Appendix 2
Essential Fish Habitat Text Descriptions
Adult Summer EFH Maps
Habitat associations, biological associations, predator/prey associations, and life histories of fishes in the Gulf of Alaska Groundfish Fishery Management Plan

Essential Fish Habitat Descriptions

General

Essential Fish Habitat (EFH) is defined in the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." EFH is described for FMP-managed species by life stage using guidance from the EFH Final Rule (50 CFR 600.815), including the EFH Level of Information definitions. New analytical tools are used and recent scientific information is incorporated for each life history stage from updated scientific habitat assessment reports. EFH descriptions include both text and maps, if information is available for a species' particular life stage. These descriptions are risk averse, supported by scientific rationale, and account for changing oceanographic conditions, regime shifts, and the seasonality of migrating fish stocks. EFH descriptions are interpretations of the best scientific information.

Table 1 EFH information levels of GOA groundfish life stages

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Walleye pollock	1	1	2	2	2
Pacific cod	x	1	2	2	2
Sablefish	x	1	1	2	2
Yellowfin sole	1	1	2	2	2
Northern rock sole	1	1	2	2	2
Southern rock sole	1	1	1	2	2
Alaska plaice	1	1	2	2	2
Dover sole	1	1	x	2	2
Rex sole	1	1	x	2	2
Arrowtooth flounder	1	1	1	2	2
Flathead sole	1	1	2	2	2
Pacific ocean perch	*Sebastes* spp. early life stages grouped 1			1	1
Northern rockfish				2	2
Shortraker rockfish				2	2
Blackspotted/rougheye rockfish				1	1
Dusky rockfish				1	1
Yelloweye rockfish				1	1
Other Rockfish (sharpchin, harlequin)	1	x	x	1	1
Thornyhead rockfish	x	x	2	2	2
Atka mackerel	1	x	x	1	1
Skates	1	x	1	2	2
Octopuses	x	x	x	x	2
Sharks	x	x	x	x	x
Sculpins	x	x	na	x	2
Squids	x	x	x	1	1
Forage fish complex	x	x	x	x	x
Grenadiers	x	x	x	x	x

x Indicates insufficient information is available to describe EFH

1 Indicates general distribution data are available for some or all portions of the geographic range of the species

2 Indicates quantitative data (density or habitat-related density) are available for the habitats occupied by a species of life stage

na One juvenile stage exists – see Late Juveniles

Essential Fish Habitat Text Descriptions for GOA Groundfish

Walleye Pollock

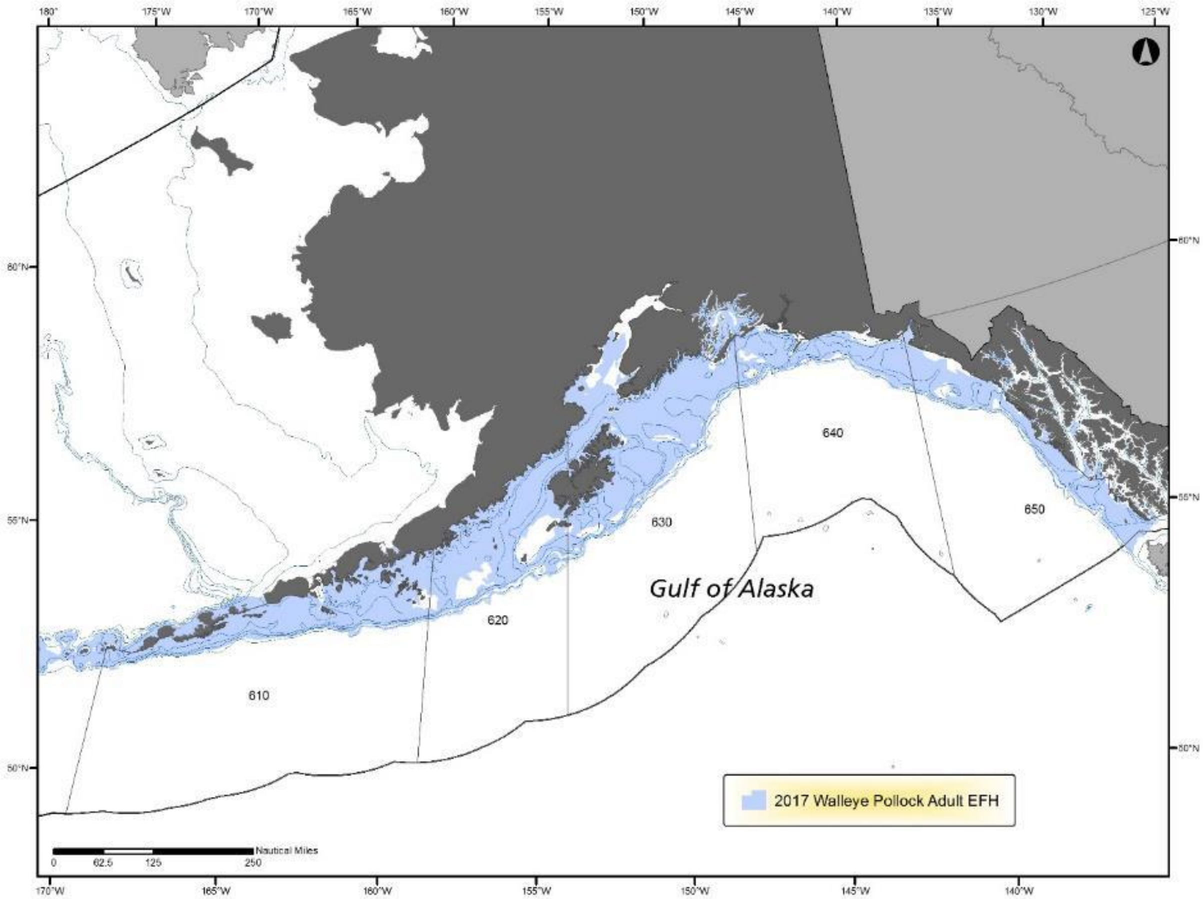
Eggs: EFH for walleye pollock eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m), upper slope (200 to 500 m), and intermediate slope (500 to 1,000 m) throughout the GOA.

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

Early Juveniles: EFH for early juvenile walleye pollock is the habitat-related density 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. Relative abundance of age 1 pollock is used as an early indicator of year class strength and is highly variable (presumably due to survival factors and differential availability between years).

Late Juveniles: EFH for late juvenile walleye pollock is the habitat-related density 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. Substrate preferences, if they exist, are unknown.

Adults: EFH for adult walleye pollock is the habitat-related density 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. Substrate preferences, if they exist, are unknown.


Gulf of Alaska
610
620
630
640
650
2017 Walleye Pollock Adult EFH
Nautical Miles
0
62.5
125
250

Pacific Cod

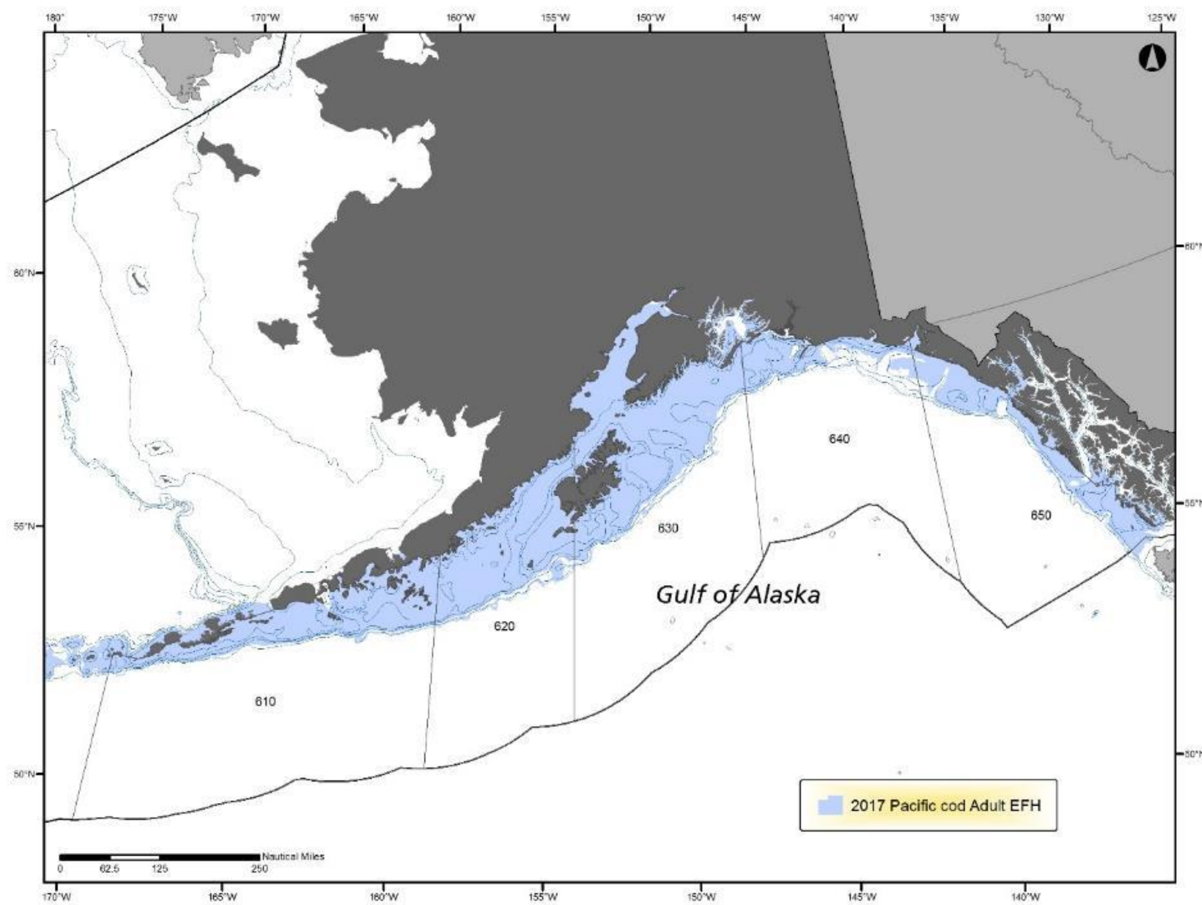
Eggs: No EFH description determined. Information is insufficient.

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..

Early Juveniles: EFH for early juvenile Pacific cod is the habitat-related density 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.

Late Juveniles: EFH for late juvenile Pacific cod is the habitat-related density 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.

Adults: EFH for adult Pacific cod is the habitat-related density 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.



Sablefish

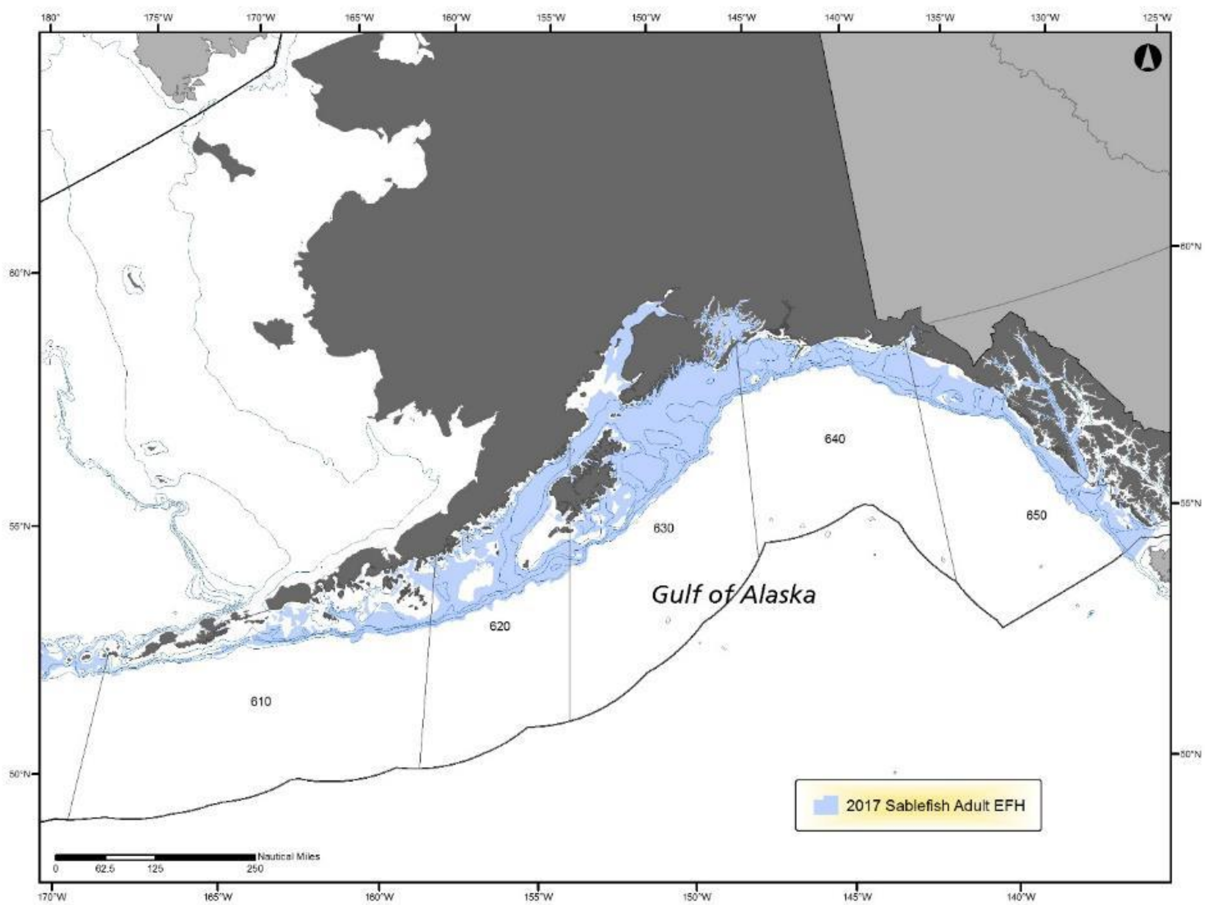
Eggs: No EFH description determined. Information is insufficient.

Larvae: EFH for larval sablefish is the general distribution area for this life stage. Larvae are 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.

Early Juveniles: EFH for early juvenile sablefish is the general distribution area for this life stage. Early juveniles have been observed in inshore water, bays, and passes, and on shallow shelf pelagic and demersal habitat.

Late Juveniles: EFH for late juvenile sablefish is the habitat-related density 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.

Adults: EFH for adult sablefish is the habitat-related density area for this life stage, located in deep shelf gulleys along the slope (400 to 800 m) throughout the GOA.



Yellowfin Sole

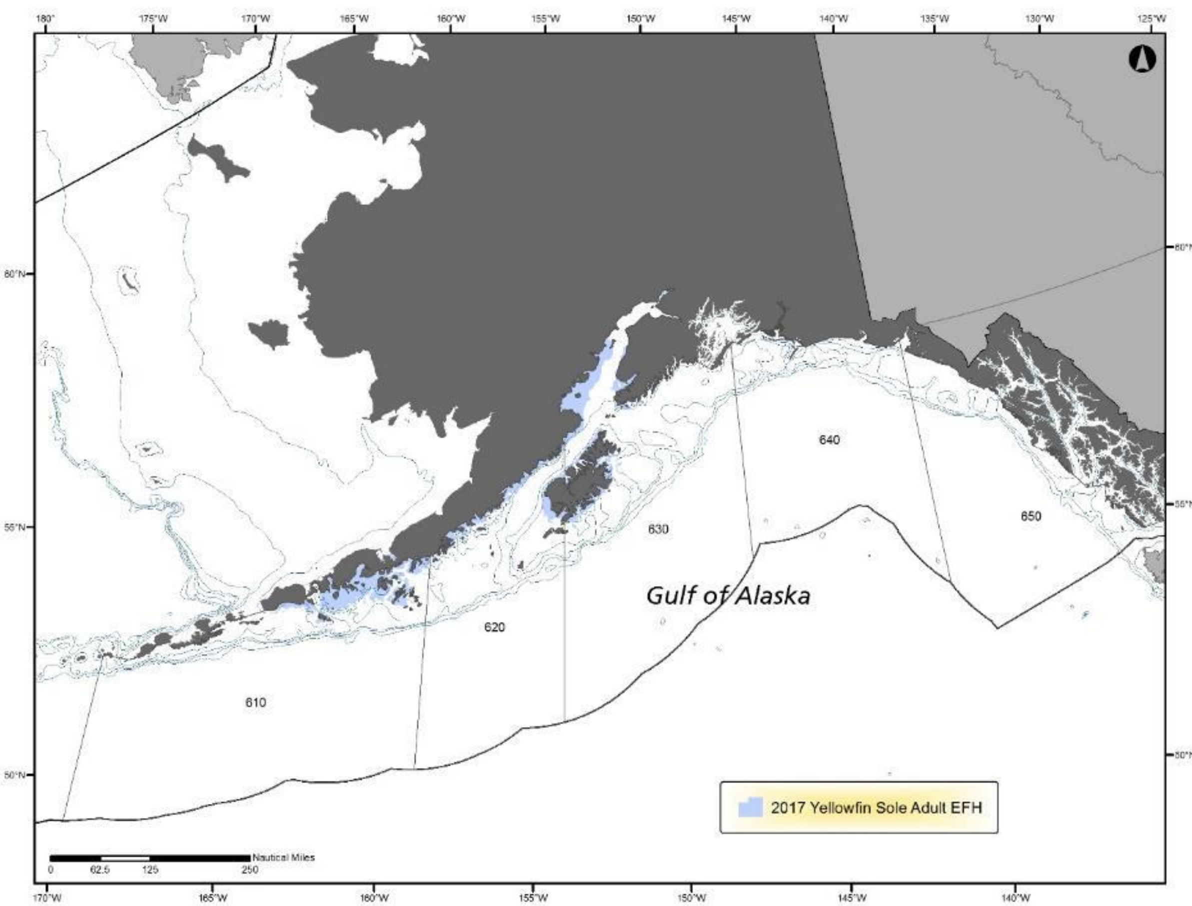
Eggs: EFH for yellowfin sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper (200 to 500 m) slope throughout the GOA.

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.

Early Juveniles: EFH for early juvenile yellowfin sole is the habitat-related density area for this life stage, located in the lower portion of the water column along the inner shelf (0 to 50 m).

Late Juveniles: EFH for late juvenile yellowfin sole is the habitat-related density 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.

Adults: EFH for adult yellowfin sole is the habitat-related density 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.



Northern Rock Sole

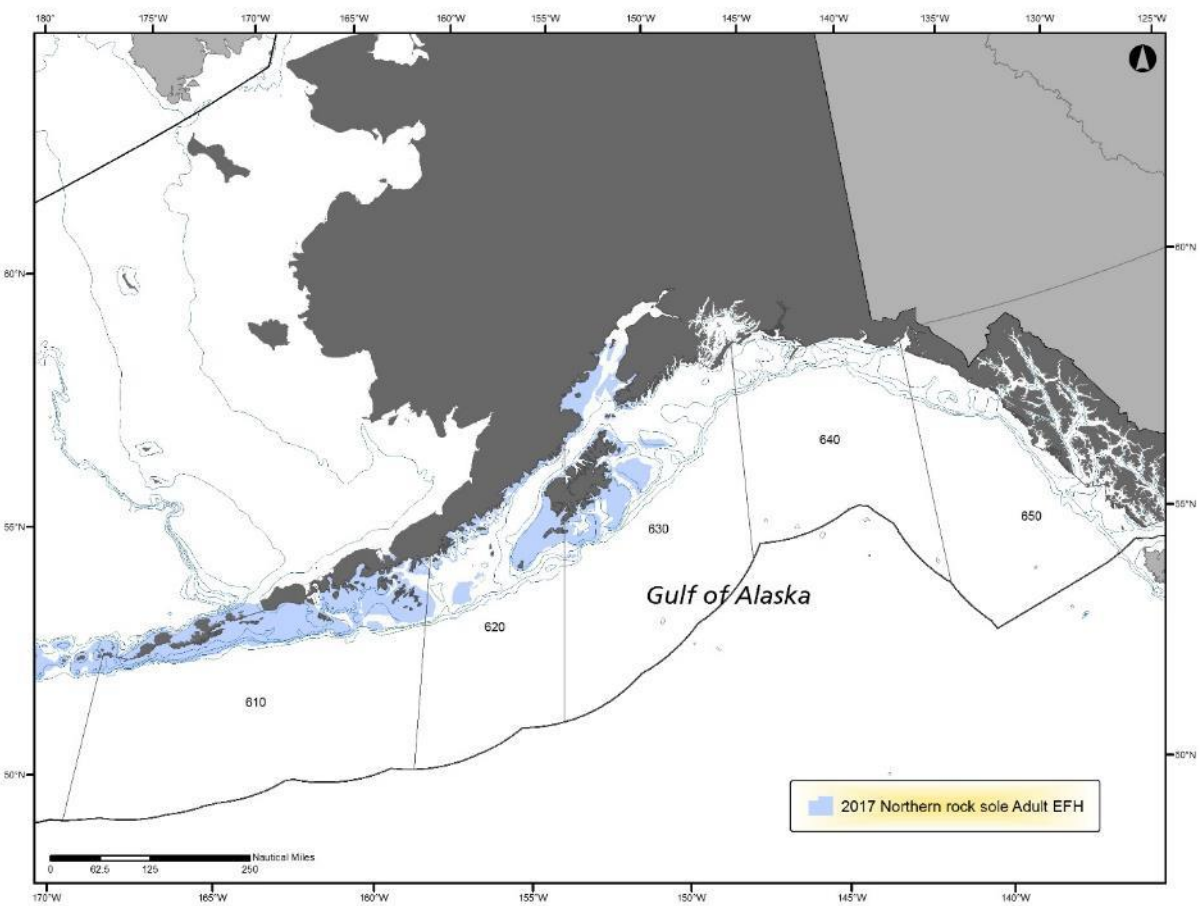
Eggs: EFH for northern rock sole eggs is the general distribution area for this life stage, located in demersal waters along the entire shelf (0 to 200 m) throughout the GOA.

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..

Early Juveniles: EFH for early juvenile northern rock sole is the habitat-related density area for this life stage, located in the lower portion of the water column along the inner shelf (0 to 50 m).

Late Juveniles: EFH for late juvenile northern rock sole is the habitat-related density 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.

Adults: EFH for adult rock sole is the habitat-related density 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.



Southern Rock Sole

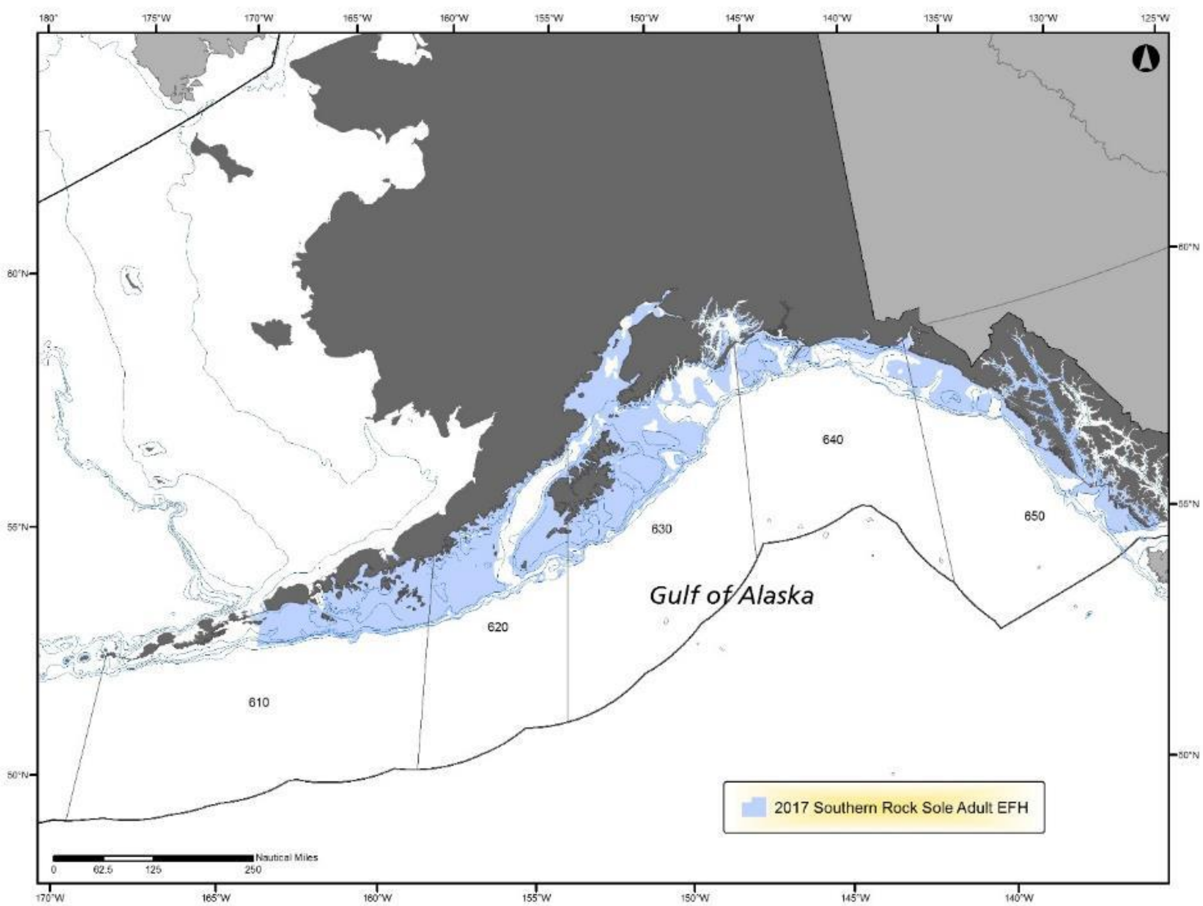
Eggs: EFH for southern rock sole eggs is the general distribution area for this life stage, located in demersal habitat throughout the shelf (0 to 200 m).

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.

Early Juveniles: EFH for early 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 shelf (0 to 50 m).

Late Juveniles: EFH for late juvenile southern rock sole is the habitat-related density 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.

Adults: EFH for adult southern rock sole is the habitat-related density 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.



Alaska Plaice

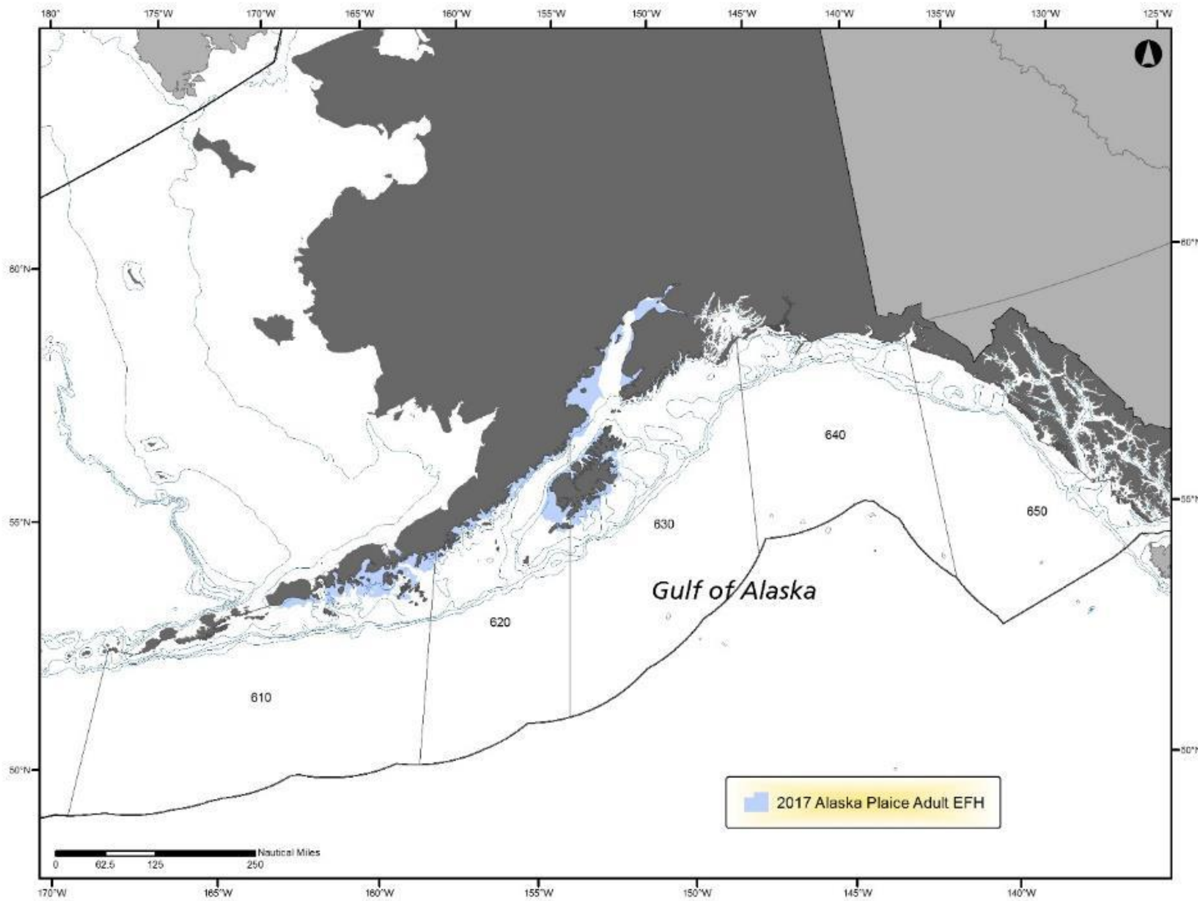
Eggs: EFH for Alaska plaice eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA in the spring.

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.

Early Juveniles: EFH for early juvenile Alaska plaice is the habitat-related density area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m) and middle (50 to 100 m) shelf throughout the GOA wherever there are softer substrates consisting of sand and mud.

Late Juveniles: EFH for late juvenile Alaska plaice is the habitat-related density 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.

Adults: EFH for adult Alaska plaice is the habitat-related density 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.



Rex Sole

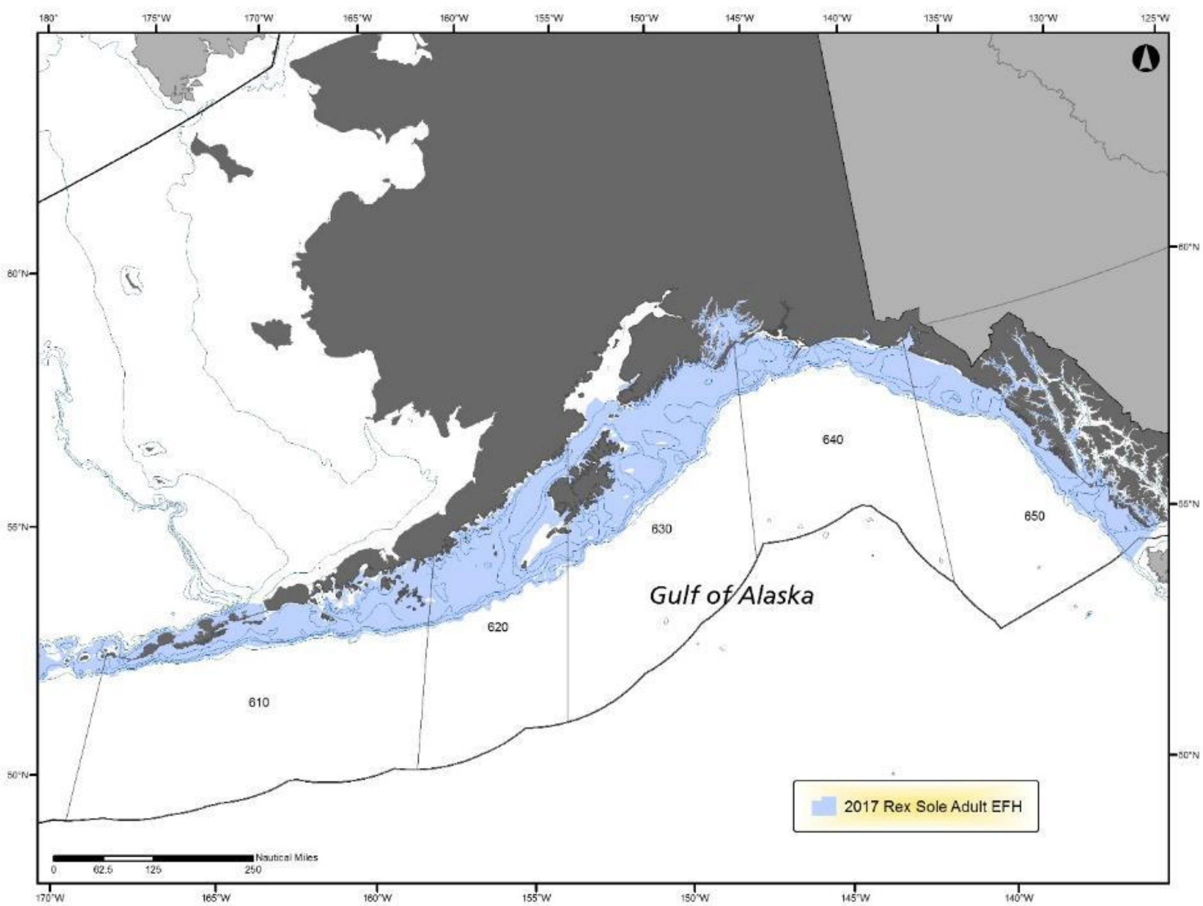
Eggs: EFH for rex sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and upper slope (200 to 500 m) throughout the GOA in the spring.

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.

Early Juveniles: No EFH description determined. Insufficient information is available.

Late Juveniles: EFH for juvenile rex sole is the habitat-related density 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.

Adults: EFH for adult rex sole is the habitat-related density 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.



Dover Sole

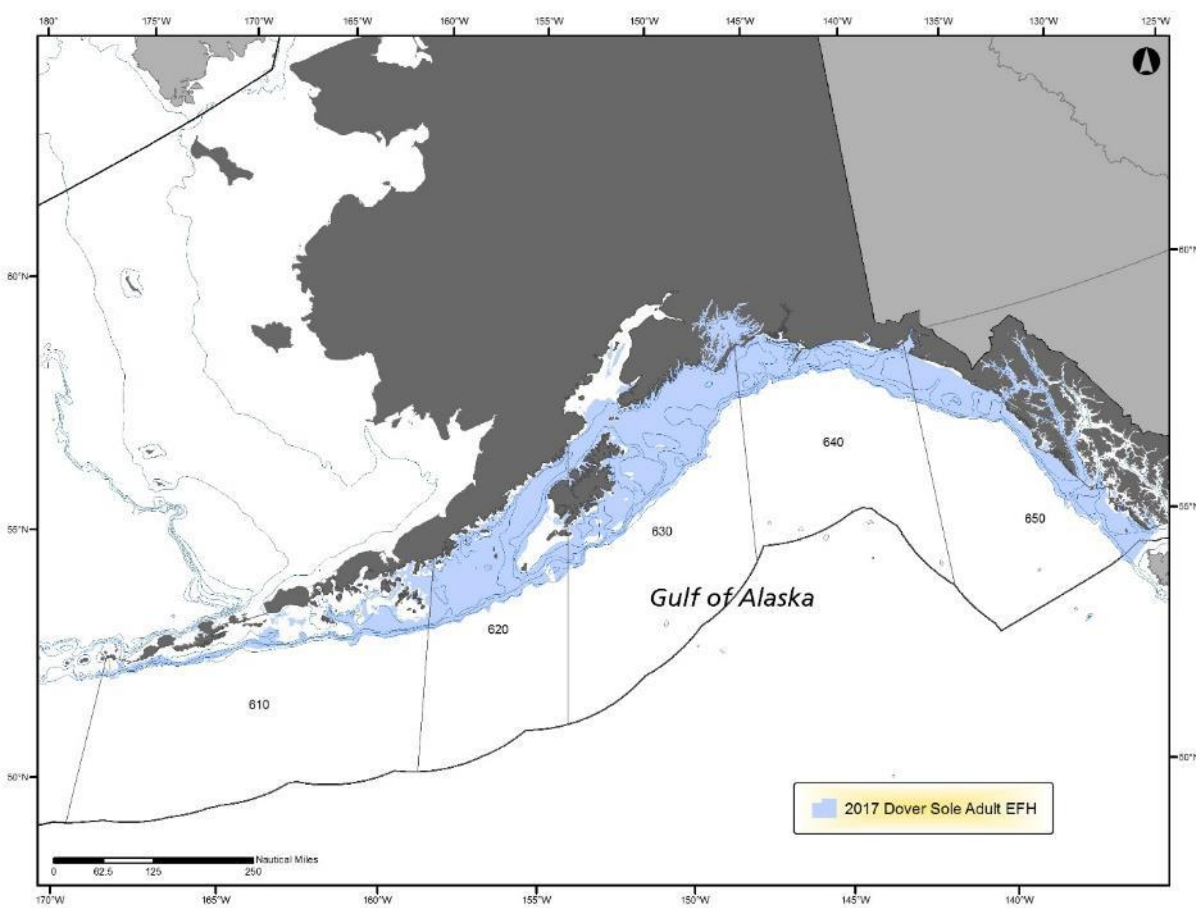
Eggs: EFH for Dover sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA.

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.

Early Juveniles: No EFH description determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile Dover sole is the habitat-related density 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.

Adults: EFH for adult Dover sole is the habitat-related density 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.



Flathead Sole

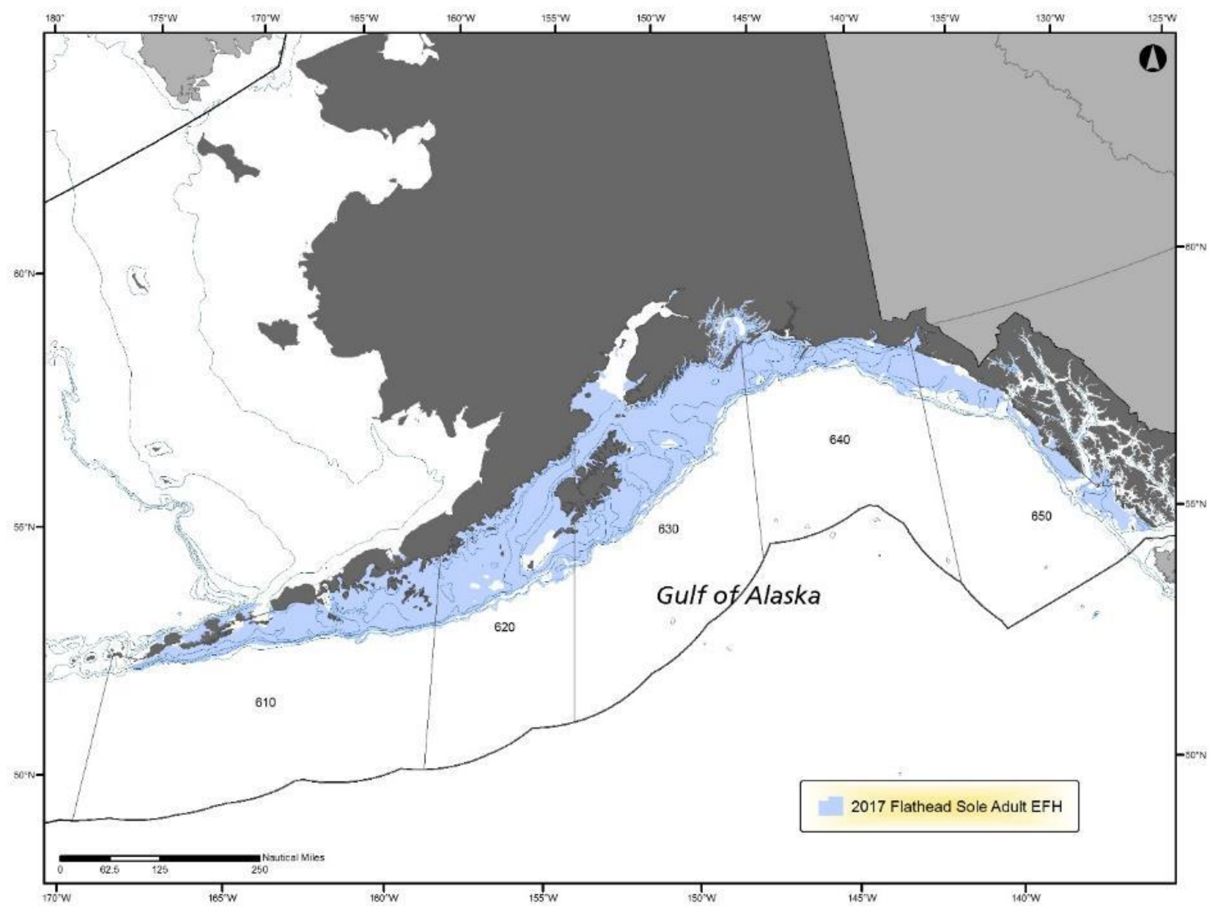
Eggs: EFH for flathead sole eggs is the general distribution area for this life stage, located in pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA.

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.

Early Juveniles: EFH for early juvenile flathead sole is the habitat-related density area for this life stage, located in the lower portion of the water column along the inner (0 to 50 m) and middle (50 to 100 m) shelf throughout the GOA wherever there are softer substrates consisting of sand and mud.

Late Juveniles: EFH for late juvenile flathead sole is the habitat-related density 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.

Adults: EFH for adult flathead sole is the habitat-related density 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.



Arrowtooth Flounder

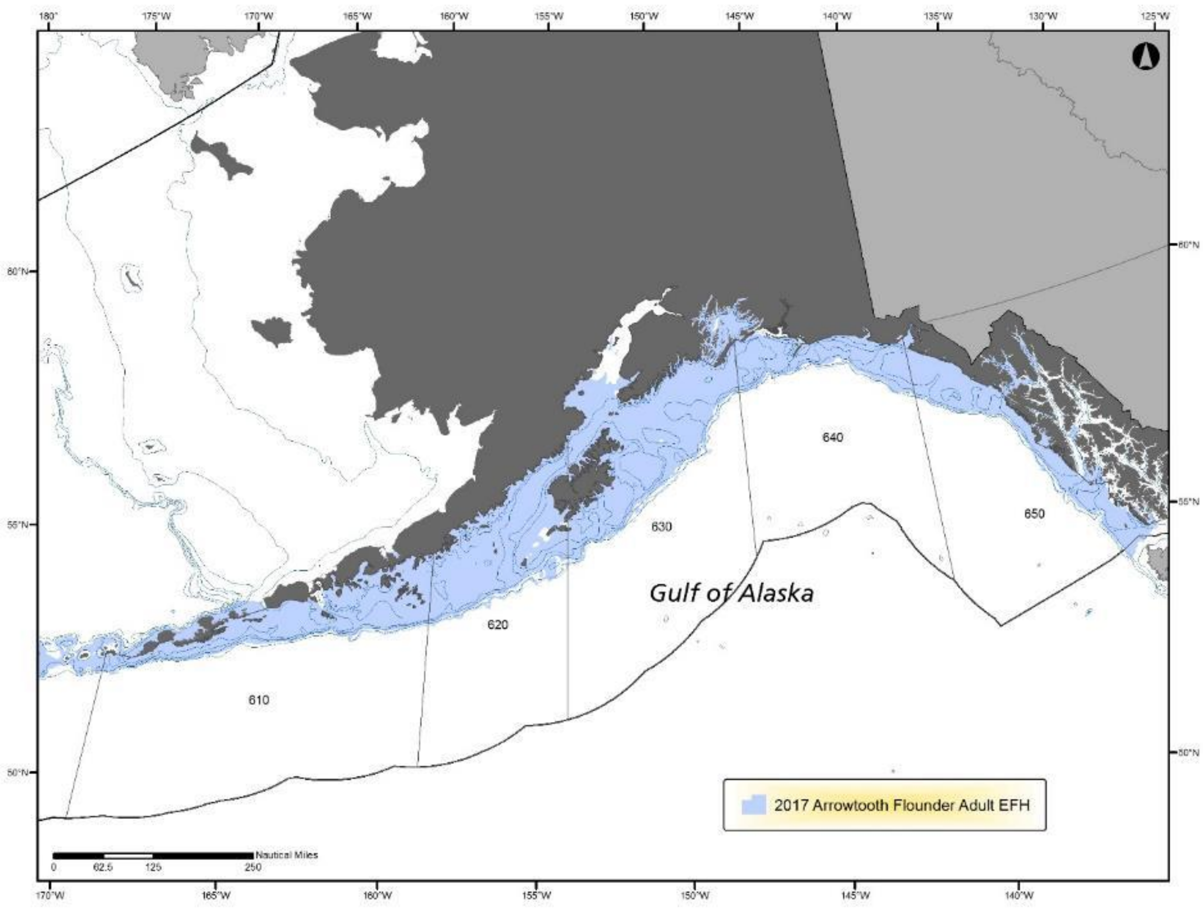
Eggs: EFH for arrowtooth flounder eggs is the general distribution area for this life stage, located in demersal habitat throughout the shelf (0 to 200 m) and upper slope (200 to 500 m).

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.

Early Juveniles: EFH for early 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) and middle (50 to 100 m) shelf throughout the GOA wherever there are softer substrates consisting of sand and mud.

Late Juveniles: EFH for late juvenile arrowtooth flounder is the habitat-related density 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.

Adults: EFH for adult arrowtooth flounder is the habitat-related density 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.



Pacific Ocean Perch

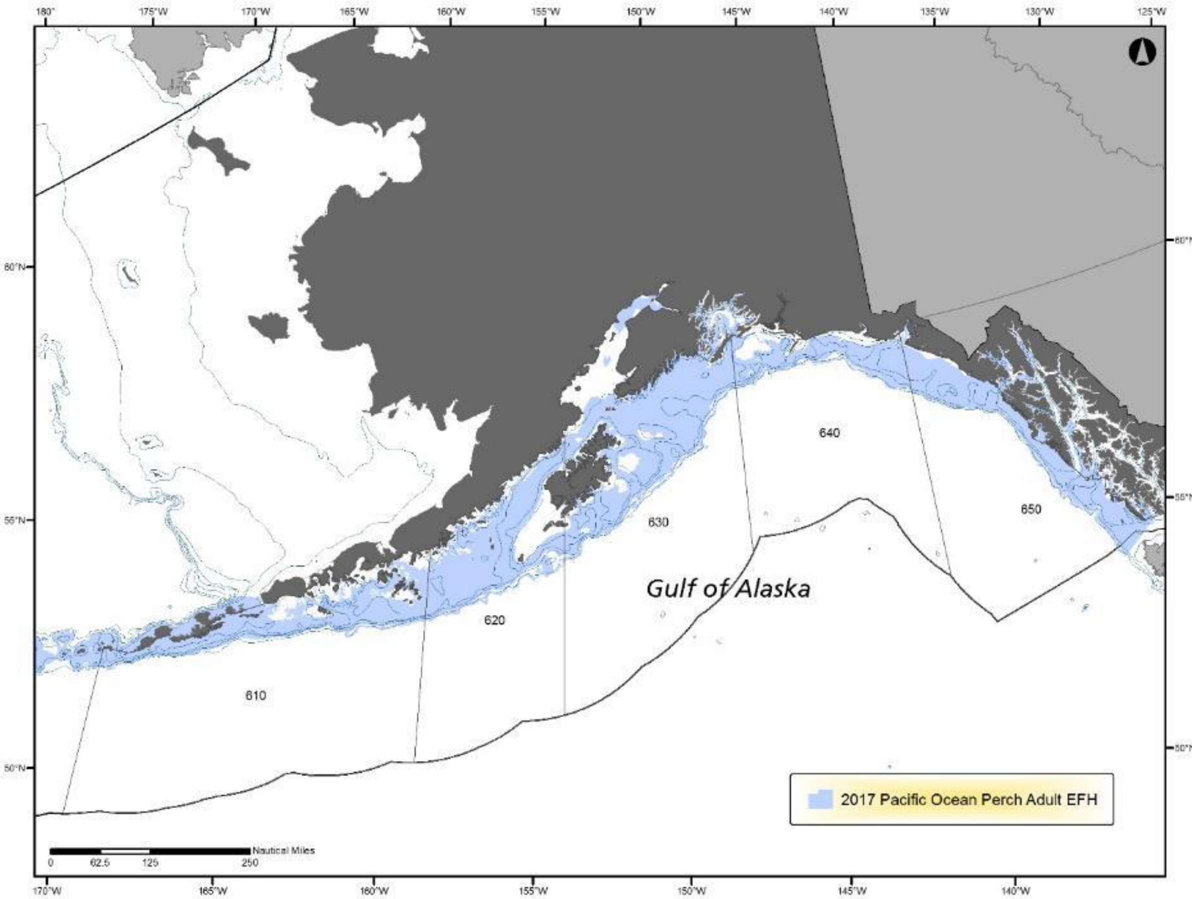
Eggs: EFH for Pacific ocean perch eggs is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m).

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. Additionally, Pacific ocean perch larvae have been found as far as 180 km offshore over depths in excess of 1,000 m.

Early Juveniles: EFH for early 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.

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.

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.


Gulf of Alaska
610
620
630
640
650
2017 Pacific Ocean Perch Adult EFH
Nautical Miles

Northern Rockfish

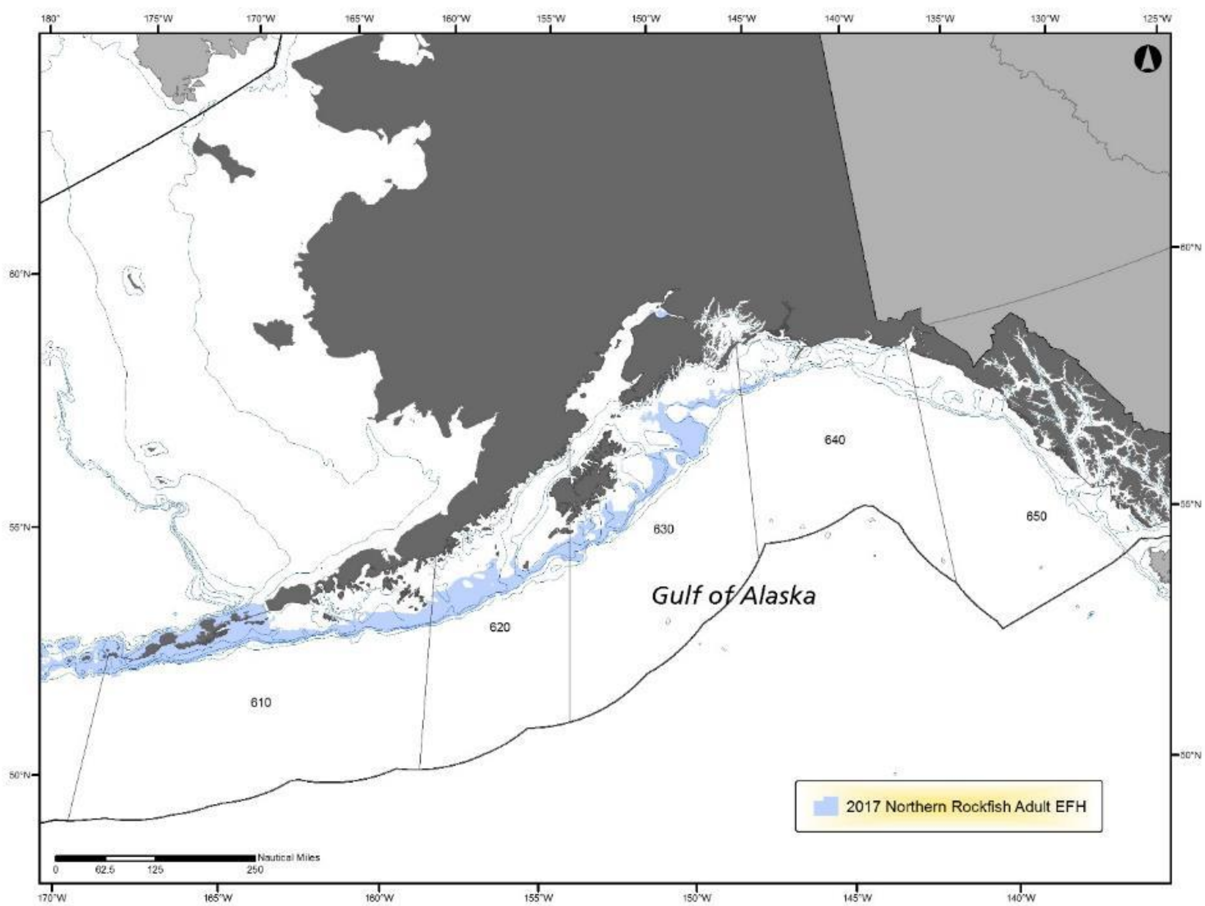
Eggs: EFH for northern rockfish eggs is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m).

Larvae: EFH for larval northern rockfish is the general distribution area for this life stage, located in pelagic waters along the middle and outer shelf (50 to 200 m) and slope (200 to 3,000 m) throughout the GOA.

Early Juveniles: EFH for early juvenile northern rockfish is the general distribution area for this life stage, located in pelagic waters along the middle and outer shelf (50 to 200 m) and slope (200 to 3,000 m) throughout the GOA.

Late Juveniles: EFH for late juvenile northern rockfish is the habitat-related density area for this life stage, located in the middle and lower portions of the water column along the outer shelf (100 to 200 m) throughout the GOA, wherever there are substrates of cobble and rock.

Adults: EFH for adult northern rockfish is the habitat-related density 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.



Shortraker Rockfish

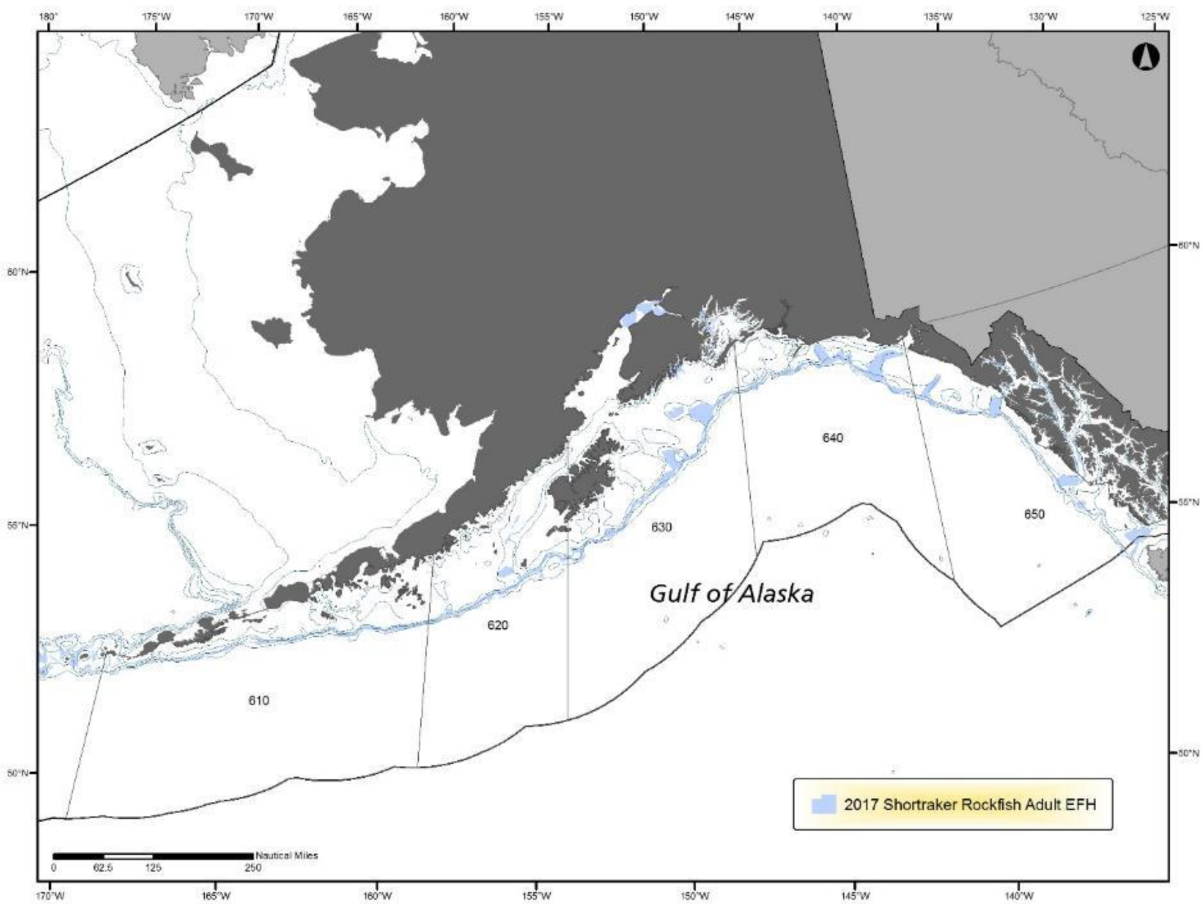
Eggs: EFH for shortraker rockfish eggs is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m).

Larvae: EFH for larval shortraker rockfish is the general distribution area for this life stage, located in pelagic waters along the middle and outer shelf (50 to 200 m) and slope (200 to 3,000 m) throughout the GOA.

Early Juveniles: EFH for early juvenile shortraker rockfish is the general distribution area for this life stage, located in pelagic waters throughout the middle and outer (50 to 200 m) shelf and slope (200 to 3,000 m).

Late Juveniles: EFH for late juvenile shortraker rockfish is the habitat-related density 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.

Adults: EFH for adult shortraker rockfish is the habitat-related density area for this life stage, located in the lower portion of the water column along the 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. Adults are especially found on steep slopes with frequent boulders.



Blackspotted and Rougheye Rockfishes

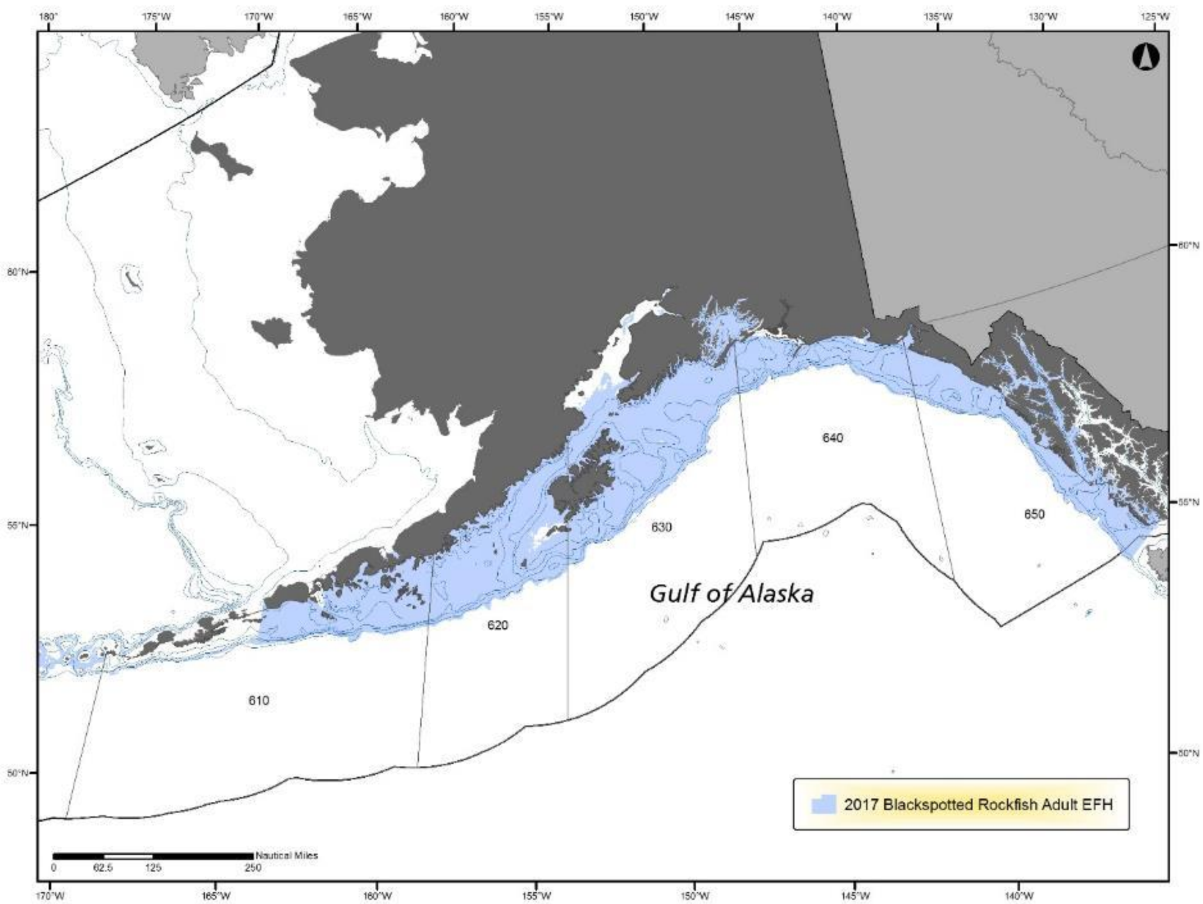
Eggs: EFH for blackspotted/rougheye rockfish eggs is the general distribution area for this life stage, located in the lower portion of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m).

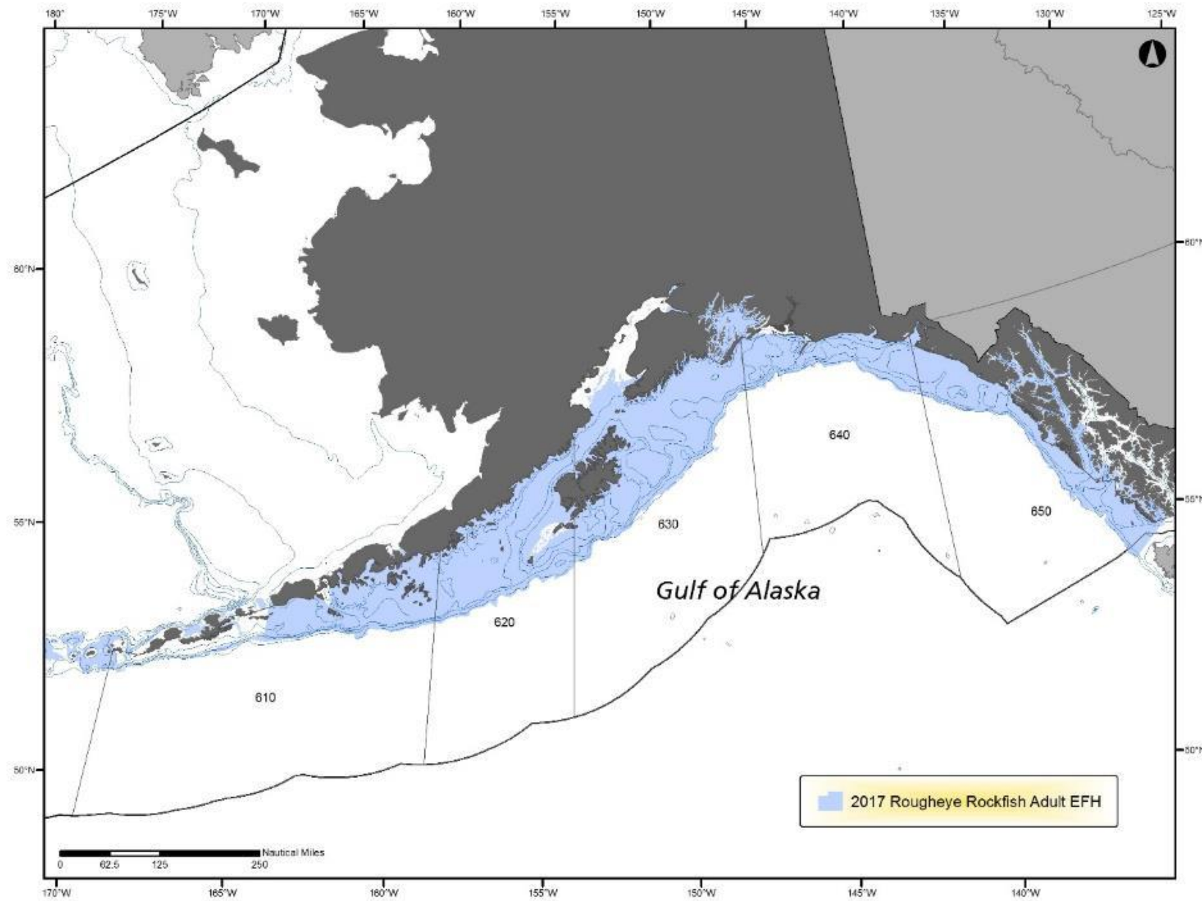
Larvae: EFH for larval blackspotted/rougheye rockfish is the general distribution area for this life stage, located in pelagic waters along the middle and outer shelf (50 to 200 m) and slope (200 to 3,000 m) throughout the GOA.

Early Juveniles: EFH for early juvenile blackspotted/rougheye rockfish is the general distribution area for this life stage, located in pelagic waters throughout the middle and outer (50 to 200 m) shelf and slope (200 to 3,000 m).

Late Juveniles: EFH for juvenile rougheye and blackspotted rockfish 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 upper slope (200 to 500 m).

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.




Gulf of Alaska
610
620
630
640
650
2017 Rougheye Rockfish Adult EFH
Nautical Miles
0
62.5
125
250
180°
175°W
170°W
165°W
160°W
155°W
150°W
145°W
140°W
135°W
130°W
125°W
60°N
55°N
50°N

Dusky Rockfish

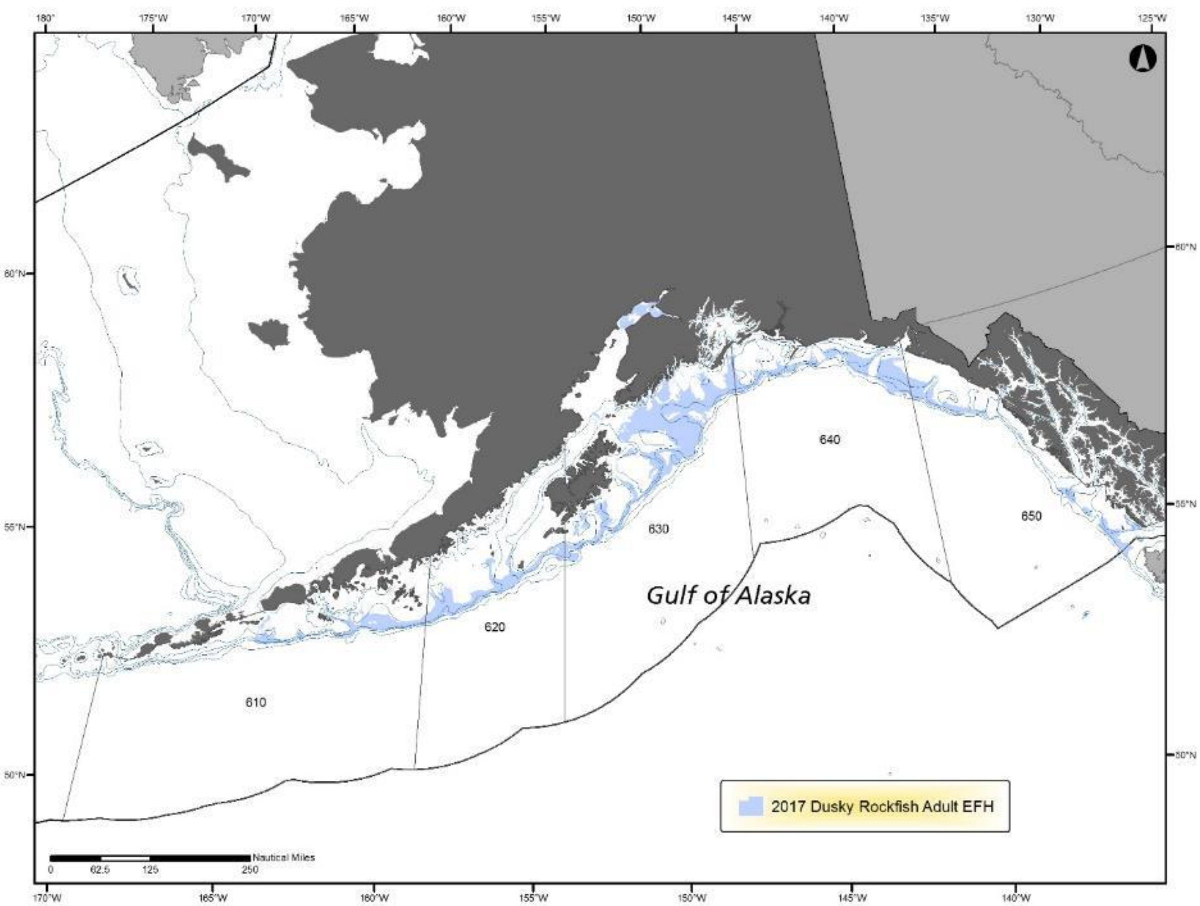
Eggs: EFH for dusky rockfish eggs is the general distribution area for this life stage, located in the middle and lower portions of the water column along the outer shelf (100 to 200 m) and upper slope (200 to 500 m).

Larvae: EFH for larval dusky rockfish is the general distribution area for this life stage, located in the pelagic waters along the entire shelf (0 to 200 m) and slope (200 to 3,000 m) throughout the GOA.

Early Juveniles: No EFH description determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile dusky rockfish is the general distribution area for this life stage, located in the middle and lower portions of the water column along the middle and outer shelfs (100 to 200 m) throughout the GOA wherever there are substrates of cobble, rock, and gravel

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.



Yelloweye Rockfish

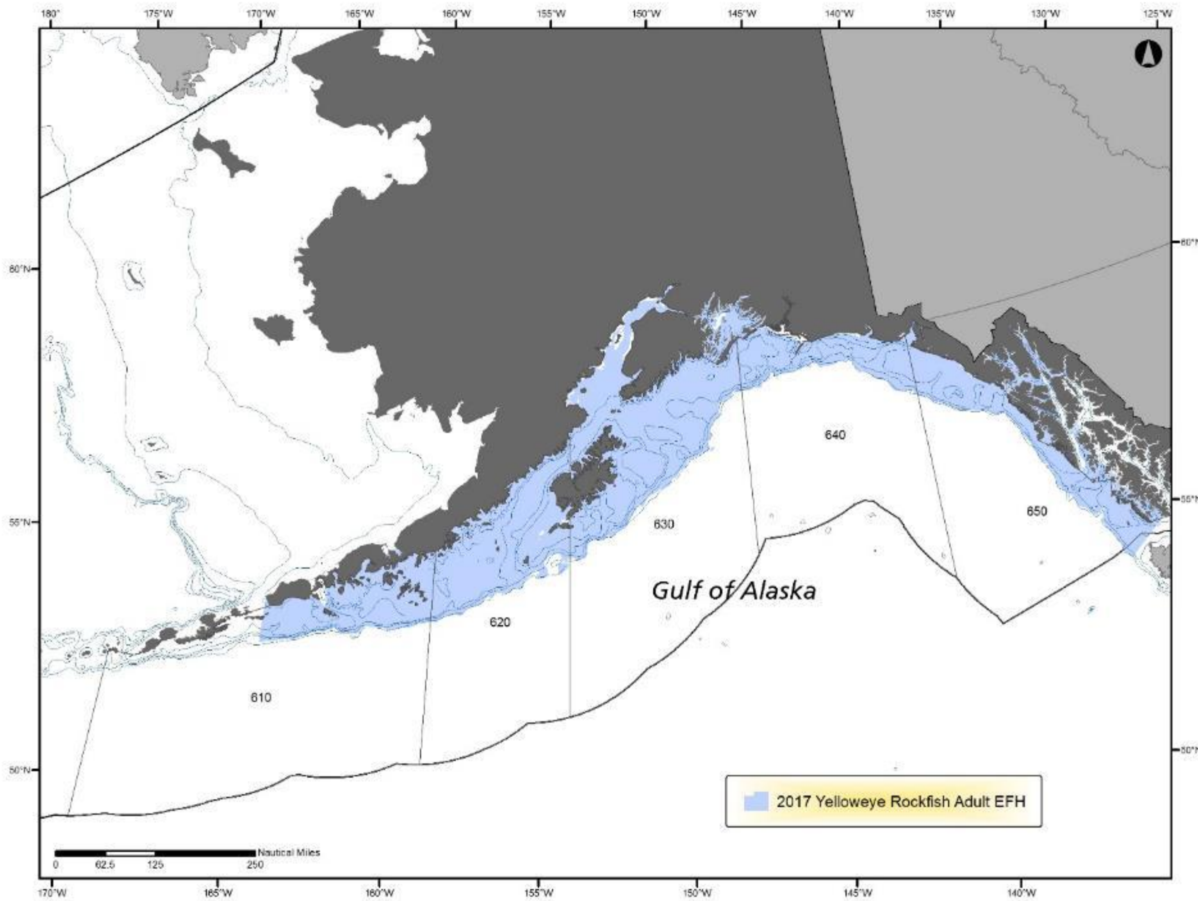
Eggs: EFH for yelloweye rockfish eggs is the general distribution area for this life stage, located in the lower portion of the water column within bays and island passages and along the inner shelf (0 to 50 m), outer shelf (100 to 100 m), and upper slope (200 to 500 m).

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.

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.

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.

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.


Gulf of Alaska
610
620
630
640
650
2017 Yelloweye Rockfish Adult EFH
Nautical Miles
0
62.5
125
250

Other Rockfish

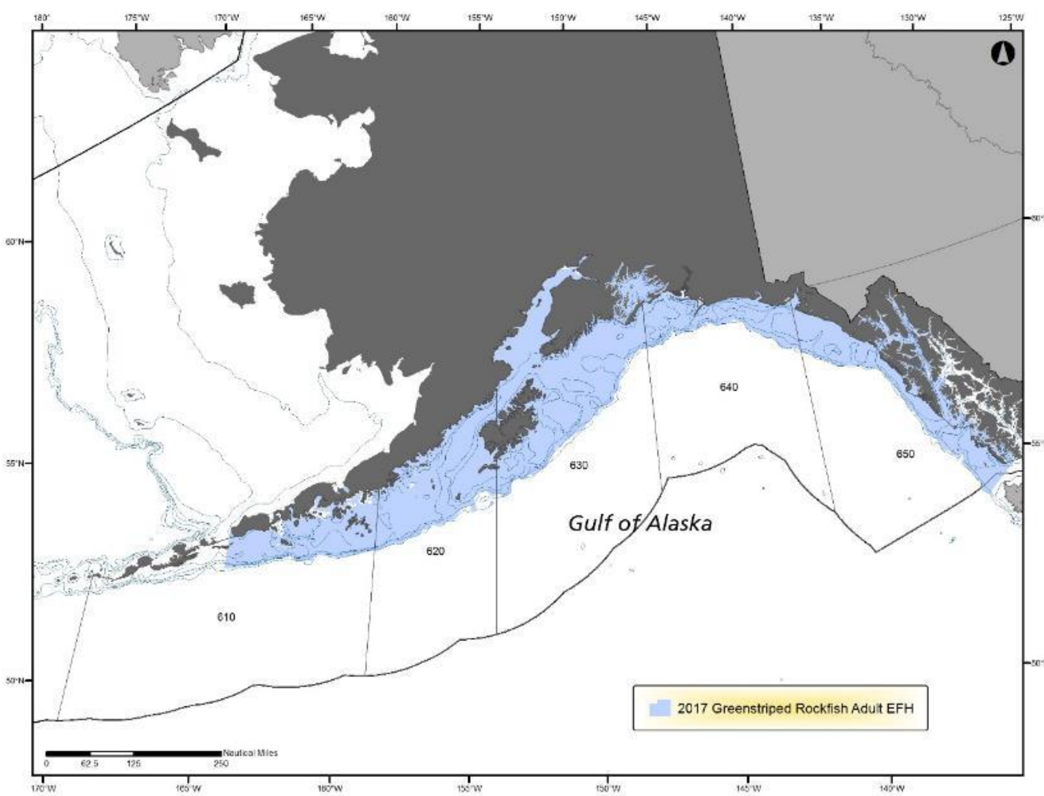
Eggs: EFH for other rockfish eggs is the general distribution area for this life stage, located in the lower portion of the water column along the shelf (0 to 200 m) and upper slope (200 to 500 m).

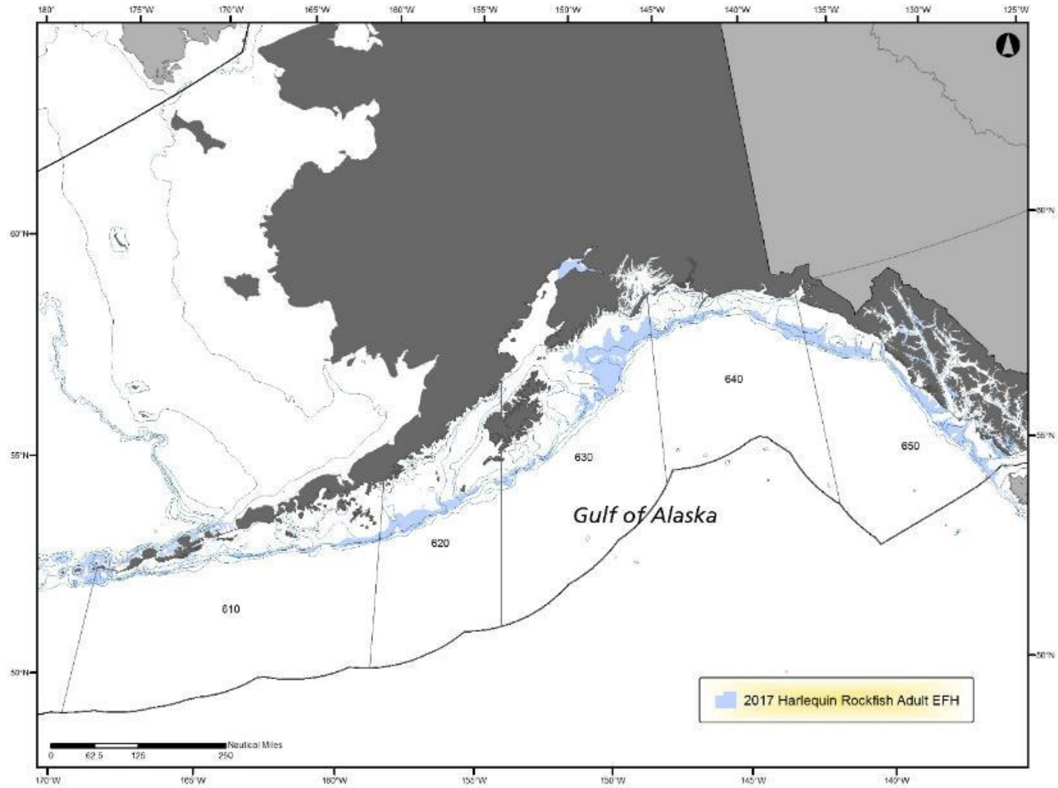
Larvae: No EFH description determined. Insufficient information is available.

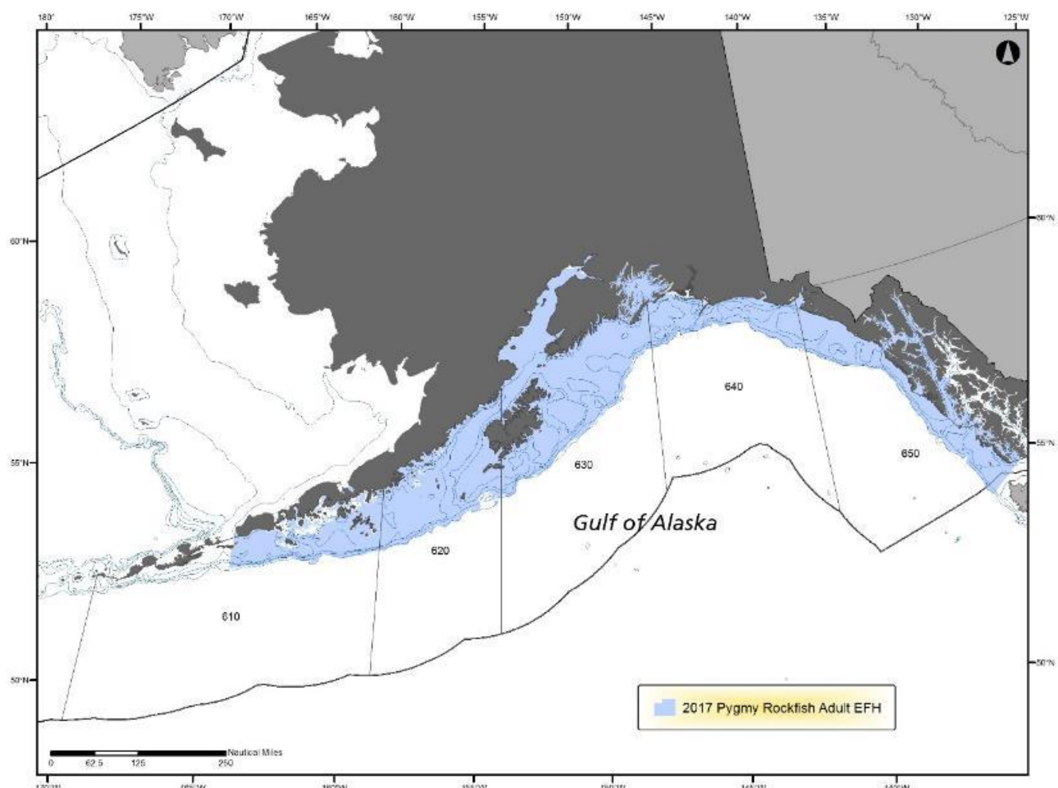
Early Juveniles: No EFH description determined. Insufficient information is available.

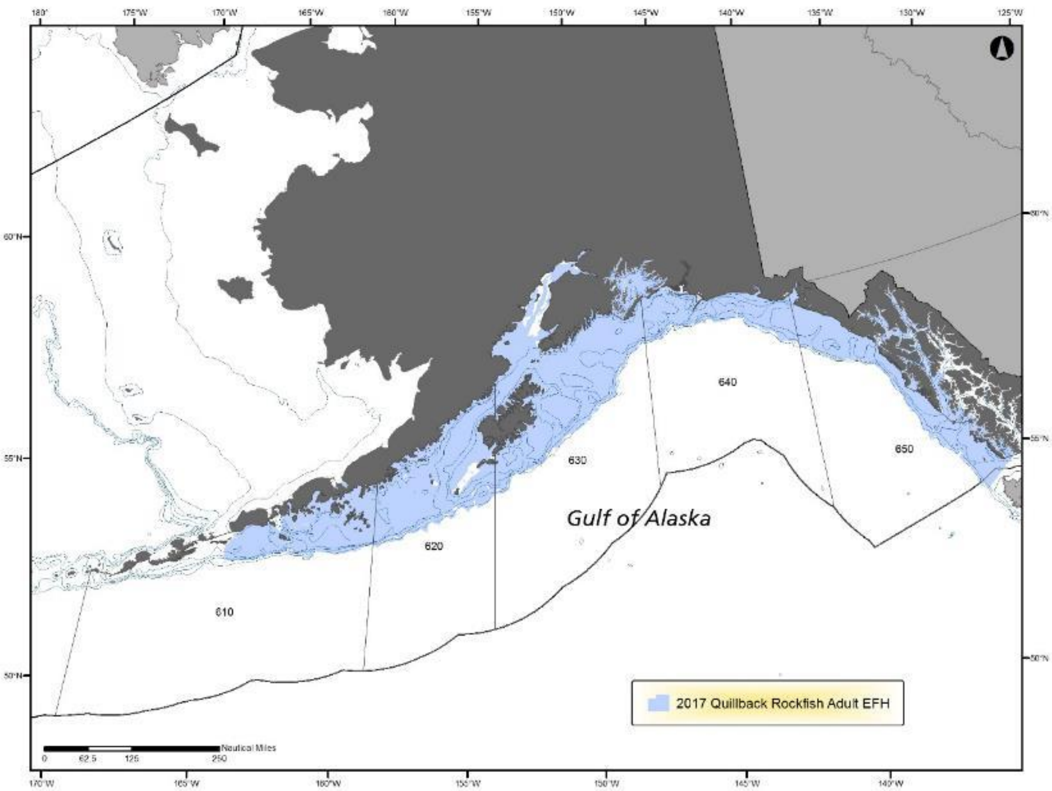
Late Juveniles: EFH for early juvenile other rockfish is the general distribution area for this life stage, based on all rockfish species combined, located in the lower portion of the water column along the middle (50 to 100 m) and outer shelf (100 to 200 m) throughout the GOA.

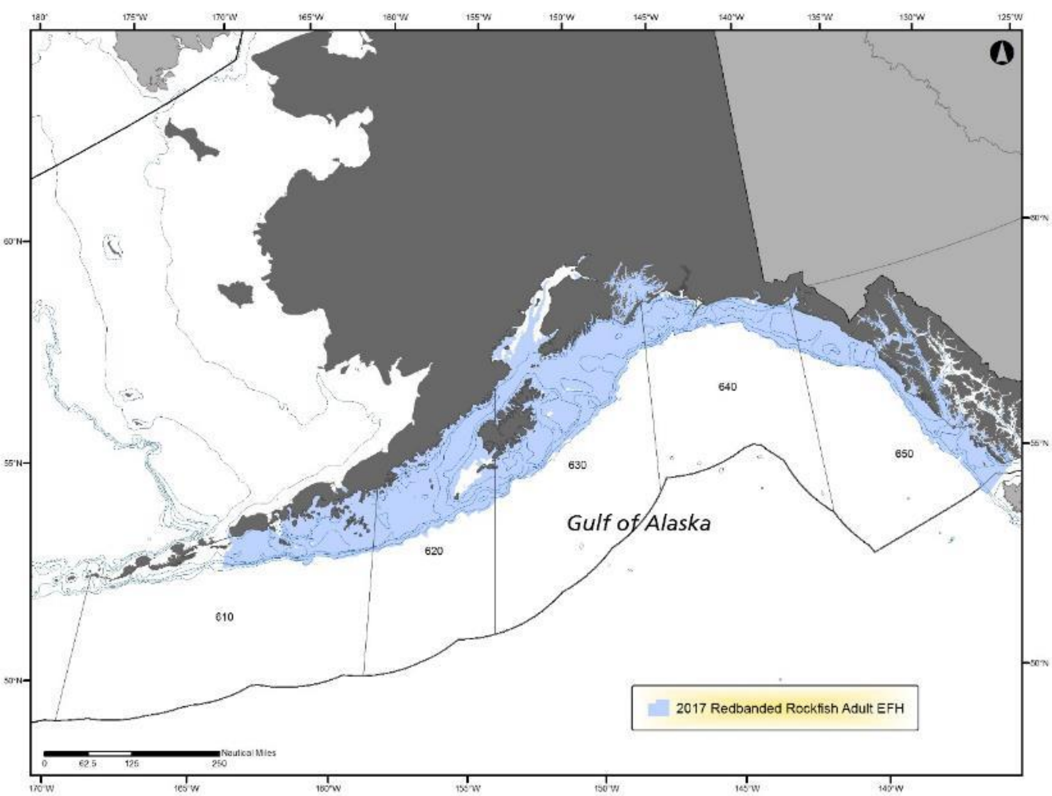
Adults: EFH for adult other rockfish is the general distribution area for this life stage, located in the lower portion of the water column along the shelf (0 to 200 m) and upper slope (200 to 500 m).

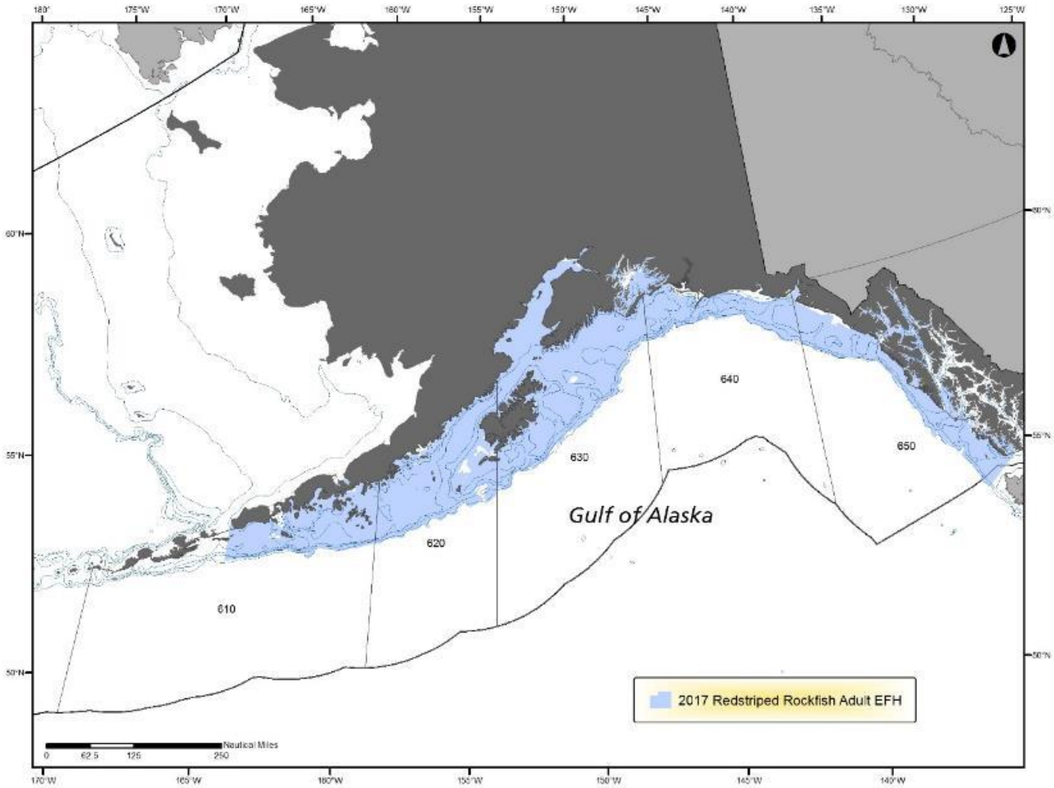


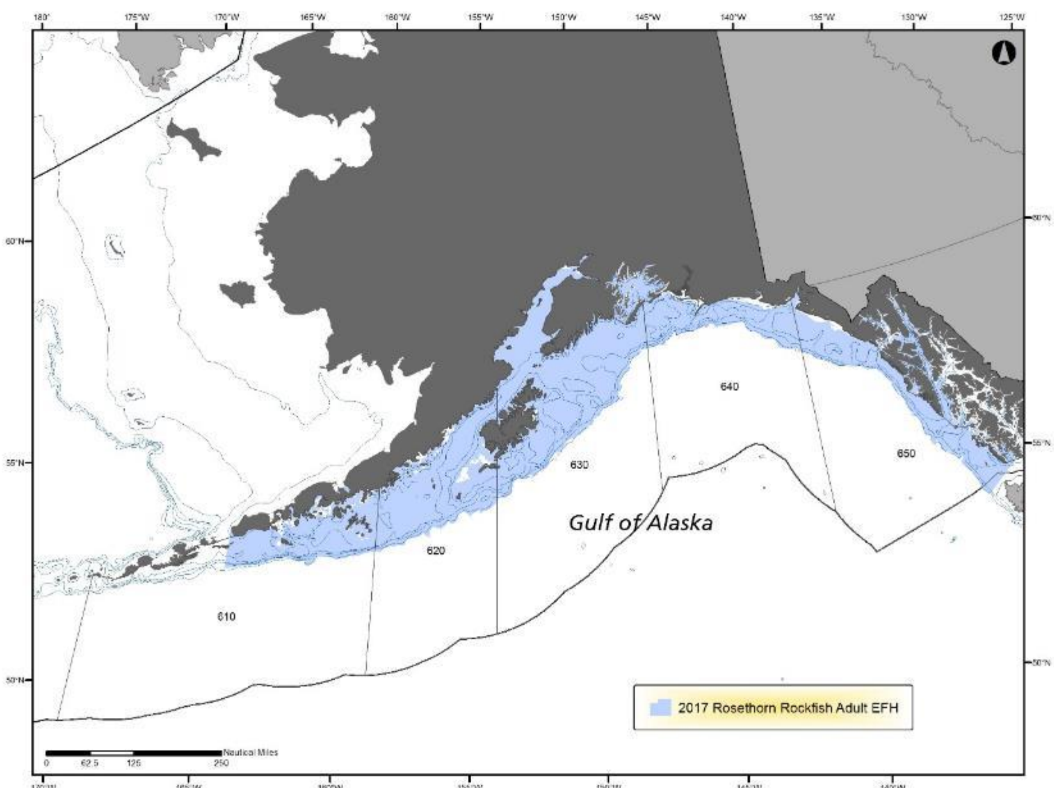

180°
175°W
170°W
165°W
160°W
155°W
150°W
145°W
140°W
135°W
130°W
125°W
60°N
55°N
50°N
610
620
630
640
650
Gulf of Alaska
2017 Harlequin Rockfish Adult EFH
Nautical Miles
0
62.5
125
250

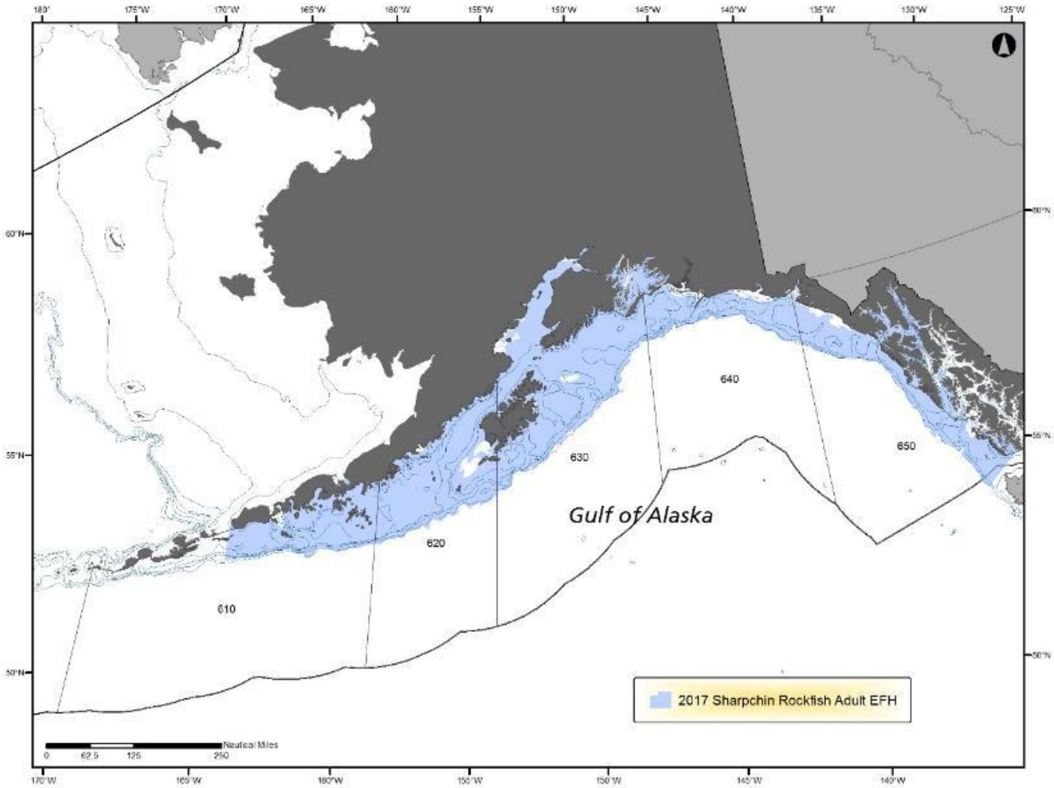

180°
175°W
170°W
165°W
160°W
155°W
150°W
145°W
140°W
135°W
130°W
125°W
60°N
55°N
50°N
610
620
630
640
650
Gulf of Alaska
2017 Pygmy Rockfish Adult EFH
Nautical Miles
0
62.5
125
250

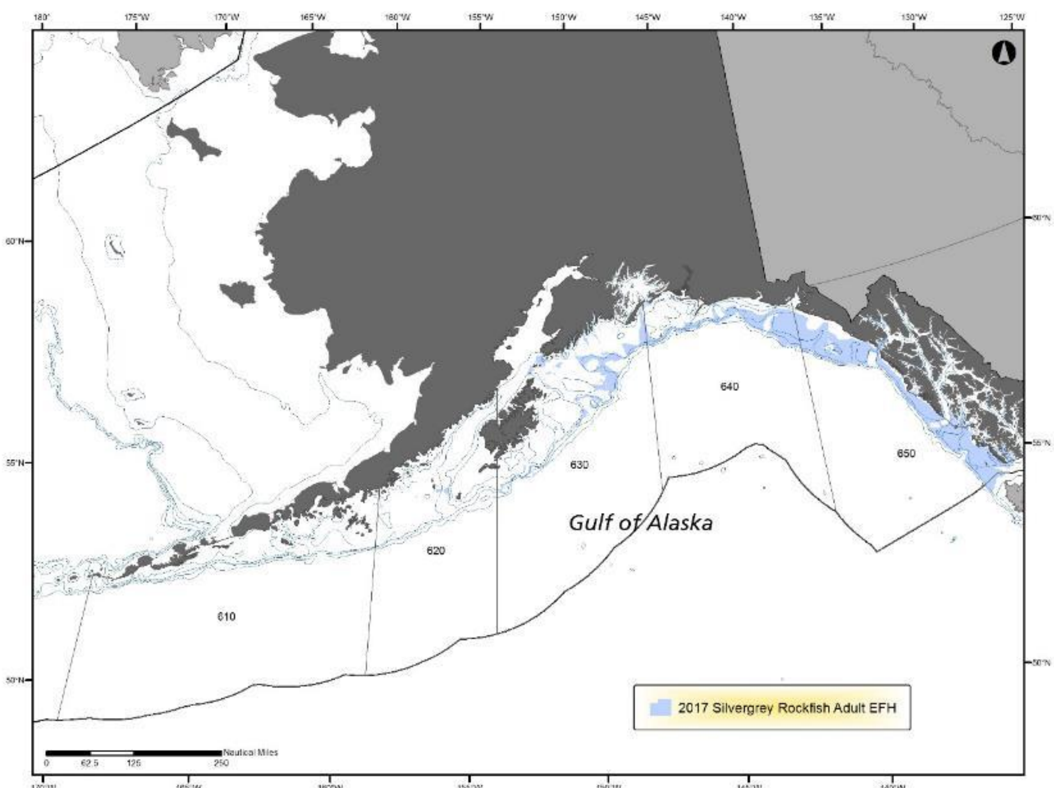

Gulf of Alaska
610
620
630
640
650
2017 Quillback Rockfish Adult EFH
Nautical Miles


Gulf of Alaska
610
620
630
640
650
2017 Redbanded Rockfish Adult EFH
Nautical Miles


Gulf of Alaska
610
620
630
640
650
2017 Redstriped Rockfish Adult EFH
Nautical Miles


Gulf of Alaska
610
620
630
640
650
2017 Rosethorn Rockfish Adult EFH
Nautical Miles


Gulf of Alaska
610
620
630
640
650
2017 Sharpchin Rockfish Adult EFH
Nautical Miles


Gulf of Alaska
610
620
630
640
650
2017 Silvergrey Rockfish Adult EFH
Nautical Miles

Shortspine Thornyhead Rockfish

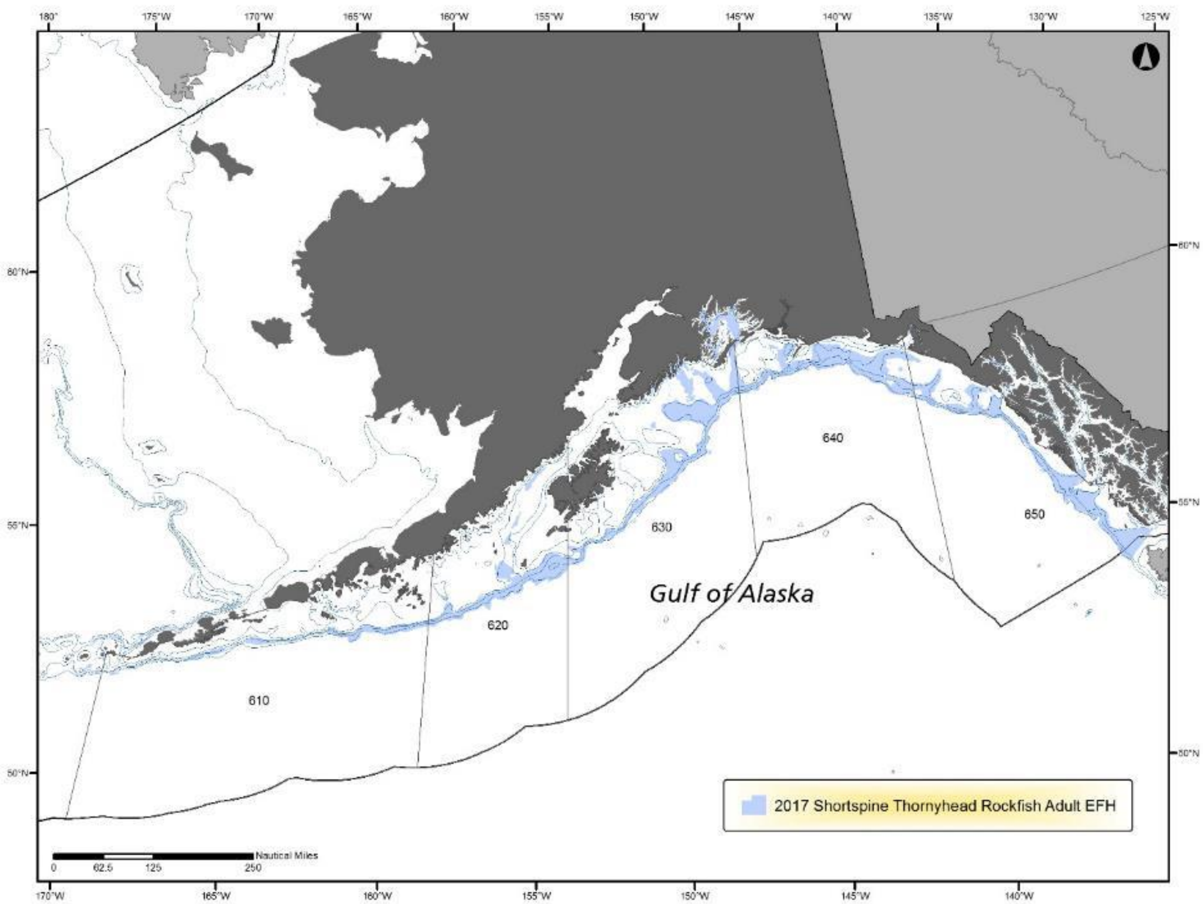
Eggs: No EFH description determined. Insufficient information is available.

Larvae: No EFH description determined. Insufficient information is available.

Early Juveniles: EFH for early juvenile thornyhead rockfish is the habitat-related density 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.

Late Juveniles: EFH for late juvenile thornyhead rockfish is the habitat-related density 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.

Adults: EFH for adult thornyhead rockfish is the habitat-related density 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.



Atka Mackerel

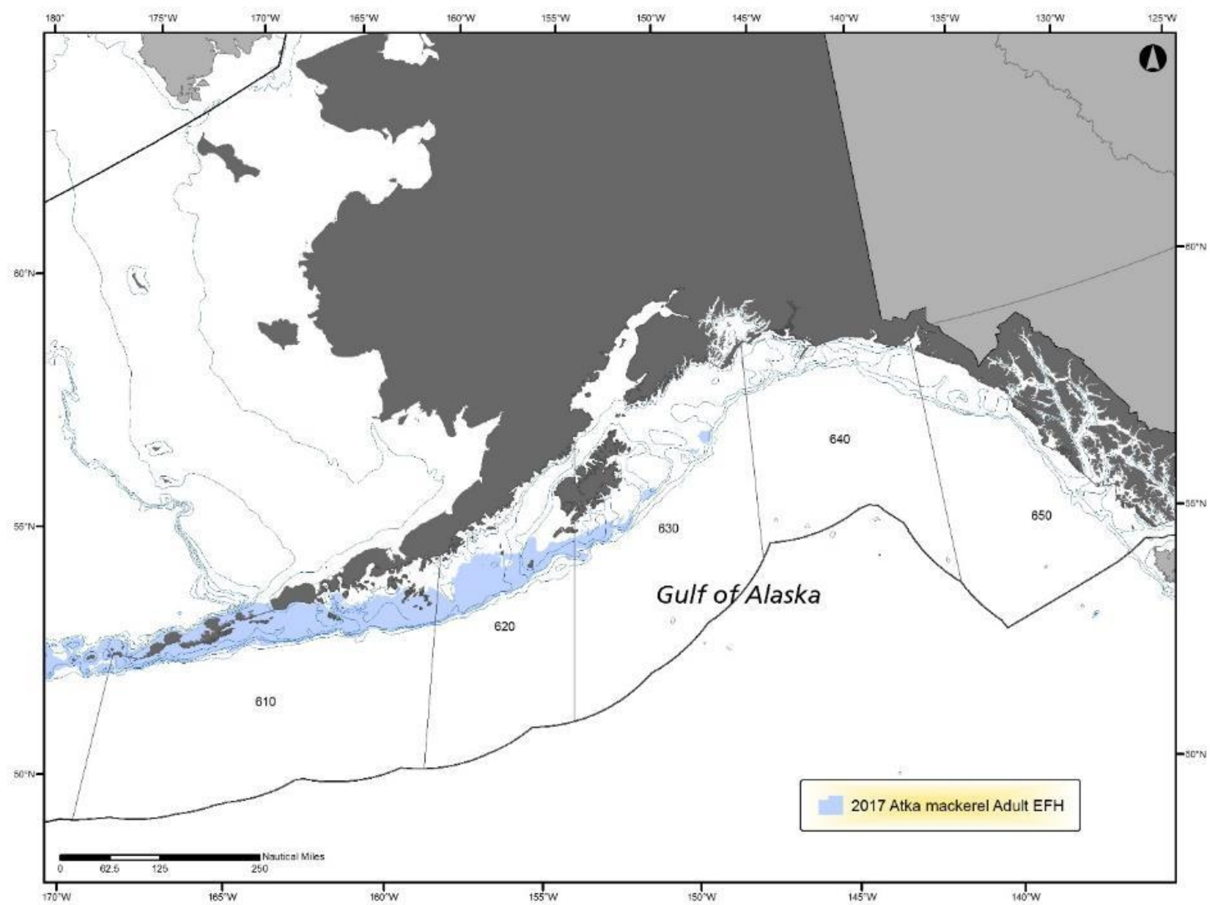
Eggs: EFH for Atka mackerel eggs is the general distribution area for this life stage, located in demersal habitat along the shelf (0 to 200 m). Several nesting sites in the GOA have been identified. There are general distribution data available; however observations are not complete for the entire GOA.

Larvae: No EFH description determined. Insufficient information is available.

Early Juveniles: No EFH description determined. Insufficient information is available.

Late Juveniles: EFH for late juvenile 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.

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.



Skates

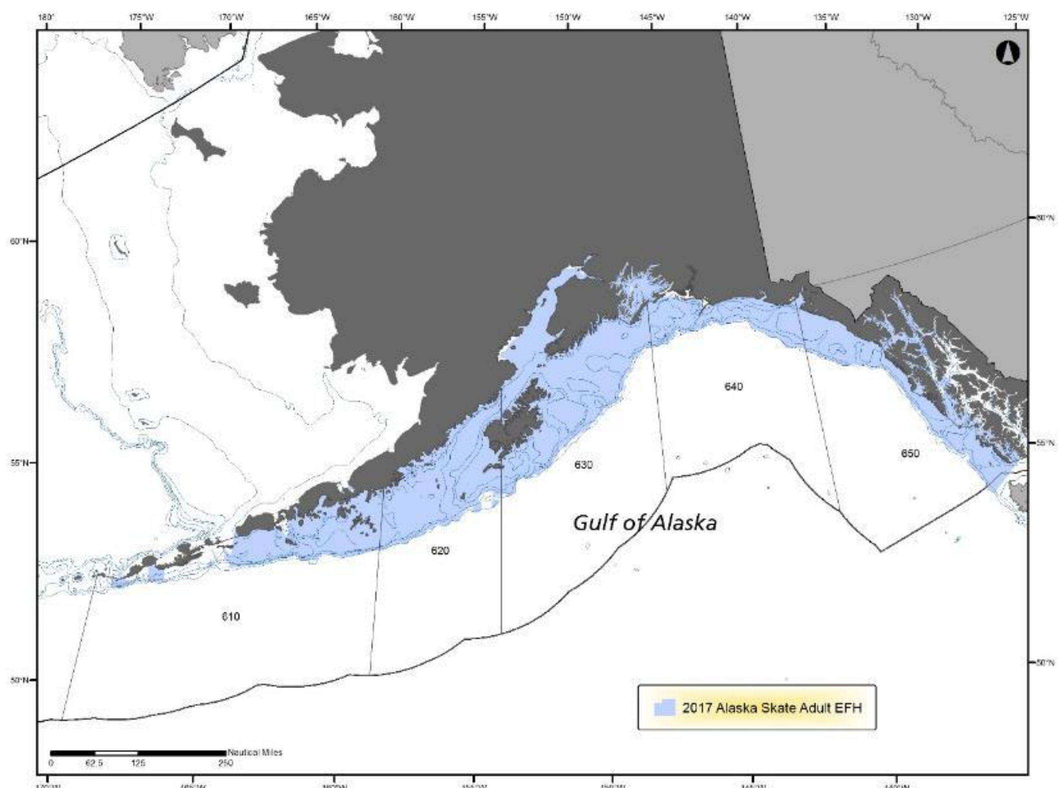
Eggs: EFH for skate egg cases is the general distribution area for this life stage, located on the seafloor below the shelf-slope interface, in depths from 140 to 360 m.

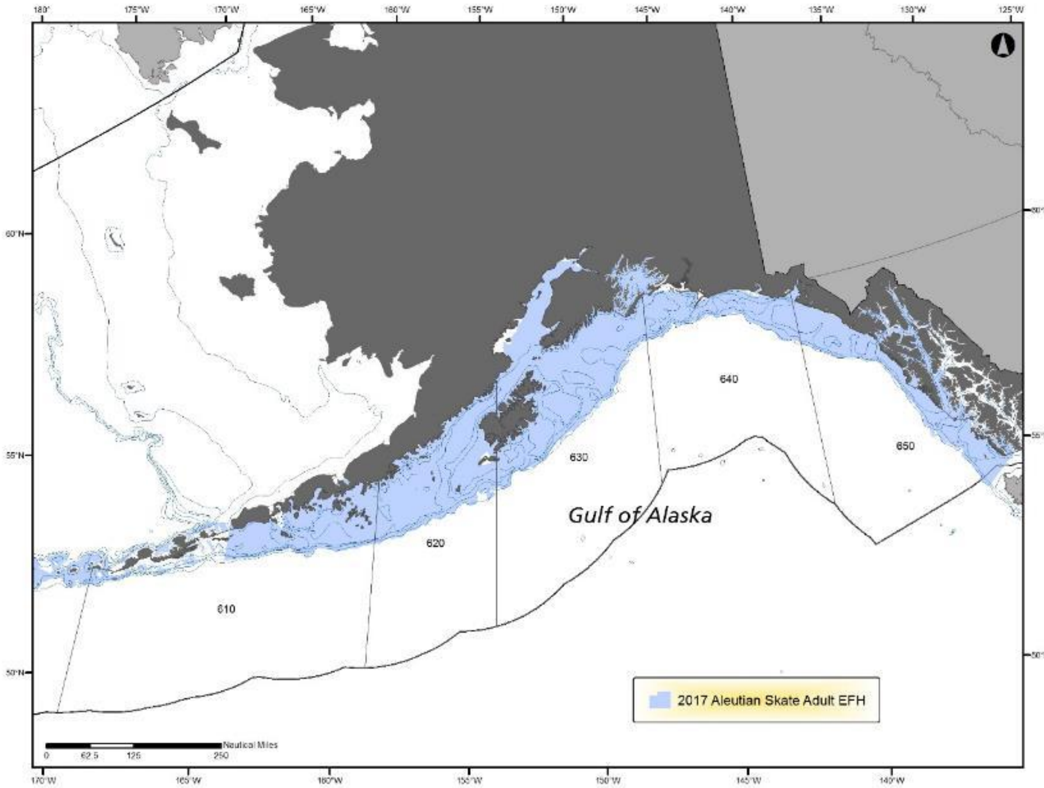
Larvae: No EFH description determined. Insufficient information is available.

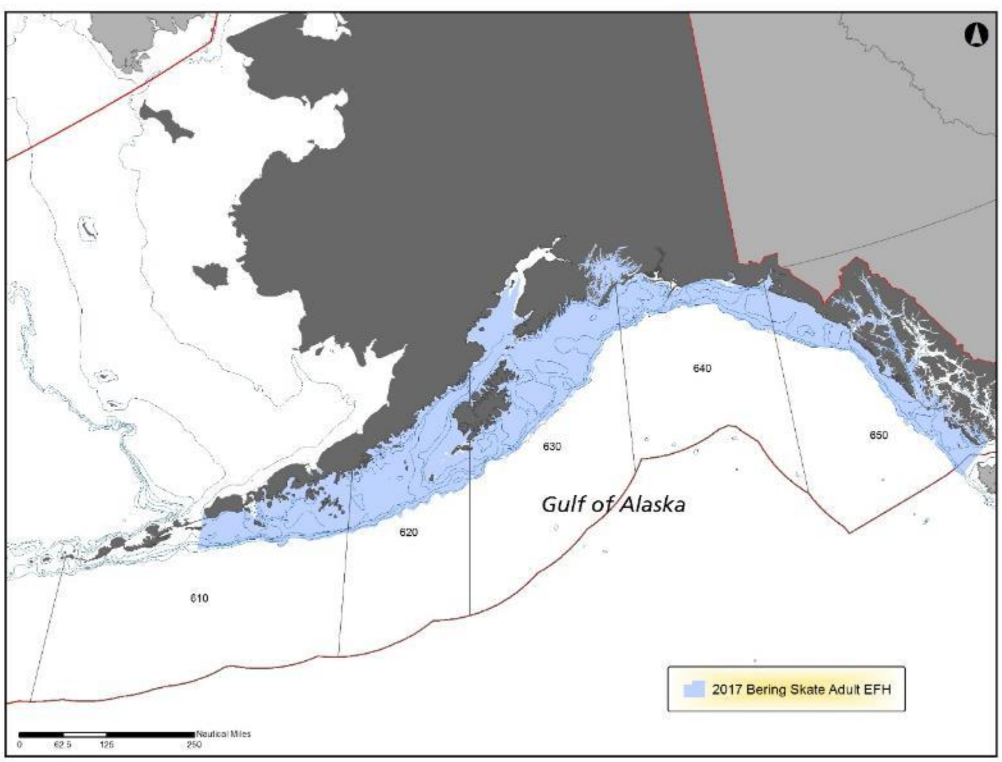
Early Juveniles: EFH for early juvenile skates is the general distribution area for this life stage, located in the lower portion of the water column on the shelf (0 to 200 m) and the upper slope (200 to 500 m) wherever there are of substrates of mud, sand, gravel, and rock.

Late Juveniles: EFH for late juvenile skates is the habitat-related density 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) wherever there are of substrates of mud, sand, gravel, and rock.

Adults: EFH for adult skates is the habitat-related density area for this life stage, located in the lower portion of the water column on the shelf (0 to 200 m), upper slope (200 to 500 m), and lower slope (500-1000 m) throughout the GOA wherever there are of substrates of mud, sand, gravel, and rock.




Gulf of Alaska
610
620
630
640
650
2017 Aleutian Skate Adult EFH
Nautical Miles


Gulf of Alaska
610
620
630
640
650
2017 Bering Skate Adult EFH
Nautical Miles

Squid

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: 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.

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.

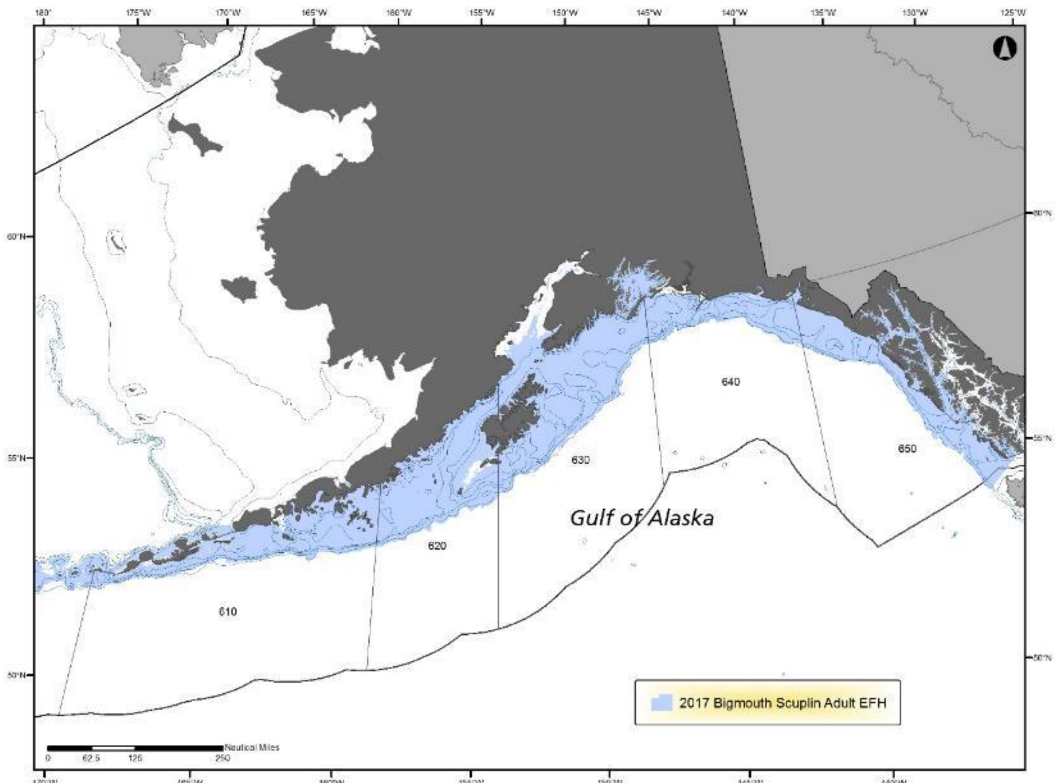
Sculpins

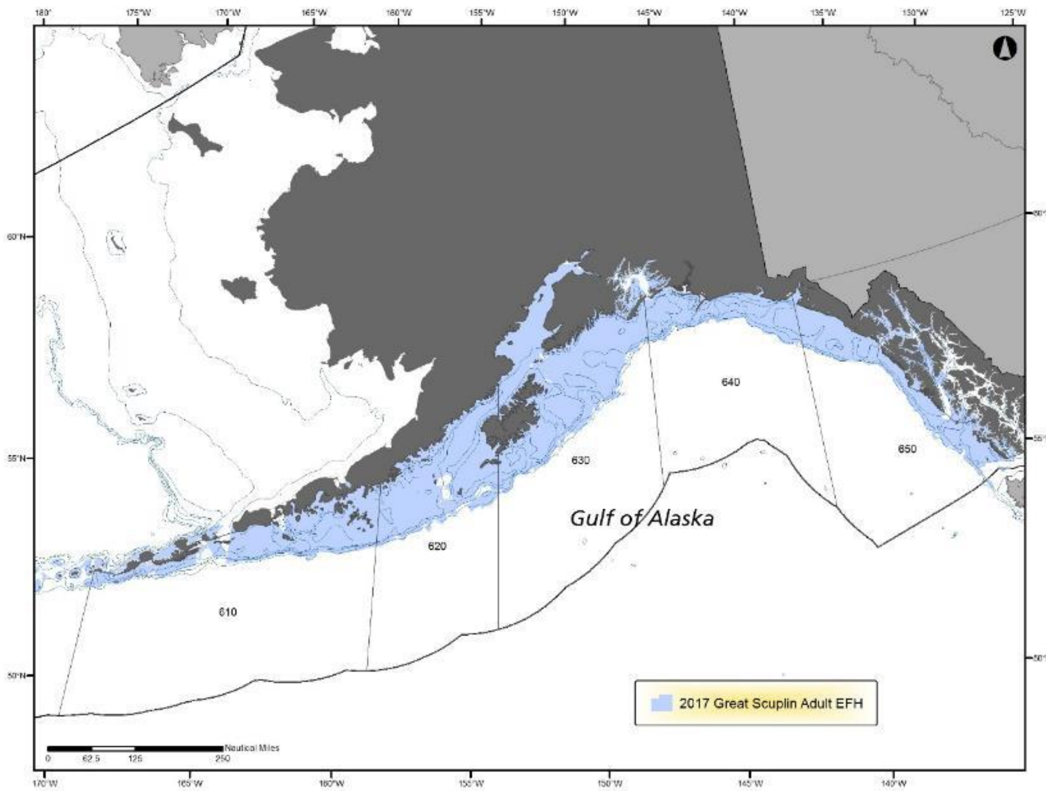
Eggs: No EFH description determined. Insufficient information is available.

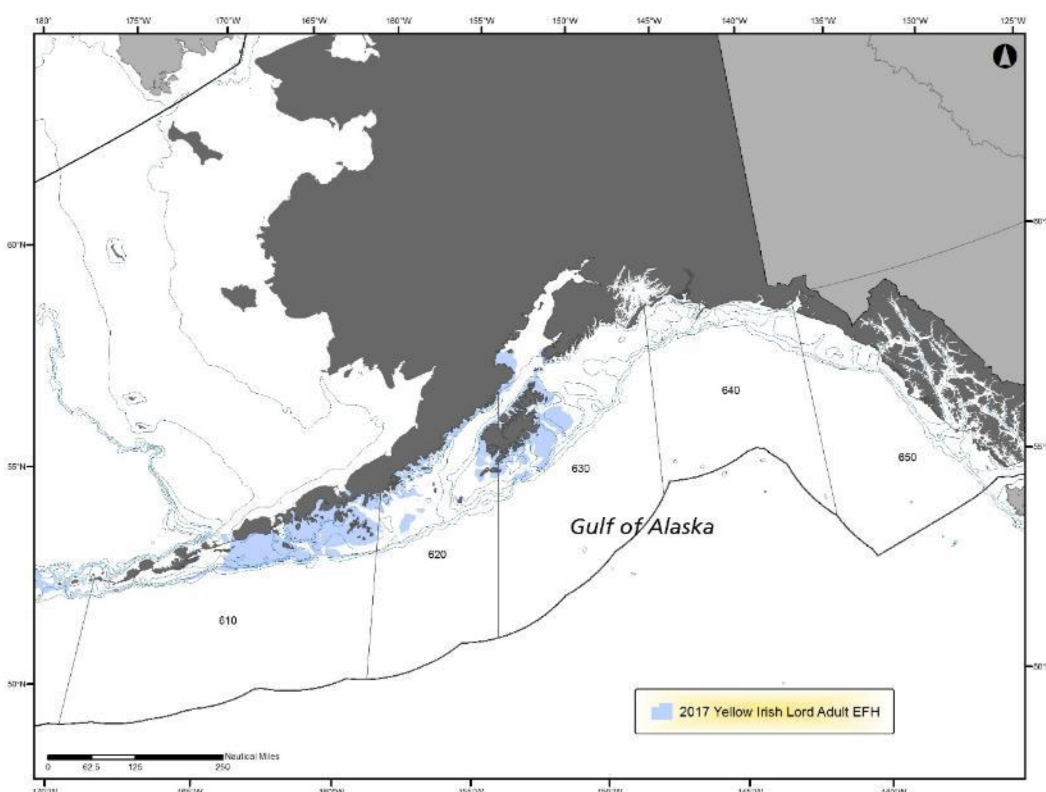
Larvae: No EFH description determined. Insufficient information is available.

Juveniles: No EFH description determined. Insufficient information is available..

Adults: EFH for adult sculpins is the habitat-related density 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.




Gulf of Alaska
610
620
630
640
650
2017 Great Sculpin Adult EFH
Nautical Miles


Gulf of Alaska
610
620
630
640
650
2017 Yellow Irish Lord Adult EFH
Nautical Miles

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.

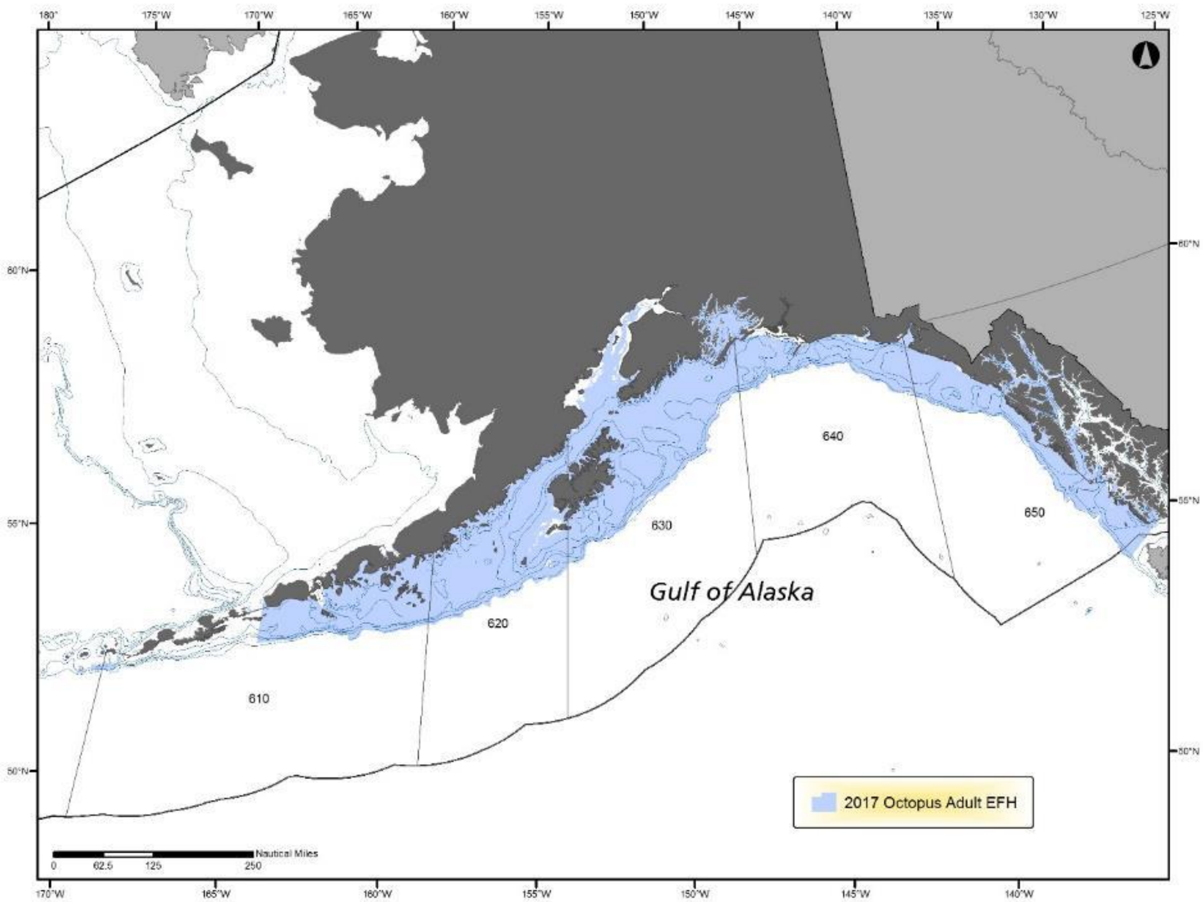
Octopus

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: EFH for adult octopus is the habitat-related density area for this life stage, located in demersal habitat throughout the intertidal, subtidal, shelf (0 to 200 m) and slope (200 to 2,000 m).



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.

Grenadiers

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.

Table 2 Summary of habitat associations for GOA groundfish

GOA Groundfish Species	LIFE STAGE	Nearshore				Shelf			Slope						Stratum Reference						
						Inner	Middle	Outer	Upper		Inter-mediate		Lower	Basin							
		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
Walleye Pollock	M						x	x	x	x				x		x	x	x	x	x	x
	J					x	x	x								x	x	x	x	x	x
	L						x	x								x	x	x	x	x	x
	E						x	x	x	x	x	x	x	x		x	x	x	x	x	x
Pacific Cod	M					x	x	x	x	x					x	x	x	x	x	x	
	LJ					x	x								x	x	x	x	x	x	
	EJ				x	x									x		x				
	L					x	x	x													
	E					x	x	x													
Sablefish	M								x	x	x	x	x				x				x
	LJ							x	x	x	x						x				x
	EJ					x	x	x							x		x				
	L						x	x	x	x	x	x	x	x							
	E								x	x	x	x	x	x							
Yellowfin Sole	M					x	x														
	LJ					x	x														
	EJ					x															
	L					x	x														
	E					x	x														
Northern Rock Sole	M					x	x	x													
	LJ					x	x														
	EJ					x															
	L					x	x	x													
	E					x	x	x													
Southern Rock Sole	M					x	x	x													
	LJ					x	x														
	EJ					x															
	L					x	x	x													
	E					x	x	x													
Alaska Plaice	M					x	x	x													
	LJ					x	x	x													
	EJ					x	x														
	L					x	x	x													
	E					x	x	x													
Rex Sole	M					x	x	x	x	x											
	LJ					x	x	x	x												
	EJ					x	x														
	L					x	x	x	x												
	E					x	x	x	x												

GOA Groundfish Species	LIFE STAGE	Location							Physical Oceano-graphy					Substrate												
						Pelagic																				
		Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock
Walleye Pollock	M		x	x	x	x	x		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	x	x	x	x	
	L		x	x	x	x			x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	
	E		x	x		x			x	x	x	x														
Pacific Cod	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	x	x	x	x	x	x		
	L					x																				
	E				x										x	x	x	x	x	x	x	x	x	x	x	x
Sablefish	M				x				x						x	x	x								x	x
	LJ				x				x						x	x	x								x	x
	EJ		x	x	x	x	x		x																	
	L	x	x						x																	
	E					x	x		x																	
Yellowfin Sole	M				x										x	x				x						
	LJ				x										x	x				x						
	EJ				x										x	x				x						
	L					x																				
	E					x																				
Northern Rock Sole	M				x										x	x				x						
	LJ				x										x	x				x						
	EJ				x										x	x				x						
	L					x					x															
	E				x																					
Southern Rock Sole	M				x										x	x				x						
	LJ				x										x	x				x						
	EJ				x										x	x				x						
	L					x					x															
	E				x																					
Alaska Plaice	M				x										x	x				x						
	LJ				x										x	x				x						
	EJ				x										x	x				x						
	L					x					x															
	E					x																				
Rex Sole	M				x										x	x				x						
	LJ				x										x	x				x						
	EJ				x										x	x				x						
	L					x									x	x										
	E					x																				

GOA Groundfish Species	LIFE STAGE	Structure										Community Associations													Oceano-graphic Properties			LIFE STAGE
		Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Algal Cover	Anemones	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sponges	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	
Walleye Pollock	M																								2-10			M
	J																								2-10			J
	L																											L
	E																											E
Pacific Cod	M				x	x			x				x	x	x	x	x						x	x				M
	LJ				x	x			x				x	x	x	x	x						x	x				LJ
	EJ											x	x	x			x		x									EJ
	L																											L
	E																								3-6	13-23	2-3	E
Sablefish	M							x																				M
	LJ																											LJ
	EJ																											EJ
	L																											L
	E																											E
Yellowfin Sole	M																											M
	LJ																											LJ
	EJ																											EJ
	L																											L
	E																											E
Northern Rock Sole	M																											M
	LJ																											LJ
	EJ																											EJ
	L																											L
	E																											E
Southern Rock Sole	M																											M
	LJ																											LJ
	EJ																											EJ
	L																											L
	E																											E
Alaska Plaice	M																											M
	LJ																											LJ
	EJ																											EJ
	L																											L
	E																											E
Rex Sole	M																											M
	LJ																											LJ
	EJ																											EJ
	L																											L
	E																											E

Table 2. Continued

GOA Groundfish Species	LIFE STAGE	Nearshore: Freshwater	Estuarine	Intertidal	Subtidal	Shelf: Inner: 1-50m	Middle: 51-100m	Outer: 101-200m	Slope: Upper: 201-300m	301-500m	Inter-mediate: 501-700m	701-1000m	Lower: 1001-3000m	Basin: >3000m	Stratum Reference: Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully
Dover Sole	M					x	x	x	x	x	x	x									
	LJ					x	x	x	x	x											
	EJ					x	x														
	L					x	x	x	x	x											
	E					x	x	x	x	x											
Flathead Sole	M					x	x	x	x												
	LJ					x	x	x													
	EJ					x	x														
	L					x	x	x													
	E					x	x	x													
Arrowtooth Flounder	M					x	x	x	x	x	x										
	LJ					x	x	x													
	EJ					x	x														
	L					x	x	x	x	x											
	E					x	x	x	x	x											
Pacific Ocean Perch	M							x	x	x								x	x	x	x
	LJ					x	x	x	x												
	EJ					x	x	x													
	L																				
Northern Rockfish	M						x	x										x			
	LJ						x	x										x	x		
	EJ																				
	L																				
Shortraker Rockfish	M								x	x										x	
	LJ																				
	EJ												x	x							
	L																				
Rougheye/ Blackspotted Rockfish	M								x	x								x	x	x	x
	LJ							x	x								x		x		
	EJ												x	x							
	L																				
Dusky Rockfish	M							x	x									x		x	x
	LJ						x	x										x		x	
	EJ																				
	L																				
Yelloweye Rockfish	M					x	x	x	x	x						x	x				
	LJ					x	x	x								x	x				
	EJ					x	x	x								x	x				
	L					x	x														
	E																				
Thornyhead Rockfish	M								x	x	x	x	x								
	LJ						x	x	x												
	EJ																				
	L																				
	E																				

GOA Groundfish Species	LIFE STAGE	Location: Surfce	Near surface	Semi-demersal	Demersal	Pelagic: 1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Physical Oceano-graphy: Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Substrate: 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			x							
	LJ				x										x	x			x							
	EJ				x										x	x			x							
	L					x					x															
	E					x																				
Flathead Sole	M				x										x	x	x			x		x				
	LJ				x										x	x	x			x		x				
	EJ				x										x	x										
	L					x					x									x						
	E					x																				
Arrowtooth Flounder	M				x										x	x	x			x						
	LJ				x										x	x	x			x						
	EJ				x										x	x	x			x						
	L					x					x															
	E				x																					
Pacific Ocean Perch	M			x	x	x			x					x	x	x	x	x	x	x	x	x	x	x	x	x
	LJ								x																x	x
	EJ			x	x	x	x	x	x								x								x	x
	L		x	x		x	x		x																	
Northern Rockfish	M				x																				x	x
	LJ				x																					
	EJ					x																				
	L																									
Shortraker Rockfish	M				x								x		x	x	x	x	x	x	x	x	x	x	x	x
	LJ				x																					
	EJ		x																							
	L					x																				
Rougheye/ Blackspotted Rockfish	M				x										x	x	x	x	x	x	x	x	x	x	x	x
	LJ																								x	x
	EJ		x	x		x																				
	L		x			x																				
Dusky Rockfish	M				x												x								x	x
	LJ				x																					
	EJ																									
	L																									
Yelloweye Rockfish	M				x				x							x									x	x
	LJ				x				x																	x
	EJ				x				x																	x
	L			x	x	x			x																	x
	E																									
Thornyhead Rockfish	M				x										x		x								x	x
	LJ				x										x		x									x
	EJ					x																				
	L					x																				
	E					x																				

GOA Groundfish Species	LIFE STAGE	Structure: Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamount	Reefs	Vertical Walls	Man-made	Community Associations: Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sponges	Sea Onions	Tunicates	Oceano-graphic Properties: Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	LIFE STAGE
Dover Sole	M																											M
	LJ																											LJ
	EJ																											EJ
	L																											L
	E																											E
Flathead Sole	M																											M
	LJ																											LJ
	EJ																											EJ
	L																											L
	E																											E
Arrowtooth Flounder	M																											M
	LJ																											LJ
	EJ																											EJ
	L																											L
	E																											E
Pacific Ocean Perch	M														x													M
	LJ																											LJ
	EJ																											EJ
	L																											L
Northern Rockfish	M																											M
	LJ																											LJ
	EJ																											EJ
	L																											L
Shortraker Rockfish	M							x								x												M
	LJ																											LJ
	EJ																											EJ
	L																											L
Rougheye/ Blackspotted Rockfish	M							x								x												M
	LJ																											LJ
	EJ																											EJ
	L																											L
Dusky Rockfish	M																											M
	LJ															x												LJ
	EJ																											EJ
	L																											L
Yelloweye Rockfish	M					x	x			x			x		x													M
	LJ					x	x			x			x		x													LJ
	EJ					x	x			x			x		x													EJ
	L					x	x			x																		L
	E																											E
Thornyhead Rockfish	M							x																				M
	LJ																											LJ
	EJ																											EJ
	L																											L
	E																											E

GOA Groundfish Species	LIFE STAGE	Nearshore				Shelf			Slope						Stratum Reference							Location				Pelagic			Physical Oceano-graphy					Substrate													Structure										Community Associations													Oceano-graphic Properties			LIFE STAGE
		Freshwater	Estuarine	Intertidal	Subtidal	Inner 1-50m	Middle 51-100m	Outer 101-200m	Upper 201-300m	Upper 301-500m	Inter-mediate 501-700m	Inter-mediate 701-1000m	Lower 1001-3000m	Basin >3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock	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	Sponges	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	
Atka Mackerel	M					x	x	x	x							x							x	x	x				x			x	x			x	x								x	x								x							x			x						3-5	>17		M
	J																					x	x																																															3-12			J
	L																					x	x																																															2-12			L
	E					x	x	x								x									x												x								x	x																		x						3-10			E
Skates	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x																																																M
	LJ																																																																								LJ
	EJ																																																																								EJ
	L																																																																								L
	E																																																																								E
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																									x																					M
	LJ																																																																								LJ
	EJ																																																																								EJ
	L																																																																								L
	E																																																																								E
Sculpins	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x																												x																					M
	LJ																																																																								LJ
	EJ																																																																								EJ
	L																																																																								L
	E																																																																								E
Octopus	M			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x				x	x	x																																														M
	LJ																																																																								LJ
	EJ																																																																								EJ
	L																																																																								L
	E																																																																								E
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																																														M
	LJ																																																																								LJ
	EJ																																																																								EJ
	L																																																																								L
	E																																																																								E
Eulachon	M						x	x	x								x									x			x			x	x																																								M
	LJ						x	x																		x			x			x	x																																								LJ
	EJ					x	x																			x			x			x																																									EJ
	L	x	x			x	x										x						x																																																		L
	E	x																																																																			4-8			E
Capelin	M						x	x									x									x			x			x	x																																					-2-3			M
	LJ						x	x																		x			x			x	x																																								LJ
	EJ					x	x																			x			x			x																																									EJ
	L		x			x	x										x						x																																																		L
	E			x											x																					x	x					x																												5-9			E
Sand Lance	M			x	x	x									x		x					x	x	x	x	x										x	x					x																															M
	LJ			x	x	x									x		x					x	x	x	x	x										x	x					x																															LJ
	EJ		x		x	x									x		x					x	x			x																																															EJ
	L		x			x									x		x					x	x			x																																															L
	E			x													x																																																								E
Other Rockfish	M					x	x	x	x	x	x					x	x								x				x							x									x	x					x	x		x	x			x		x							x						M
	LJ					x	x	x								x	x								x				x																	x					x	x		x	x			x		x							x						LJ
	EJ					x	x	x								x	x								x				x																	x					x	x		x	x			x		x							x						EJ
	L					x	x																	x	x	x			x																	x					x	x		x	x																		L
	E																																																																								E

Table 3 Summary of biological associations for GOA groundfish

GOA Groundfish Species	Life Stage	Reproductive Traits																											
		Age at Maturity (unless otherwise noted)				Fertilization/ Egg Development						Spawning Behavior						Spawning Season											
		Female		Male																									
		50%	100%	50%	100%	External	Internal	Oviparous	Ovoviviparous	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
Walleye Pollock	M	4-5		4-5		x							x						x	x	x	x							
Pacific Cod	M	5		5		x							x					x	x	x	x	x							
Sablefish	M	65cm		67c		x							x					x	x	x									
Yellowfin Sole	M	10.5				x						x										x	x	x					
Northern Rock Sole	M	9				x						x						x	x	x									
Southern Rock Sole	M	9				x						x						x	x	x									
Alaska Plaice	M	6-7				x														x	x	x							x
Rex Sole	M	24cm		16cm		x													x	x	x	x	x	x					
Dover Sole	M	6.7	11			x						x							x	x	x	x							
Flathead Sole	M	8.7				x						x								x	x	x	x						
Arrowtooth Flounder	M	5		4		x												x	x	x	x							x	x
Pacific Ocean Perch	M	10.5	20.0				x				x	x														x	x	x	x
Northern Rockfish	M	13					x				x	x								x	x	x							
Shortraker Rockfish	M	20+					x				x	x							x	x	x	x	x	x	x				
Rougheye/Blackspotted Rockfish	M	19+					x				x	x						x	x	x	x								x
Dusky Rockfish	M	11					x				x	x																	
Yelloweye Rockfish	M	22		18			x		x												x	x	x	x					
Thornyhead Rockfish	M	21.5 cm							x			x									x	x	x	x					
Atka Mackerel	M	3.6		3.6		x						x			x	x							x	x	x	x	x		
Skates	M						x	x						x															
Squid	M						x					x																	
Sculpins	M					x										x													
Octopus	M						x					x			x	x													
Sharks	M	35		21			x	x	x	x	x			x			x	x	x	x						x	x	x	x
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
Other Rockfish	M						x		x	x							x												

Table 4 Summary of predatory prey associations for GOA groundfish

Predator to

GOA Groundfish 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																														
Pacific Cod	M							x		x			x							x										x	
	LJ							x		x			x							x										x	
	EJ							x		x			x							x											
	L			x	x						x																				
	E																														
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																														
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																														
Northern Rock Sole	M									x			x			x	x														
	LJ									x			x			x	x														
	EJ				x																										
	L	x		x																											
	E																														
Southern Rock Sole	M									x			x			x	x														
	LJ									x			x			x	x														
	EJ				x																										
	L	x		x																											
	E																														
Alaska Plaice	M									x			x																		
	LJ																														
	EJ																														
	L																														
	E																														
Rex Sole	M							x		x			x					x													
	LJ							x		x			x					x													
	EJ																														
	L	x		x																											
	E																														
Dover Sole	M												x						x												
	LJ												x						x												
	EJ																														
	L	x		x																											
	E																														

Prey of

GOA Groundfish Species	Life Stage	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	Sperm whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrestrial 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																														
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																														
Sablefish	M																														
	LJ						x									x									x						
	EJ																														
	L																														
	E																														
Yellowfin Sole	M																														
	LJ								x							x															
	EJ								x							x															
	L																														
	E																														
Northern Rock Sole	M																														
	LJ							x	x					x		x															
	EJ																														
	L																														
	E																														
Southern Rock Sole	M																														
	LJ							x	x					x		x															
	EJ																														
	L																														
	E																														
Alaska Plaice	M																														
	LJ																														
	EJ																														
	L																														
	E																														
Rex Sole	M														x																
	LJ														x																
	EJ																														
	L																														
	E																														
Dover Sole	M							x								x															
	LJ							x								x															
	EJ																														
	L																														
	E																														

Table 4. Continued

Predator to

GOA Groundfish 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)	Hering	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																														
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																														
Pacifc Ocean Perch	M							x		x	x									x											
	LJ							x		x	x									x											
	EJ																														
	L			x	x																										
Northern Rockfish	M				x			x			x																				
	LJ																														
	EJ																														
	L																														
Shortraker Rockfish	M													x						x				x							
	LJ																														
	EJ																														
	L																														
Rougheye/ Blackspotted Rockfish	M							x			x			x				x		x				x							
	LJ									x										x											
	EJ																														
	L																														
Dusky Rockfish	M							x		x	x							x		x	x										
	LJ							x		x	x							x		x	x										
	EJ																														
	L																														
Yelloweye Rockfish	M																	x		x	x		x				x				
	LJ																														
	EJ										x																				
	L																														
	E																														
Thornyhead Rockfish	M				x					x								x		x											
	LJ				x					x								x		x											
	EJ																														
	L																														
	E																														
Atka Mackerel	M							x			x													x							
	J							x			x																				
	L										x																				
	E																														

Prey of

GOA Groundfish Species	Life Stage	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	Sperm whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrestrial Mammals
Flathead Sole	M							x	x						x	x				x											
	LJ							x							x																
	EJ							x	x						x																
	L																														
	E																														
Arrowtooth Flounder	M																														
	LJ							x	x																						
	EJ																														
	L																														
	E																														
Pacifc Ocean Perch	M									x						x															
	LJ									x						x															
	EJ						x			x	x					x															
	L																														
Northern Rockfish	M																														
	LJ																														
	EJ																														
	L																														
Shortraker Rockfish	M																														
	LJ																														
	EJ																														
	L																														
Rougheye/ Blackspotted Rockfish	M								x							x															
	LJ								x						x	x															
	EJ																														
	L																														
Dusky Rockfish	M								x	x	x				x	x															
	LJ								x	x	x				x	x															
	EJ																														
	L																														
Yelloweye Rockfish	M						x			x	x					x															
	LJ						x			x	x					x															
	EJ																														
	L																														
	E																														
Thornyhead Rockfish	M														x																
	LJ														x																
	EJ																														
	L																														
	E																														
Atka Mackerel	M								x						x	x		x	x	x	x			x							
	J																	x		x							x	x			
	L																														
	E																														

Table 4. Continued

Predator to

GOA Groundfish 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																														
Squid	M							x			x										x	x	x	x							
	LJ																														
	EJ																														
	L																														
	E																														
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																														
Octopus	M															x	x	x	x	x	x				x		x		x		x
	LJ																														
	EJ																														
	L																														
	E																														
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																														
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																									
	E																														
Other Rockfish	M																	x		x	x	x	x	x			x				
Rockfish	LJ																														
	EJ										x																				
	L																														
	E																														

Prey of

GOA Groundfish Species	Life Stage	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	Sperm whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrestrial Mammals
Skates	M																		x												
	LJ																														
	EJ																														
	L																														
	E																														
Squid	M	x						x	x	x	x					x	x	x	x	x	x		x	x			x	x	x	x	
	LJ																														
	EJ																														
	L																														
	E																														
Sculpins	M							x	x		x	x	x		x	x	x	x	x	x	x										
	LJ																														
	EJ																														
	L																														
	E																														
Octopus	M							x	x	x	x					x	x	x	x	x		x									
	LJ																														
	EJ																														
	L																														
	E																														
Sharks	M									x						x	x														
	LJ																														
	EJ																														
	L																														
	E																														
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	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	X						X	X															
	E																														
Other Rockfish	M						x			x	x					x	x														
Rockfish	LJ						x			x	x					x	x														
	EJ																														
	L																														
	E																														

Habitat Information

The following sections describe the habitat of the GOA management area and defines essential fish habitat for each of the managed species.

Habitat Types

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

The dominant circulation in the GOA (Musgrave *et al.* 1992) is characterized by the cyclonic flow of the Alaska gyre. The circulation consists of the eastward-flowing Subarctic Current system at approximately 50º N. latitude and the Alaska Coastal Current (Alaska Stream) system along the northern GOA. Large seasonal variations in the wind-stress curl in the GOA affect the meanders of the Alaska Stream and nearshore eddies. The variations in these nearshore flows and eddies affect much of the region's biological variability.

The GOA has a variety of seabed types such as gravely sand, silty mud, and muddy to sandy gravel, as well as areas of hardrock (Hampton *et al.* 1986). Investigations of the northeast GOA shelf (less than 200 m) have been conducted between Cape Cleare (148º W. longitude) and Cape Fairweather (138º W. longitude) (Feder and Jewett 1987). The shelf in this portion of the GOA is relatively wide (up to 100 km). The dominant shelf sediment is clay silt that comes primarily from either the Copper River or the Bering and Malaspina glaciers. When the sediments enter the GOA, they are generally transported to the west. Sand predominates nearshore, especially near the Copper River and the Malaspina Glacier. Most of the western GOA shelf (west of Cape Igvak) consists of slopes characterized by marked dissection and steepness. The shelf consists of many banks and reefs with numerous coarse, clastic, or rocky bottoms, as well as patchy bottom sediments. In contrast, the shelf near Kodiak Island consists of flat relatively shallow banks cut by transverse troughs. The substrate in the area from Near Strait and close to Buldir Island, Amchitka, and Amukta Passes is mainly bedrock outcrops and coarsely fragmented sediment interspersed with sand bottoms.

Temperature anomalies in the GOA illustrate a relatively warm period in the late 1950s, followed by cooling (especially in the early 1970s), and then by a rapid temperature increase in the latter part of that decade. Subsurface temperature anomalies for the coastal GOA also show a change from the early 1970s into the 1980s, similar to that observed in the sea surface (U.S. GLOBEC 1996). In addition, high latitude temperature responses to El Nino southern oscillation events can be seen, especially at depth, in 1977, 1982, 1983, 1987, and the 1990s. Between these events, temperatures in the GOA return to cooler and more neutral temperatures. The 1997/98 El Nino southern oscillation event, one of the strongest recorded this century, has significantly changed the distribution of fish stocks off California, Oregon, Washington, and Alaska. The longer-term impacts of this event remain to be seen.

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

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

Location

BAY = nearshore bays, with depth if appropriate (e.g., fjords)
BCH = beach (intertidal)
BSN = basin (>3,000 m)
FW = freshwater
ICS = inner continental shelf (1–50 m)
IP = island passes (areas of high current), with depth if appropriate
LSP = lower slope (1,000–3,000 m)
MCS = middle continental shelf (50–100 m)
OCS = outer continental shelf (100–200 m)
USP = upper slope (200–1,000 m)

Water column

D = demersal (found on bottom)
N = neustonic (found near surface)
P = pelagic (found off bottom, not necessarily associated with a particular bottom type)
SD/SP = semi-demersal or semi-pelagic, if slightly greater or less than 50% on or off bottom

General

NA = not applicable
U = unknown
EBS = eastern Bering Sea
GOA = Gulf of Alaska
EFH = essential fish habitat

Bottom Type

C = coral
CB = cobble
G = gravel
K = kelp
M = mud
MS = muddy sand
R = rock
S = sand
SAV = subaquatic vegetation (e.g., eelgrass, not kelp)
SM = sandy mud

Oceanographic Features

CL = thermocline or pycnocline
E = edges
F = fronts
G = gyres
UP = upwelling

Table 5 Essential fish habitat information levels currently available for GOA groundfish, by life history stage.

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Walleye pollock	1	1	2	2	2
Pacific cod	x	1	2	2	2
Sablefish	x	1	1	2	2
Yellowfin sole	1	1	2	2	2
Northern rock sole	1	1	2	2	2
Southern rock sole	1	1	1	2	2
Alaska plaice	1	1	2	2	2
Dover sole	1	1	x	2	2
Rex sole	1	1	x	2	2
Arrowtooth flounder	1	1	1	2	2
Flathead sole	1	1	2	2	2
Pacific ocean perch	*Sebastes* spp. early life stages grouped 1			1	1
Northern rockfish				2	2
Shortraker rockfish				2	2
Blackspotted/rougheye rockfish				1	1
Dusky rockfish				1	1
Yelloweye rockfish				1	1
Other Rockfish (sharpchin, harlequin)	1	x	x	1	1
Thornyhead rockfish	x	x	2	2	2
Atka mackerel	1	x	x	1	1
Skates	1	x	1	2	2
Octopuses	x	x	x	x	2
Sharks	x	x	x	x	x
Sculpins	x	x		x	2
Squids	x	x	x	1	1
Forage fish complex	x	x	x	x	x
Grenadiers	x	x	x	x	x

x indicates insufficient information is available to describe EFH
1 indicates general distribution data are available for some or all portions of the geographic range of the species
2 indicates quantitative data (density or habitat-related density) are available for the habitats occupied by a species of life stage
na indicates one juvenile stage exists – see Late Juveniles

Walleye pollock (*Theragra calcogramma*)

The Gulf of Alaska (GOA) pollock stocks are managed under the Fishery Management Plan for Groundfish of the Gulf of Alaska (FMP), and the eastern Bering Sea and Aleutian Islands pollock stocks are managed under the Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area. Pollock occur throughout the area covered by the FMP and straddle into the Canadian and Russian Exclusive Economic Zone (EEZ), the U.S. EEZ, international waters of the central Bering Sea, and into the Chukchi Sea.

Life History and General Distribution

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

Four stocks of pollock are recognized for management purposes: GOA, 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 GOA 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 m and 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. There are also ancilliary surveys for different life stages including those of the BASIS program (typically conducted in late summer and early fall) and some cooperative surveys with the Russian Federation scientists (typically covering the region a few hundred miles within the US zone from the Convention line).

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 Aleutian Islands (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 the rough bottom.

The Aleutian Basin stock, 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 appears throughout the Aleutian Basin apparently for feeding, but 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 eastern Bering Sea shelf region.

The GOA 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 GOA comes from annual winter echo-integration 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 GOA 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 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 and May) in smaller spawning aggregations. The deep spawning pollock of the Aleutian Basin appear to spawn slightly earlier, late February and early March. In the GOA, peak spawning occurs in late March in Shelikof Strait. Peak spawning in the Shumagin area appears to be 2 to 3 weeks earlier than in Shelikof Strait.

Spawning occurs in the pelagic zone and eggs develop throughout the water column (70 to 80 m in the Bering Sea shelf, 150 to 200 m in Shelikof Strait). Development is dependent on water temperature. In the Bering Sea, eggs take about 17 to 20 days to develop at 4 °C in the Bogoslof area and 25.5 days at 2 °C on the shelf. In the GOA, development takes approximately 2 weeks at ambient temperature (5 °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 (approximately 25 mm standard length). In the GOA, larvae are distributed in the upper 40 m of the water column, and their diet is similar to Bering Sea larvae. Fisheries-Oceanography Coordinated Investigations 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 the bottom depending on temperature. Age 1 pollock from strong year-classes appear to be found in great numbers on the inner shelf, and farther north on the shelf than weak year classes, which appear to be more concentrated on the outer continental shelf. From age 2 to 3 pollock are primarily pelagic and then are 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 centimeters (cm).

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

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.

Habitat and Biological Associations

Egg-Spawning: Pelagic on outer continental shelf generally over 100 to 200 m depth in Bering Sea. Pelagic on continental shelf over 100 to 200 m depth in GOA.

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

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 GOA, 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. EEZ and the Aleutian 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	NA	G?	
Larvae	60 days	copepod nauplii and small euphausiids	Mar–Jul	MCS, OCS	P	NA	G?, F	pollock larvae with jellyfish
Juveniles	0.4 to 4.5 years	pelagic crustaceans, copepods, and euphausiids	Aug +	OCS, MCS, ICS	P, SD	NA	CL, F	
Adults	4.5 to 16 years	pelagic crustaceans and fish	spawning Feb–Apr	OCS, BSN	P, SD	U	F, UP	increasingly demersal with age

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Pacific cod (*Gadus macrocephalus*)

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 latitude 34° N. with a northern limit of about latitude 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 eastern Bering Sea. 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 BSAI and 0.38 in the 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.

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. 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.

Habitat and Biological Associations

Egg/Spawning: Spawning takes place in the sublittoral-bathyal zone (40 to 290 m) near the 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 30 to 150 m.

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 located throughout the shelf and upper slope. 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 (euphausiids, mysids, 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	

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Sablefish (*Anoplopoma fimbria*)

Life History and General Distribution

Sablefish are distributed from Mexico through the GOA to the Aleutian Chain, Bering Sea, along the Asian coast from Sagami Bay, and along the Pacific sides of Honshu and Hokkaido Islands and the Kamchatka 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 because they are caught in bottom trawls and with bottom longline gear. Spawning or very ripe sablefish are observed in late winter or early spring along the continental slope. Eggs are 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 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 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 leave the nearshore bays. One or two years later, they begin appearing on the continental shelf and move to their adult distribution as late juvniles or mature adults (Hanselman et al. 2015).

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 and the position of the North Pacific Polar Front in the fall before spawning (Shotwell et al. 2014). Another study linked recent recruitment variability to high chlorophyll *a* and juvenile pink salmon abundance in Southeast Alaska (Martinson et al.2015). Recruitment success did not appear to be directly related to the presence of El Niño 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 gullies. As juveniles in the inshore waters and on the continental shelf, they are subject to myriad factors that determine their ability to grow, compete for food, avoid predation, and otherwise survive to adults. Perhaps increased competition from predators of juveniles such as the large increases of arrowtooth flounder in the Gulf of Alaska, 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:

Bering Sea:	males 65 cm, females 67 cm
Aleutian Islands:	males 61 cm, females 65 cm
GOA:	males 57 cm, females 65 cm

Relevant Trophic Information

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

Gao et al. (2004) studied stable isotopes in otoliths of juvenile sablefish from Oregon and Washington and found that as the fish increased in size they shifted from midwater prey to more benthic prey. In nearshore southeast Alaska, juvenile sablefish (20-45 cm) diets included fish such as Pacific herring and smelts and invertebrates such as krill, amphipods and polychaete worms (Coutré et al. 2015). In late summer, juvenile sablefish also consumed post-spawning pacific salmon carcass remnants in high volume revealing opportunistic scavenging (Coutré et al. 2015). Young-of-the-year sablefish are commonly found in the stomachs of salmon taken in the Southeast Alaska troll fishery during the late summer.

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, euphausiids, 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 adult sablefish diet (Laidig et al. 1997). Off the southwest coast of Vancouver Island, euphausiids were the dominant prey (Tanasichuk 1997). Among other groundfish in the GOA, the diet of sablefish overlaps mostly with that of large flatfish, arrowtooth flounder and Pacific halibut (Yang and Nelson 2000).

Habitat and Biological Associations

The estimated productivity and sustainable yield of the combined GOA, Bering Sea, and Aleutian Islands 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. There were episodic years of strong recruitment in the current physical regime starting in 1977. Since 2000, there has only been one year class that has exceeded the average level. This period of low-recruitment appears to be related to environmental conditions in the larval to settlement stages of the sablefish early life history.

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, 200–3,000 m	NA	U	
Larvae	up to 3 months	copepod nauplii, small copepodites	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, polychaete worms, krill, and salmon caracasess near stream mouths		OCS, MCS, ICS, during first summer, then observed in BAY and IP, until end of 2nd summer; not observed until 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 observed 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, squid,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	

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Yellowfin sole (*Limanda aspera*)

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

Life History and General Distribution

Yellowfin sole are distributed in North American waters from off British Columbia, Canada (approximately latitude 49° N.) to the Chukchi Sea (about latitude 70° N.) and south along the Asian coast to about latitude 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 and 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 ranges from 10.1 (TenBring and Wilderbuer 2015) to 10.5 years (Nichol 1995) (approximately 29 cm) for females based on samples collected in 1992-1993 and 2012-2013. Natural mortality rate is believed to range from 0.12 to 0.16.

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

Relevant Trophic Information

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

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.

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/zooplankton?	summer, autumn?	BAY, BCH,ICS	P			
Early Juveniles	to 5.5 years	polychaetes, bivalves, amphipods, echiurids	all year	BAY, ICS, OCS, MCS	D	S		
Late Juveniles	5.5 to 10 years	polychaetes, bivalves, amphipods, echiurids	all year	BAY, ICS, OCS, MCS, IP	D	S		
Adults	10+ years	polychaetes, bivalves, amphipods, echiurids	spawning/ feeding May–August non-spawning Nov–April	BAY, BCH, ICS, MCS, OCS, IP	D	S		

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Northern rock sole (*Lepidopsetta polyxystra*)

The shallow water flatfish management complex in the GOA consists of eight species: northern rock sole (*Lepidopsetta polyxystra)*, southern rock sole (*Lepidopsetta bilineata*), 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.

Life History and General Distribution

Northern rock sole are distributed from Puget Sound through the BSAI 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 Bering Sea (Alton and Sample 1976). Adults exhibit a benthic lifestyle and, in the eastern Bering Sea, occupy separate winter (spawning) and summertime feeding distributions on the continental shelf. Northern rock sole spawn during the winter through early spring period of December through 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 GOA 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 1976). Fertilization is believed to be external. Incubation time is temperature dependent and may range from 6.4 days at 11 ºC to about 25 days at 2.9 ºC

(Forrester 1964). Newly hatched larvae are pelagic and have occurred sporadically in eastern Bering Sea 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 1976, Orr and Matarese 2000). Forrester and Thompson (1969) report that by age 1, they are found with adults on the continental shelf during summer.

In the springtime, after spawning, northern rock sole begin actively feeding and exhibit a widespread distribution throughout the shallow waters of the continental shelf. This migration has been observed on both the eastern (Alton and Sample 1976) and western (Shvetsov 1978) areas of the Bering Sea 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 eastern Bering Sea is rare (Musienko 1963). Juveniles are separate from the adult population, remaining in shallow areas until they reach age 1 (Forrester 1964). 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).

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.

Habitat and Biological Associations

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

<u>Adults</u>: Summertime feeding on primarily sandy substrates of the eastern Bering Sea 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: Northern 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/zooplankton?	winter/spring	OCS, MCS, ICS	P			
Early Juveniles	to 3.5 years	polychaetes, bivalves, amphipods, misc. crustaceans	all year	BAY, ICS, OCS, MCS	D	S, G		
Late Juveniles	up to 9 years	polychaetes, bivalves, amphipods, misc. crustaceans	all year	BAY, ICS, OCS, MCS	D	S, G		
Adults	9+ years	polychaetes, bivalves, amphipods, misc. crustacean	feeding May–September spawning Dec–April	MCS, ICS MCS, OCS	D	S, G	ice edge	

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Southern rock sole (*Lepidopsetta bilineata*)

The shallow water flatfish management complex in the GOA consists of eight species: southern rock sole (*Lepidopsetta bilineata*), 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 that 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.

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 Bering Sea (Alton and Sample 1976, 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 GOA (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 GOA 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 1976). Fertilization is believed to be external. Incubation time is temperature dependent and may range from 6.4 days at 11 ºC to about 25 days at 2.9 ºC (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). Southern rock sole larvae are reportedly 20 mm in length when they assume their side-swimming, bottom-dwelling form (Alton and Sample 1976) 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 (Von Szalay et al. 2010). 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 1964). 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 (Turnock et al. 2002).

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.

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 eastern Bering Sea 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.

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/zooplankton?	summer	OCS, MCS, ICS	P			
Early Juveniles	to 3.5 years	polychaetes, bivalves, amphipods, misc. crustaceans	all year	BAY, ICS, OCS, MCS	D	S, G		
Late Juveniles	up to 9 years	polychaetes, bivalves, amphipods, misc. crustaceans	all year	BAY, ICS, OCS, MCS	D	S, G		
Adults	9+ years	polychaetes, bivalves, amphipods, misc. crustaceans	feeding May–September spawning June–August	MCS, ICS MCS, OCS	D	S, G		

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Alaska plaice (*Pleuronectes quadrituberculatus*)

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

Life History and General Distribution

Alaska plaice inhabit continental shelf waters of the North Pacific ranging from the GOA 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 GOA. 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, particularly in the Shelikof Strait area (Waldron and Favorite 1977, Bailey et al. 2003)) and throughout the water column at depths 10-20 m in the Bering Sea (Duffy-Anderson et al. 2010).

Fecundity estimates (Fadeev 1965) indicate female fish produce an average of 56,000 eggs at lengths of 28 to 30 cm and 313,000 eggs at lengths of 48 to 50 cm. The age or size at metamorphosis is unknown. The estimated length of 50 percent maturity is 32 cm (~ 9 yrs.) from anatomical observations made in March and April, and 9.5 years from a histological analysis conducted in 2014 (TenBrink and Wilderbuer 2015). 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.

Relevant Trophic Information

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

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2 to 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/zooplankton ?	spring and summer	ICS, MCS	P			
Juveniles	up to 7 years	polychaete, amphipods, echiurids	all year	ICS, MCS	D	S, M		
Adults	7+ years	polychaete, amphipods, echiurids	spawning March–May non-spawning and feeding June–February	ICS, MCS ICS, MCS	D	S, M		

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Rex sole (*Glyptocephalus zachirus*)

Life History and General Distribution

Rex sole are distributed from Baja California to the Bering Sea and western Aleutian Islands (Hart 1973, Miller and Lea 1972). They are most abundant at depths between 100 and 200 m and are found fairly uniformly throughout the 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 and Horton 1977). Abookire and Bailey (2007) concluded that larval duration is about 9 months in the GOA (rather than 12 months off the coast of Oregon) and that size-at-transformation for rex sole is 49 to 72 mm. Although maturity studies from Oregon indicate that females are 50 percent mature at 24 cm, females in the GOA achieve 50 percent maturity at larger size (35.2 cm) and grow faster such that they achieve 50 percent 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 (McGilliard and Palsson 2015).

Relevant Trophic Information

Based on results from an ecosystem model for the GOA (Aydin et al. 2007), rex sole in the GOA occupy an intermediate trophic level. Polychaetes, euphausiids, 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 longnose skate and arrowtooth flounder.

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, euphausiids, and miscellaneous worms.

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/zooplankton ?	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		

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Dover sole (*Microstomus pacificus*)

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 Bering Sea and the western Aleutian Islands (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. 2002). 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 to 7 years), but GOA females are much larger (44 cm) than their southern counterparts (33 cm) at 50 percent 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 (McGilliard and Palsson 2015).

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).

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).

Habitat and Biological Associations: Dover sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Colum n	Botto m Type	Oceano- graphic Features	Othe r
Eggs		NA	spring, summer	ICS?, MCS, OCS, USP	P			
Larvae	up to 2 years	U phyto/zooplankton?	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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Flathead sole (*Hippoglossoides elassodon*)

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 Bering Sea, 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 to 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 and remain in shallow areas. The natural mortality rate used in recent stock assessments is 0.2 (McGilliard and Palssonet al. 2015).

Relevant Trophic Information

Based on results from an ecosystem model for the GOA (Aydin et al. 2007), flathead sole in the GOA 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 GOA (64 percent by weight in sampled stomachs; Yang and Nelson 2000), while euphausiids 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 percent) and age-0 walleye pollock (less than 0.5 percent 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.

Habitat and Biological Associations

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

Juveniles: Usually inhabit shallow areas (less than100 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.

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		NA	winter	ICS, MCS, OCS	P			
Larvae	U	U phyto/zooplankton?	spring, summer	ICS, MCS, OCS	P			
Juveniles	U	polychaetes, bivalves, ophiuroids	all year	MCS, ICS, OCS	D	S, M		
Adults	U	polychaetes, bivalves, ophiuroids, pollock, Tanner crab	spawning Jan–April non-spawning May–December	MCS, OCS, ICS	D	S, M	ice edge	

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Arrowtooth flounder (*Atheresthes stomias*)

Life History and General Distribution

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

Adults exhibit a benthic lifestyle and occupy separate winter and summer distributions on the eastern Bering Sea 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 eastern Bering Sea 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 7 years for females (46 cm) for GOA females (Stark 2008). 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).

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

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.

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/ zooplankton?	spring, summer?	BAY, ICS, OCS	P			
Juveniles	males - up to 4 years females - up to 5 years	euphausiids, crustaceans, amphipods, pollock	all year	ICS, OCS, USP	D	G,M,S		
Adults	males 4+ years females 5+ years	pollock, Gadidae sp., misc. fish, euphausiids	spawning Nov–March non-spawning April–Oct	ICS, OCS, USP, BAY	D	G,M,S	ice edge (EBS)	

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Pacific ocean perch (*Sebastes alutus*)

Life History and General Distribution

Pacific ocean perch (*Sebastes alutus*) have a wide distribution in the North Pacific from southern California around the Pacific rim to northern Honshu Island, Japan, including the Bering Sea. The species appears to be most abundant in northern British Columbia, the GOA, and the Aleutian Islands (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 be a significant pelagic component to their distribution. Pacific ocean perch often move off-bottom at night to feed, apparently following diel euphausiid migrations (Brodeur 2001). Commercial fishing data in the GOA since 1995 show that pelagic trawls fished off-bottom have accounted for as much as 31 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 2000). Genetic techniques using allozymes (Seeb and Kendall 1991), mitochondrial DNA (Li 2004), and single nucleotide polymorphism (SNP) (Kamin et al. 2013) are capable of identifying larvae and juveniles to species. 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, Kamin et al. 2013), 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). Rooper et al. (2005) found that potential growth of POP in the nursery area was correlated to recruitment indicating this is a very important life stage for this species. As they grow, they continue to migrate deeper, eventually reaching the continental slope, where they attain adulthood. Adult and juvenile populations are believed to be spatially separated (Carlson and Straty, 1981; Rooper et al., 2005).

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 (8.4 - 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) (Hulson et al. 2015). 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 per female in Alaska ranging from 10,000 to 300,000, depending upon size of the fish (Leaman 1991). No significant difference in growth among sexes has been found.

Relevant Trophic Information

Pacific ocean perch are mostly planktivorous (Carlson and Haight 1976, Yang 1993, Yang and Nelson 2000). 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). 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.

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 m off the 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 of 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: Pacific ocean perch in these life stages from samples collected in epipelagic waters far offshore in the GOA (Gharrett et al. 2002, Kamin et al. 2013). Some of the samples were as much as 180 km from land, beyond the continental slope and over very deep water.

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 Bering Sea (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.

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	Othe r
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 Aleutian Islands)	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

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Northern rockfish (*Sebastes polyspinis*)

Life History and General Distribution

Northern rockfish range from northern British Columbia through the GOA and Aleutian Islands to eastern Kamchatka and the Kuril Islands, including the Bering Sea (Mecklenburg et al. 2002). The species is most abundant from about Portlock Bank in the central GOA to the western end of the Aleutian Islands; 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 approximately 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 2002).

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 (8 - 12.8 years for females in the GOA), and an old maximum age of 67 years in the GOA (Hulson et al. 2015). No information on fecundity is available and no significant differences exist in growth between sexes.

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 Aleutian Islands 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 Aleutian Islands included Chaetognaths (arrow worms), amphipods, squid, and polychaetes.

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.

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 (less than 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.

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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Shortraker Rockfish (*Sebastes borealis*)

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 greater than 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 less than 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 percent maturity for female shortraker rockfish has been estimated to be 21.4 years for the GOA, 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 percent 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).

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 Aleutian Islands 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 Aleutian Islands (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.

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	NA	NA	NA	NA	NA	NA	
Larvae	U	U	parturition: Feb–Aug	U; BAY	probably P	NA	U	
Post-larvae/ early juvenile	U	U	summer to ?	LSP, BSN	probably D	NA	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

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Rougheye rockfish (*Sebastes aleutianus*) and blackspotted rockfish (*S. melanostictus*)

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 and at-sea misidentification rates have been estimated between 9% and 46%. 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). Preliminary results from a genetic study using otoliths from the 2009 and 2013 bottom trawl survey suggest differences in growth between the two species with rougheye rockfish growing faster and reaching a greater maximum size than blackspotted rockfish (Shotwell et al. 2015). Currently, species-specific catch data are not available. However, recent success with otolith morphometrics suggests that historical samples could be reanalyzed and corrected to species. Until such information is available, it will be difficult to undertake distinct population assessments. In the current stock assessment, rougheye and blackspotted rockfish are referred together as the rougheye and blackspotted (RE/BS) 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 GOA. Adults in the GOA inhabit a narrow band along the upper continental slope at depths of 984 to 1,640 feet (300 to 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 percent 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), although the highest age collected over the surveys used in the stock assessment was 135 (Shotwell et al. 2015). 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).

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 octopuses and copepods (Yang et al. 2006). Predators of rougheye rockfish likely include halibut (*Hippoglossus stenolepis*), Pacific cod (*Gadus macrocephalus*), and sablefish (*Anoplopoma fimbria*).

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 the GOA (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 GOA 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). 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	NA	NA	NA	NA	NA	NA	
Larvae	U	U	parturition: Dec–Apr	U	Pelagic	NA	U	
Post-larvae/ early juvenile	U	U	summer to ?	LSP, BSN	Epipelagic	NA	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

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Dusky rockfish (Sebastes variabilis)

The forms of dusky rockfish commonly recognized as "light dusky rockfish" and "dark dusky rockfish" are now officially recognized as two species (Orr and Blackburn 2004). *S. ciliatus* applies to the dark shallow-water species with a common name dark rockfish, and *S. variabilis* applies to variably colored usually deeper-water species with the common name dusky rockfish.

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 2006). 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 (less than 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*.

Relevant Trophic Information

In the GOA, euphausiids are likely the predominant food item of adults but sand lance have also been documented in adult dusky rockfish stomachs. Other pretty items consumed include larvaceans, cephalopods, pandalid shrimp, and hermit crabs.

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.

Habitat and Biological Associations

Egg/Spawning: No information is known, except that parturition probably occurs in the spring, and may extend into summer.

Larvae: No information is known.

Juveniles: No information is known for small juveniles less than 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 (less than 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. Several studies have documented adult dusky rockfish commonly found in both trawlable and untrawalable habitats. 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 (V. O'Connell, ADFG, personal communication). 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

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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*

Life History and General Distribution

These species are distributed from Ensenada, in northern Baja California, to Umnak Island and Unalaska Island, of the Aleutian Islands, 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, ADFG, personal communication). 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 years. 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 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.

Relevant Trophic Information

Yelloweye rockfish eat a large variety of organisms, primarily fishes including 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.

Habitat and Biological Associations

Early juveniles: 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 GOA (Southeast Alaska Groundfish Project, Alaska Department of Fish and Game, unpublished data).

Late juveniles/adults: 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.

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	NA	NA	NA	NA	NA	NA	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	Parturition	Known Habitat
Quillback	Kodiak Island to San Miguel Island, CA to 274 m (commonly 12–76 m)	At least 32 size at 50 percent maturity=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 size at 50 percent maturity =5 yr	crustaceans octopuses 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 demersal shelf rockfish.
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 size at 50 percent maturity = 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.

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Thornyhead rockfish *(Sebastolobus* spp.*)*

Life History and General Distribution

Thornyhead rockfish 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 GOA, and south to Baja California. This species is common throughout the GOA, eastern Bering Sea, and Aleutian Islands. The population structure of shortspine thornyheads, however, is not well defined. Thornyhead rockfish 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 GOA Thornyhead rockfish spawn a bi-lobed mass of fertilized eggs which floats in the water column. Juvenile shortspine thornyhead rockfish 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 thornyhead rockfish are sexually mature at about 21.5 cm.

Relevant Trophic Information

Shortspine thornyhead rockfish prey mainly on epibenthic shrimp and fish. Yang (1993, 1996) showed that shrimp were the top prey item for shortspine thornyhead rockfish in the GOA, whereas, cottids were the most important prey item in the Aleutian Islands region. Differences in abundance of the main prey between the two areas might be the main reason for the observed diet differences. Shortspine thornyhead rockfish are consumed by a variety of piscivores, including arrowtooth flounder, sablefish, "toothed whales" (sperm whales), and sharks. Juvenile shortspine thornyhead rockfish are thought to be consumed almost exclusively by adult thornyhead rockfish.

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.

Juveniles: Juvenile shortspine thornyhead rockfish 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.

Adults: Adults are demersal and can be found at depths ranging from about 90 to 1,500 m. Once in benthic habitats thornyhead rockfish 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 thornyhead rockfish 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*).

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	> 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		MCS, OCS, USP, LSP	D	M, S, R, SM, CB, MS, G	year-round?	

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Other Rockfish stock complex (*Sebastes sp.*)

With the exception of yelloweye rockfish, EFH has not been described for the species in this stock complex. The Other Rockfish assessment authors were asked to review model based EFH descriptions for 14 of the species within this complex, as a first attempt to define EFH for the complex. The assessment authors have concerns over using the model based EFH descriptions: 1) the models are based on trawl survey and commercial fishery data. The species in the Other Rockfish complex are known to be poorly sampled by the trawl survey and are only caught as bycatch in commercial fisheries. Further, summer commercial fishery data was not included, which is the season where most of the Other Rockfish catch occurs. 2) The numbers of hauls that catch these species are small, thus the models are informed by limited data. It is likely that the models do not fully represent the habitats used by the species.

Due to the complexity of this stock complex, the assessment authors suggest that the Council provide guidance to the EFH authors on how to proceed with defining EFH for the complex. A few options are:

1) Define EFH for the full complex, which would include lumping all of the species data together (making note that not all species are included in the complex GOA wide), re-running the model and evaluating the utility of the model to define EFH for this complex.
2) Define EFH for a set of representative species, such as silvergrey, harlequin and sharpchin, which would include examining the models for just those species and evaluating the utility of the model to define EFH for those species. An option with this would be to lump the remaining species, such that the EFH would be defined for the three species and one lumped group.
3) Define EFH for each species in the complex separately. This option is extremely data poor, and many species would have insufficient data to define EFH.
4) Undertake a detailed examination of available alternative data sets to inform the EFH definitions for these species.

The stock assessment authors recommend a combination of options 1 and 4 to the EFH authors. This approach seems appropriate because the complex is managed as a whole, thus the EFH should be defined for the complex as a whole. Further, the assessment authors suggest including other survey indices (e.g., IPHC and AFSC longline) as occurrence data and re-evaluating the utility of the models.

Atka mackerel (Pleurogrammus monopterygius)

Life History and General Distribution

Atka mackerel are distributed along the continental shelf across the North Pacific Ocean and Bering Sea from Asia to North America. On the Asian side they extend fron the Kuril Islands to Provideniya Bay; moving eastward, they are distributed throughout the Komandorskiye and Aleutian Islands, north along the eastern Bering Sea shelf, and through the Gulf of Alaska (GOA) to southeast Alaska. They are most abundant along the Aleutian Islands. Historically, an Atka mackerel population existed in the GOA primarily in the Kodiak, Chirikof, and Shumagin areas, and supported a large foreign fishery through the early 1980s. By the mid-1980s, this fishery, and presumably the population, had all but disappeared. Evidence of low population levels was supported by Atka mackerel bycatch in other fisheries. The decline of the GOA Atka mackerel fishery suggests that the area may be the edge of the species' range. During periods of high recruitment in the Aleutian Islands, it is thought that juvenile Atka mackerel may move into the GOA under favorable conditions. Recently, Atka mackerel have been detected by the summer trawl surveys primarily in the Shumagin (Western) area of the GOA.

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 Aleutian Islands 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 (when they are closely associated with the bottom). Atka mackerel are a substrate-spawning fish with male parental care. Single or multiple clumps of adhesive eggs are laid on rocky substrates in individual male territories within nesting colonies where males brood eggs for a protracted period. Nesting colonies are widespread across the continental shelf of the Aleutian Islands and western Gulf of Alaska down to bottom depths of 144 m. Possible factors limiting the upper and lower depth limit of Atka mackerel nesting habitat include insufficient light penetration and the deleterious effects of unsuitable water temperatures, wave surge, or high densities of kelp and green sea urchins. The spawning phase begins in late July, peaks in early September, and ends in mid-October. After spawning ends, territorial males with nests contintute to brood egg masses until hatching. 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 (mortality equals 0.3), and young average and maximum ages (about 5 and 15 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).

The approximate upper size limit of juvenile fish is estimated at 35 cm.

Relevant Trophic Information

Atka mackerel are consumed by a variety of piscivores, including groundfish (e.g., Pacific cod, Pacific halibut, and arrowtooth flounder), marine mammals (e.g., northern fur seals and Steller sea lions), and seabirds (e.g., thick-billed murres, tufted puffins, and short-tailed shearwaters). 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.

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 Aleutian Islands 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.

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 3–20 °C; optimum 9–13 °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	U	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, I	P, D (males) semidemersal (females) semidemersal / D (all sexes): D when currents high/day, semidemersal slack tides/night	GR, R, K	F,E	3–5 °C all stages >17 ppt only

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Skates (*Rajidae*)

In the Gulf of Alaska, skates are managed as three separate entities. Although EFH is defined for all skates as a single group, the description below is divided by the three management groups:

big skate (*Beringraja binoculata*)
longnose skate (*Raja rhina)*
other skates complex (*Bathyraja* sp. and *Amblyraja badia*)

Life History and General Distribution:

Big skate: Big skate is the largest skate species in the GOA, with a maximum observed size of 244 cm total length. Big skates have a maxium age of 15 years and mature at 5-6 years and 70-90 cm. Adults and juveniles are demersal and feed on bottom invertebrates and fish. Big skates are found primarily in shallow water on the shelf (<100 m), and are rarely observed in deeper waters. Spawning and nursery sites are unknown, although the frequent observation of big skate eggcases in the nearshore suggests that nursery sites are in shallow water. Most of the big skate population occurs in the central GOA (CGOA; NMFS statistical areas 620 & 630), with lesser amounts in the western GOA (WGOA: area 610) and eastern GOA (EGOA (areas 640 & 650).

Longnose skate: Longnose skate is smaller than big skate (maximum size 180 cm) but is longer-lived (maximum age is 25 years). They mature later than big skates (9-12 years, 70-100 cm). Longnose skates predominate at bepths between 100 m and 200 m, but unlike big skates they are also commonly observed at depths <100 m and >200 m. Spawning and nursery sites are unknown. Most of the longnose population is in the CGOA and to a lesser extent the EGOA; there are very few longnose skates in the WGOA.

Other skates complex: The Bathyraja species make up most of this complex, with Aleutian skate (Bathyraja aleutica) the most abundant complex member. Other skates occur at all depths in the GOA, but they are the dominant species group only at depths below 200m. Other skates occur throughout the GOA but like the two main species they are most abundant in the CGOA.

Relevant Trophic Information

Skates feed on bottom invertebrates (crustaceans, molluscs, and polychaetes) and fish. Older and larger skates have few predators but young skates are preyed upon by larger groundfishes, particularly Pacific cod and Pacific halibut.

Habitat and Biological Associations

<u>*Egg/Spawning*</u>: Deposits eggs in leathery, horned cases in nursery sites along the upper continental slope.

<u>*Juveniles and Adults*</u>: After hatching, juveniles probably remain in shelf and slope waters, but distribution is unknown. Adults found across wide areas of shelf and slope and distribution varies by species

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	U	D	U	U	
Larvae	NA	NA	NA	NA	NA	NA	NA	
Juveniles	U	invertebrates, small fish	all year	BAY, ICS, MCS,OCS, USP, LSP	D	U	U	
Adults	U	invertebrates, small fish	all year	BAY, ICS, MCS,OCS, USP, LSP	D	U	U	

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Squids (Cephalopoda, Teuthida)

The species representatives for squids are:

Gonatidae:	red or magistrate armhook squid (*Berryteuthis magister*)
Onychoteuthidae:	boreal clubhook squid (*Onychoteuthis borealjaponicus*)
	giant or robust clubhook squid (*Moroteuthis robusta*)
Sepiolidae:	eastern Pacific bobtail squid (*Rossia pacifica*)

Life History and General Distribution:

Squids are members of the molluscan class Cephalopoda along with octopus, cuttlefish, and nautiloids. In Gulf of Alaska (GOA), gonatid and onychoteuthid squids are generally the most common, along with chiroteuthids. All cephalopods are stenohaline, occurring only at salinities less than 30 ppt. Fertilization is internal, and for many species 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 through early summer, with eggs hatching during the summer. Most small squid are generally thought to live only 2 years or less, but the giant *Moroteuthis robusta* may live longer.

B. magister is widely distributed in the boreal north Pacific from California, throughout the Bering Sea, to Japan in waters of depth 30 to 1,500 m; adults most often found at mesopelagic depths or near bottom, rising to the surface at night; juveniles are widely distributed across shelf, slope, and abyssal waters in mesopelagic and epipelagic zones, and rise to surface at night. It migrates seasonally, moving northward and inshore in summer, and southward and offshore in winter, particularly in the western north Pacific. In the GOA, most *B. magister* occur along the continental slope and in troughs (e.g. the Shelikof Sea Valley). The maximum size for females is 50 cm mantle length (ML), and for males is 40 cm ML. Fecundity is estimated at 10,000 eggs/female. Spawning occurs in February and March in Japan; timing of spawning in Alaska is not known but there appear to be multiple seasonal spawning cohorts each year. Eggs hatch after 1 to 2 months of incubation; development is direct. Adults are thought to die after mating and/or spawning.

O. borealjaponicus, an active, epipelagic species, is distributed in the north Pacific from the Sea of Japan, throughout the Aleutian Islands and south to California, but is absent from the Sea of Okhotsk and not common in the Bering Sea. Juveniles can be found over shelf waters at all depths and near shore. Adults apparently prefer the upper layers over slope and abyssal waters and 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 Bering Sea, Aleutian Islands, and GOA. Mantle length can be up to 2.5 m long (at least 7 m with tentacles), 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 species distributed from Japan to California in the North Pacific and in the Bering Sea in waters of about 20 to 300 m depth. Other *Rossia* species deposit demersal egg masses.

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, early juvenile squid eat small zooplankton (e.g. copepods). 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. Predation on various species and life stages of squids differs with the size and foraging behavior of the predator, e.g. adult *B. magister* are eaten mainly by marine mammals. In some areas squids may constitute up to 80% of the diets of sperm whales, bottlenose dolphins, and beaked whales. Seabirds (e.g., kittiwakes, puffins, murres) on island rookeries close to the shelf break are also known to feed heavily on squid. In the GOA, only about 5 percent or less of the diets of most groundfish consisted of squid.However, squid play a larger role in the diet of salmon.

Habitat and Biological Associations for *Berryteuthis magister*

<u>*Egg/Spawning*</u>: Eggs are laid on the bottom on the upper slope (200 to 800 m); incubate for 1 to 2 months.

<u>*Young Juveniles*</u>: Distributed epipelagically (top 100 m) from the coast to open ocean.

<u>*Old Juveniles and Adults*</u>: Distributed mesopelagically (most from 150 to 500 m) on the shelf (possibly only in the summer), 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: *B. magister*

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	varies	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 winter	all shelf, USP, LSP, BSN, OS, USP, LSP, BSN	semipelagic, P	UP, F?	U	euhaline waters, 2–4 °C

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Sculpins (Cottidae)

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*)

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 Bering Sea. 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 Bering Sea 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. The approximate upper size limit of juvenile fish is unknown.

Yellow Irish lords: They are distributed from subtidal areas near shore to the edge of the continental shelf (down to 200 m) throughout the Bering Sea, Aleutian Islands, and eastward into the GOA as far as Sitka, Alaska. They grow up to 40 cm in length. Twelve to 26 mm larvae have been 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 and throughout the Bering Sea and GOA. They are rarely over 30 cm in length and spawn 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 Bering Sea, from Hokkaido, Japan, Sea of Okhotsk, and Chukchi Sea, to the southeast Bering Sea and in the Aleutian Islands. They are found at 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 Bering Sea and Aleutian Islands, and throughout the GOA. They are up to 70 cm in length.

Great sculpin: They are distributed from the intertidal area to 200 m, but may be most common on sand and muddy/sand bottoms in moderate depths (50 to 100 m). They are up to 80 cm in length. They are found throughout the Bering Sea, Aleutian Islands, 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 Bering Sea and GOA (not common in the Aleutian Islands) from intertidal areas to depths of about 100 m, but most common in shallow waters (less than 50 m). They are 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.

Relevant Trophic Information

Sculpins feed on bottom invertebrates (e.g., crabs, barnacles, mussels, and other molluscs); larger species eat fish.

Habitat and Biological Associations

<u>Egg/Spawning</u>: 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 (MCS-OCS?)	D	R (others?)	U	
Larvae	U	copepods	all year?	ICS-MCS, OCS, US	N,P	NA?	U	
Juveniles and Adults	U	bottom invertebrates (crabs, molluscs, barnacles) and small fish	all year	BCH, ICS, MCS, OCS, USP	D	R, S, M, SM	U	

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Sharks

The species representatives for sharks are:

Lamnidae: Salmon shark (*Lamna ditropis*)

Squalidae: Sleeper shark (*Somniosus pacificus*)
Spiny dogfish (*Squalus suckleyi*)

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. Salmon shark are large (up to 3 m in length), aplacental, viviparous (with small litters of one to four pups and embryos nourished by yolk sac and oophagy), widely migrating sharks, with homeothermic capabilities and highly active predators (salmon and white sharks). Salmon sharks are distributed epipelagically along the shelf (can be found in shallow waters) from California through the Gulf of Alaska (GOA) to the northern Bering Sea and off Japan. In groundfish fishery and survey data, salmon sharks occur chiefly on outer shelf/upper slope areas in the Bering Sea, but near the coast to the outer shelf in the GOA, particularly near Kodiak Island. Salmon sharks are not commonly seen in Aleutian Islands.

The Pacific sleeper shark is distributed from California around the Pacific Rim to Japan and in the Bering Sea principally on the outer shelf and upper slope. However, they do often occur in near shore, and shallow waters in the GOA. Tagging data suggests that they spend a significant amount of time moving vertically thorugh the water column. Adult Pacific sleeper shark have been reported as long as 7 m, however, size at maturity is unknown, as well as reproductive mode. Other members of the Squalidae are aplacental viviparous, and it is likely a safe assumption that Pacific sleeper shark are as well. In groundfish fishery and survey data, Pacific sleeper sharks occur chiefly on outer shelf/upper slope areas in the Bering Sea, but near coast to the outer shelf in the GOA, particularly near Kodiak Island in Shelikof Strait, inside waters of Southeast Alaska and Prince William Sound.

Spiny dogfish are widely distributed throughout the North Pacific Ocean. In the North Pacific, spiny dogfish may be most abundant in the GOA; they also occur in the Bering Sea. Spiny dogfish are pelagic species found at the surface and to depths of 700 m but mostly at 200 m or less on the shelf and the neritic zone; they are often found in aggregations. Spiny dogfish are aplacental viviparous. Litter size is proportional to the size of the female and range from 2 to 23 pups, with 10 average. Gestation may be 22 to 24 months. Young are 24 to 30 cm at birth, with growth initially rapid, then 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 36 years old; 50 percent of males are mature at 74 cm and 21 years old. Females give birth in shallow coastal waters, usually in September through January. 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.

Relevant Trophic Information

Sharks are top level predators in the GOA. The only likely predator would be larger fish or mammals preying on young/small sharks. Spiny dogfish opportunistic generalist feeders, eating a wide variety of foods, including fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus). Salmon shark are believed to eat primarily fish, including salmon, sculpins, and gadids, Pacific sleeper shark are predators of flatfish, cephalopods, rockfish, crabs, seals, and salmon and may also prey on pinnipeds.

Habitat and Biological Associations

Egg/Spawning: Salmon sharks and spiny dogfish are aplacental viviparous; reproductive strategy of Pacific sleeper sharks is not known. Spiny dogfish give birth in shallow coastal waters, while salmon sharks pupping grounds are located in the offshore transitional domain south of the GOA.

Juveniles and Adults: Spiny dogfish are widely dispersed throughout the water column on shelf in the GOA, and along outer shelf in the eastern Bering Sea; apparently they are not as commonly found in the Aleutian Islands and are not commonly found at depths greater than 200 m.

Salmon sharks are found throughout the GOA, but are less common in the eastern Bering Sea and Aleutian Islands; they are epipelagic and are found primarily over shelf/slope waters in the GOA and on the outer shelf in the eastern Bering Sea. Salmon shark do exihibit seasonal abundances in areas with high density of salmon returns, such as Prince William Sound.

Pacific sleeper sharks are widely dispersed on shelf/upper slope in the GOA and along the outer shelf/upper slope only in the eastern Bering Sea; they are generally demersal, but may utilize the full water column.

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								
Salmon shark	9 mo gestation		Late spring pupping	Pelagic transition zone	P	NA	U	
Pacific sleeper shark	U		U	U	U	U	U	
Spiny dogfish	18-24 mo gestation		Fall/early winter pupping	Near shore bays	P/D	U	U	
Juveniles and Adults:	NA							
Salmon shark	30+ years	fish (salmon, sculpins and gadids)	all year	ICS, MCS. OCS, US in GOA	P	NA	U	4-24 °C
Pacific Sleeper shark	U	omnivorous; flatfish, cephalopods, rockfish, crabs, seals, salmon, pinnipeds	all year	ICS, MCS, OCS, US in GOA	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, MCS, OCS in GOA give birth ICS in fall/winter?	P	U	U	euhalin e 4–16 °C

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Octopuses

There are at least seven species of octopuses currently identified from the GOA, including one species of genus *Octopus* that has not been fully described (*Octopus sp. A*, Conners and Jorgensen 2008). The species most abundant at depths less than 200 m 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 1,000 m. *Japetella* *diaphana* and bathypelagic finned species *Vampyroteuthis infernalis* are found in pelagic waters of the GOA. Preliminary evidence (Conners and Jorgensen 2008, 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 identification of octopuses in the Bering Sea and GOA has changed since the previous essential fish habitat review and is still developing. The state of knowledge of octopuses in the GOA, including the true species composition, is very limited.

Life History and General Distribution

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*.

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 GOA, 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 (statistical areas 610, 620, and 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. Alaska Fisheries Science Center 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 1,000 m. The majority of octopus caught with pots in the GOA came from 40 to 60 fathoms (70 to 110 m); catches from longline vessels tended to be in deeper waters of 200 to 400 fathoms (360 to 730 m). 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 to 2 years or 3 to 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 to 15 kg at maturity while males are 7 to 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 through October and move to shallower waters to spawn during October through January. There is a 2-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 to 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 percent, while survival to 10 mm was estimated to be 1 percent; mortality at the 1 to 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 and 1,000 m. It is believed to spawn 100 to 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 less than 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 to 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 to 90 eggs.

Benthoctopus leioderma is a medium-sized species, maximum total length approximately 60 cm. Its life span is unknown. It occurs from 250 to 1,400 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 GOA but would not be confused with *E. dofleini*. It is found from 300 to 1,100 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 GOA 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.

Relevant Trophic Information

Octopuses 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, octopuses 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 4-foot dogfish.

Habitat and Biological Associations

<u>*Egg/Spawning*</u>: 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.

<u>*Larvae:*</u> Pelagic for *Enteroctopus dofleini*, demersal for other octopus species.

<u>*Young Juveniles*</u>: Are semi-demersal; are widely dispersed on shelf, upper slope.

<u>*Old Juveniles and Adults*</u>: Are demersal; are widely dispersed on shelf and upper slope, preferentially among rocks, cobble, but also on sand/mud.

Habitat and Biological Associations: *Enteroctopus dofleini*, *Octopus 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 (ICS, MCS?)	D, P*	R, G?	U	euhaline waters
Young juveniles	U	zooplankton	summer–fall	U (ICS, MCS, OCS, USP?)	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	ICS, MCS, OCLS, USP	D?	R, G, S, MS	U	euhaline waters

* Larvae is pelagic for *Enteroctopus dofleini*, demersal for other octopus species.

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Capelin (*Mallotus villosus;* Osmeridae)

Life History and General Distribution

Capelin is a short-lived, pelagic, schooling fish species with a circumpolar distribution that includes the entire coastline of Alaska and the Bering Sea and extends south along British Columbia to the Strait of Juan de Fuca. In the North Pacific, capelin grow to a maximum of 25 cm and 5 years of age. Capelin, a member of the Osmeridae (smelts), spawn at ages 2 to 4 (11-17 cm) in spring and summer (May to August; earlier in south, later in north) on coarse sand and fine gravel beaches especially along the Alaska Peninsula and in the vicinity of Kodiak Island. 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 occur over the shelf in summer and fall (rarely found in waters deeper than about 200 m). Adults occur throughout the GOA but the center of capelin abundance appears to be in the central and western GOA. Larvae, juveniles, and adults have diurnal vertical migrations following scattering layers; at night they are near the surface and at depth during the day. Smelts are captured during trawl surveys, but their small size and patchy distribution reduce the reliability of biomass estimates. The approximate upper size limit of juvenile fish is 13 cm.

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. 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. 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 Bering Sea.

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 through 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 9 ºC.

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 3 ºC), 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 and fall, feed along semi-permanent fronts separating inner, mid, and outer shelf regions (approximately 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?

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Eulachon (*Thaleichthys pacificus*; Osmeridae)

Life History and General Distribution

Eulachon is a relatively short-lived, anadromous, schooling fish species distributed from the Pribilof Islands in the eastern Bering Sea (EBS), throughout the Gulf of Alaska (GOA), and south to California. Eulachon, a member of the Osmeridae (smelts), are pelagic but often occur near the bottom and are generally found in deep water. During summer, eulachon are distributed throughout the GOA but they are particularly dense to the west and south of Kodiak Island. In the North Pacific, eulachon grow to a maximum age of 5 years and a maximum size of 23 cm. They spawn at ages 3 to 5 (14-20 cm) in spring and early summer (April through June) in rivers on coarse sandy bottom. Known spawning areas in the GOA are rivers feeding the upper reaches of Cook Inlet and Prince William Sound, as well as rivers along the mainland in Southeast Alaska. Age at 50 percent maturity is 3 years. Each female produces approximately 25,000 eggs, which adhere to sand grains and other substrates on the river bottom. Eggs hatch in 30 to 40 days at 4 to 7 °C. Most eulachon die after first spawning. Larvae drift out of rivers and develop at sea. Smelts are captured during trawl surveys, but their small size and patchy distribution reduces the reliability of biomass estimates. The approximate upper size limit of juvenile fish is 14 cm.

Relevant Trophic Information

Eulachon 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. Pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (harbor porpoise and fin, sei, humpback, and beluga whales) feed on smelts as they assemble nearshore in spring to spawn. 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 Bering Sea.

Habitat and Biological Associations

Egg/Spawning: Anadromous; return to spawn in spring (May to June) in rivers; demersal eggs adhere to bottom substrate (e.g., sand, cobble). 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 Shelikof Strait east 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		spawning May–June	MCS, OCS, USP Rivers, FW	P	S (CB?)		
	ages 3 to 5+	copepods, euphausiids	non-spawning (July–Apr)	MCS, OCS, USP Rivers, FW	P	NA?	F?	

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Grenadiers (family *Macrouridae*)

Life History and General Distribution

At least seven species of grenadier are known to occur in Alaskan waters, but only three are commonly found at depths shallow enough to be encountered in commercial fishing operations or in fish surveys: giant grenadier (*Albatrossia pectoralis*), Pacific grenadier (*Coryphaenoides acrolepis*), and popeye grenadier (*Coryphaenoides cinereus*). Of these, giant grenadier has the shallowest depth distribution and the largest biomass, and hence is by far the most frequently caught grenadier in Alaska. On the slope (>400 meters) giant grenadier have by far the highest catch per unit effort and biomass in NMFS trawl surveys. Adults are caught in NMFS longline and trawl surveys but no other life stages are found in any NMFS surveys. The great majority of giant grenadier caught in surveys are female (96-99%). These results imply that much of the male population may reside in depths >1,000 that are not covered by the survey, at least during the summer period when the survey is occurring.

Giant grenadier range from Baja California, Mexico around the arc of the north Pacific Ocean to Japan, including the Bering Sea and the Sea of Okhotsk, and they are also found on seamounts in the Gulf of Alaska and on the Emperor Seamount chain in the North Pacific. In Alaska, they are especially abundant on the continental slope in waters >400 m depth. Giant grenadier are the largest in size of the world's grenadier species; maximum weight of one individual in a Bering Sea trawl survey was 41.8 kg. In a female maturity study, the maximum age was 58 years and the age at 50% maturity for females in the GOA was 23 years and the length at 50% maturity was 26 cm (pre-anal fin length).

Pacific grenadier have a geographic range nearly identical to that of giant grenadier, i.e., Baja California, Mexico to Japan. Popeye grenadier range from Oregon to Japan. Compared to giant grenadier, both species are much smaller and generally found in deeper water. Food studies off the U.S. West Coast indicate that Pacific grenadier are more benthic in their habitat than are giant grenadier, as the former species fed mostly on bottom organisms such as polychaetes, mysids, and crabs.

Relevant Trophic Information

The only food studies on grenadiers in the northeast Pacific have been on adults. One study of giant grenadier off the U.S. west coast concluded that the fish fed primarily off-bottom on bathy- and mesopelagic food items that included gonatid squids, viperfish, deep-sea smelts, and myctophids. Smaller studies of giant grenadier food habits in Alaska showed generally similar results. In the Aleutian Islands, the diet comprised mostly squid and myctophids, whereas in the Gulf of Alaska, squid and pasiphaeid shrimp predominated as prey. Research on these deep-sea prey organisms in Alaska has been virtually non-existent, so information on prey availability or possible variations in abundance of prey are unknown.

In contrast to giant grenadier, a study of Pacific grenadier food habits off the U.S. west coast found a much higher consumption of benthic food items such as polychaetes, cumaceans, mysids, and juvenile Tanner crabs (*Chionoecetes* sp.), especially in smaller individuals. Carrion also contributed to its diet, and larger individuals consumed some pelagic prey including squids, fish, and bathypelagic mysids.

The only documented predators of giant grenadier are Pacific sleeper sharks and Baird's beaked whales. Sperm whales are another potential predator, as they are known to dive to depths inhabited by giant grenadier on the slope and have been observed depredating on longline catches of giant grenadier. Giant grenadier is a relatively large animal that is considered an apex predator in its environment on the deep slope, so it may have relatively few predators as an adult.

Habitat and Biological Associations

Little or no environmental information has been collected in Alaska for the deep slope habitat in which grenadiers live. The absence of larvae or post-larvae giant grenadier in larval surveys in Alaska, which have nearly all been conducted in upper parts of the water column, implies that larval giant grenadier may reside in deeper water.

Habitat and Biological Associations: Grenadiers

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	na	U	U	U	U	U	
Larvae	U	U	U	U	U	U	U	
Juveniles	U to 20 years	U	all year	continental slope, deep shelf gulleys and other habitats (few juveniles have been found)	Sometimes caught with bottom tending gear. presumably D	U	U	
Adults	20-58 years	opportunistic: gonatid squids, viperfish, deep-sea smelts, myctophids, pasiphaeid shrimp	Spawning may be year-round	continental slope, and deep shelf gulleys	Caught with bottom tending gear. presumably D	Likley in most bottom types	U	

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