooling fish distributed from the Pribilof Islands in the EBS, throughout the GOA, and south to California. Consistently found pelagically in Shelikof Strait (hydroacoustic surveys in late winter-spring) and between Unimak Island and the Pribilof Islands (bycatch in groundfish trawl fisheries) from the middle shelf to over the slope. In the North Pacific, eulachon grow to a maximum of 23 cm and 5 years of age. They spawn at ages 3 to 5 in spring and early summer (April to June) when they are about 14 to 20 cm in rivers on coarse sandy bottom. Their age at 50 percent maturity is 3 years. Fecundity equals ~25,000 eggs per female. Eggs adhere to sand grains and other substrates on river bottom. Eggs hatch in 30 to 40 days in BC at 4 to 7ºC. Most eulachon die after first spawning. Larvae drift out of rivers and develop at sea. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

The approximate upper size limit of juvenile fish is 14cm.

1.3.2 Fishery

Eulachon and candlefish are not target species in groundfish fisheries of BSAI or GOA, but are caught as bycatch (ranging from at least 18-850 t from 2003-2009; observers have only consistently identified smelts to species since 2005) principally by midwater pollock fisheries in Shelikof Strait (GOA), on the east side of Kodiak (GOA), and between the Pribilof Islands and Unimak Island on the outer continental shelf and slope (EBS); almost all are discarded. Small local coastal fisheries occur in spring and summer and eulachon are a very important subsistence resource for coastal Alaska residents.

Deleted: up to several hundred tons per year in the 1990s

1.3.3 Relevant Trophic Information

Eulachon may be important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance, and juvenile

pollock (Hunt et al. 1981a, Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise and fin, sei, humpback, and beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987, Wespestad 1987). Smelts are also found in the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot, and salmon throughout the North Pacific Ocean and the BS (Allen 1987; Yang 1993; Livingston, in prep.).

1.3.4 Habitat and Biological Associations

Egg/Spawning: Anadromous; return to spawn in spring (May to June) in rivers; demersal eggs adhere to bottom substrate (sand, cobble, etc.). Hatching occurs in 30 to 40 days.

Larvae: After hatching, 5 to 7 mm larvae drift out of river and develop pelagically in coastal marine waters; centers of distribution are unknown.

Juveniles and Adults: Distributed pelagically in mid-shelf to upper slope waters (50 to 1,000 m water depth), and have been found in highest concentrations between the Pribilof Islands and Unimak Island on the outer shelf, and in Shelikofeast of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

Habitat and Biological Associations: Eulachon (Candlefish)

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	30 to 40 days	na	April-June	Rivers-FW	D	S (CB?)		4 - 8°C for egg development
Larvae	1 to 2 months ?	Copepods phytoplankton mysids, larvae	summer/fall	ICS ?	P?	U NA?	U	
Juveniles	2.5+ years up to age 3	Copepods Euphausiids	all year	MCS-OCS-USP	P	U NA?	U F?	
Adults	3 years ages 3 to 5+	Copepods Euphausiids	Spawning (May-June) non-spawning (July-Apr)	Rivers-FW MCS-OCS-USP	D P	S (CB?) NA?	F?	

1.3.5 Additional Sources of Information

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Jim Blackburn, ADFG, Kodiak, AK.

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Appendix E: Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses):

[NOTE: No EFH distribution maps included in the FMP for forage fish]

1.3.7 Evaluation of Effects on EFH of Groundfish Species

Effects of Fishing on Essential Fish Habitat of Forage Species

The forage species category was created by Amendments 36 and 39 to the BSAI and GOA FMP. This category includes eight families of fish (Osmeridae, Myctophidae, Bathylagidae, Ammodytidae, Trichodontidae, Pholidae, Stichaeidae, and Gonostomatidae) and one order of crustaceans (Euphausiacea). The aforementioned amendments prohibit the directed fishery of any forage species. The species included in this category have diverse life histories and it is impractical to analyze the group as a whole. Therefore, for the purpose of this document, each family and order will be analyzed separately.

Family Osmeridae

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—Most of the Alaska species of smelt spawn on beaches, rivers, or in estuaries. Certain species of smelt, such as capelin, have been shown to have an affinity towards spawning grounds with specific substrate grain size (coarse sand or fine gravel). Therefore, non-living substrate is assumed to be very important for spawning/breeding. However, smelt spawning areas do not overlap with areas of intensive fishing. There is little to no fishing pressure in the nearshore environment needed by these species. Hence, the effects of fishing are anticipated to have little impact on the stock. The rating for the effects of fishing on spawning and breeding of smelt is MT.

Juvenile and adult smelt feed primarily on neritic plankton. There is little evidence that survival or prey availability of smelt is dependent on habitat that is disturbed by fishing. Therefore, the effects of fishing on the feeding and growth to maturity of smelt are rated MT.

Family Myctophidae

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—Myctophids are pelagic throughout all life history stages. There is little evidence that Myctophid survival is dependent on habitat affected by fishing. Myctophids are broadcast spawners with pelagic eggs. Juvenile and adult Myctophids prey on neritic zooplankton and do not require physical structure for protection. Therefore, the effects of fishing on the spawning and breeding, feeding, and growth to maturity of Myctophids is rated MT.

Family Ammodytidae

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—The sole member of family Ammodytidae found in Alaska is the Pacific sand lance (*Ammodytes hexapterus*). Sand lance have been shown to have an affinity towards spawning grounds with specific substrate grain size (coarse sand). Therefore, non-living substrate is assumed to be very important for spawning/breeding. However, smelt spawning areas do not overlap with known areas of intensive fishing. There is little to no fishing pressure in the nearshore habitat needed by these species. Hence, the effects of fishing on the EFH of sand lance is rated MT.

Juvenile and adult sand lance feed primarily on copepods. There is little evidence that survival or prey availability of sand lance is dependent on habitat disturbed by fishing. Therefore, the effects of fishing on the feeding and growth to maturity of smelt are rated MT.

Family Trichodontidae

Issue	Evaluation
Spawning/Breeding	MT (Minimal, temporary, or no effect)
Feeding	U (Unknown)
Growth to maturity	U (Unknown)

Summary of Effects—Two members of the family Trichodontidae are found in the BSAI and GOA: the sailfin sandfish (*Arctoscopus japonicus*) and the Pacific sandfish (*Trichodon trichodon*). However, the sailfin sandfish is rarely encountered in Alaska waters. For the purposes of this document, attention will be focused on the Pacific sandfish.

Pacific sandfish lay demersal adhesive egg masses in rocky intertidal areas. The presence of the proper non-living substrate is important for the spawning/breeding of sandfish. However, there is little overlap of the spawning areas with known areas of intensive fishing. Hence, the effects of fishing on spawning/breeding of sandfish are rated MT.

Pacific sandfish are ambush predators that lay in wait for prey buried under the sand. They have been shown to consume some epifauna prey, but more than 95 percent of their diet consisted of small fish. It is unknown how the habitat for these prey species is affected by fishing.

Pacific sandfish larvae are pelagic, but juveniles and adults are demersal. Little is known about sandfish distribution in the BSAI and GOA. The effect of fishing on the survival of Pacific sandfish is unknown due to lack of data.

Family Pholidae

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—There are several species of Pholids (or gunnels) found in Alaska waters. Most species of gunnels reside, feed, and breed in the shallow, nearshore habitat, where there is little to no

fishing effort. Due to the lack of fishing pressure in the environs used by Pholids, the effects of fishing on the habitat necessary for spawning/breeding, feeding, and growth to maturity are all rated MT.

Family Stichaeidae

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—Due to the lack of fishing pressure in the environs used by pricklebacks, the effects of fishing on the spawning/breeding, feeding, and growth to maturity are all rated MT.

Family Gonostomatidae

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—Bristlemouths are pelagic throughout all life history stages. There is little evidence that bristlemouths survival is dependent on habitat that is affected by fishing. Bristlemouths are broadcast spawners with pelagic eggs. Juvenile and adult bristlemouths prey on neritic zooplankton and do not require physical structure for protection. Therefore, the effects of fishing on the habtitat necessary for spawning/breeding, feeding, and growth to maturity of bristlemouths are rated MT.

Order Euphausiacea

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—Euphausiids (or krill) are small, shrimp-like crustaceans which, along with copepods, make up the base of the food web in the BSAI and GOA. Euphausiids are pelagic throughout their entire life cycle and do not have a strong link to habitat that is affected by fishing. Euphausiids do not require habitat that is disrupted by fishing for spawning/breeding, feeding, or growth to maturity. Therefore, the effects of fishing on habitat for euphausiids is MT.