Fishery Management Plan
for Groundfish of the Gulf of Alaska
APPENDICES

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1 Appendix A History of the Fishery Management Plan

The Fishery Management Plan (FMP) for Groundfish of the Gulf of Alaska (GOA) was implemented on December 1, 1978. Since that time, it has been amended over sixty times, and its focus has changed from the regulation of mainly foreign fisheries to the management of fully domestic fisheries. The FMP was substantially reorganized in Amendment 75. Outdated catch data or other scientific information, and obsolete references, were also removed or updated.

Section A.1 contains a list of amendments to the FMP since its implementation in 1978. A detailed account of each of the FMP amendments, including its purpose and need, a summary of the analysis and implementing regulations, and results of the amendment, is contained in Appendix D to the Final Programmatic Supplemental Environmental Impact Statement for the Alaska Groundfish Fisheries, published by National Marine Fisheries Service (NMFS) in 2004.

1.1 Amendments to the FMP

Amendment 1, implemented December 1, 1978:

1. Extended optimum yields (OYs), domestic annual harvest (DAH), total allowable level of foreign fishing (TALFF) to October 31, 1979.
2. Changed fishing year to November 1 - October 31.

Amendment 2, implemented January 1, 1979:

Allowed directed foreign longline fishery for Pacific cod west of 157° W. longitude outside of 12 miles year-round.

Amendment 3, implemented December 1, 1978:

1. Established special joint venture reserve wherein TALFF = 0.8(OY)- DAH, - joint venture processing (JVP).
2. Specified that allocations will be reevaluated on January 1, 1979 and reapportioned if necessary.

Amendment 4, implemented August 16, 1979:

1. Allowed foreign fishing beyond 3 miles between 169° W. and 170° W. longitude.
2. Removed prohibition on taking more than 25 percent TALFF during December 1 to May 31.
3. Allowed foreign longlining for sablefish seaward of 400 m from May 1 to September 30 and seaward of 500 m from October 1 to April 30 between 140° W. and 170° W. longitude.
4. Allowed directed Pacific cod longline fishery between 140° W. and 157° W. longitude beyond 12 miles except as prohibited within 400 m isobath during halibut season.
5. Exempted foreign longliners from nationwide closures upon attaining OY if the OY is not for species targeted by longliners.
6. Increased squid OY to 5,000 mt from 2,000 mt.
7. Increased Atka mackerel OY to 26,800 mt from 24,800 mt.
8. Reduced number of management areas to three from five.
9. Removed domestic one-hour tow restriction on off-bottom trawls from December to May.
10. Provided for the annual review of domestic permits and the reporting of catch within 7 days of landing.

Amendment 5, implemented June 1, 1979:

Established a separate OY for rattails (grenadiers) of 13,200 mt.

Amendment 6, implemented September 22, 1979:

Released unused DAH to TALFF and reapportioned DAH by regulatory areas.

Amendment 7, implemented November 1, 1979:

1. Extended plan year through October 31, 1980.
2. Implemented the processor preference amendment wherein
   DAH = domestic annual processed catch (DAP) + the portion of U.S. harvest discarded + JVP + the amount of non-processed fish harvested;
   Reserve = 20 percent of OY;
   TALFF = OY - DAH, - Reserve
3. Provided for review and reapportionment of Reserve to DAH or TALFF on January 2, March 2, May 2, and July 2.
4. Increased Pacific cod OY to 60,000 mt from 34,800 mt.
5. Increased Atka mackerel OY to 28,700 mt from 26,800 mt.
6. Created separate OY for Sebastolobus species, of 3,750 mt.
7. Provided for new domestic reporting requirements to increase accuracy of forecasting U.S. fishing activity.

Amendment 8, implemented November 1, 1980:

1. Changed FMP year to calendar year and eliminated expiration date.
2. Distributed OYs for squid, ‘Other species’, Sebastolobus spp., and ‘Other rockfish’ Gulfwide.
3. Established four species categories: Unallocated, Target, Other, and Non-specified.
4. Divided Eastern regulatory area into Yakutat, Southeast Inside and Southeast Outside for sablefish only.
5. Set a reserve release schedule of 40 percent in April, 40 percent in June, and 20 percent in August.
6. Required biodegradable panels in sablefish pots.

Amendment 9, implemented October 2, 1981:

Established Lechner Line around Kodiak, which is closed from two days before king crab season to February 15.

Amendment 10, implemented June 1, 1982:

1. Closed area east of 140° W. longitude to all foreign fishing.
2. Deleted U.S. sanctuaries east of 140° W. longitude as not necessary.
3. Permitted foreign mid-water trawling only, year-round between 140° W. and 147° W. longitude.
4. For Pacific Ocean perch (POP) in the Eastern regulatory area: reduced ABC to 875 mt from 29,000 mt, changed OY = ABC, DAH = 500 mt, TALFF = 200 mt, and Reserve = 175 mt.

Amendment 11, implemented October 16, 1983:

1. Increased pollock OY in Central Gulf to 143,000 mt from 95,200 mt.
2. Established a new management objective for sablefish: sablefish in the Gulf of Alaska will be managed Gulfwide to benefit the domestic fishery.

3. Divided the Yakutat district into two sablefish management districts: Western Yakutat and Eastern Yakutat.
4. Set sablefish OY equal to ABC. ABC set at 75 percent of equilibrium yield to promote stock rebuilding. Gulfwide OY is 8,230-9,478 mt, of which 500 mt is in State internal waters of Southeast.
5. Specified that DAH will be determined annually based on previous year's domestic catch, plus amounts necessary to accommodate projected needs of the domestic fishery reserves and unneeded DAH can be reapportioned as needed.
6. Granted field order authority for Regional Director to adjust time and/or area restrictions on foreign fisheries for conservation reasons.
7. Placed radio or telephone catch reporting requirements on domestic vessels leaving State waters to land fish outside Alaska.

Amendment 12 was not submitted.

Amendment 13, implemented August 13, 1984:

Combined Western and Central regulatory areas for pollock management and set a combined OY of 400,000 mt (follow up to emergency regulations passed in December 1983 and May 1984).

Amendment 14, implemented November 18, 1985:

1. Established gear and area restrictions and OY apportionments to specific gear types for sablefish.
2. Established a Central Southeast Outside District with a 600 mt OY for demersal shelf rockfish.
3. Reduced pollock OY in the combined Western/Central regulatory area from 400,000 mt to 305,000 mt.
4. Reduced Pacific Ocean perch OY in the Western and Central regulatory areas from 2,700 mt and 7,900 mt to 1,302 mt and 3,906 mt, respectively.
5. Reduced Gulfwide ‘Other Rockfish’ OY from 7,600 mt to 5,000 mt.
6. Reduced Atka mackerel OY in the Central and Eastern regulatory areas from 20,836 mt and 3,186 mt to bycatch levels only of 500 mt and 100 mt, respectively.
7. Reduced Gulfwide ‘Other species’ OY to the framework amount of 22,460 mt.
8. Established catcher/processor reporting requirements.
9. Implemented a framework procedure for setting and adjusting halibut prohibited species catch (PSC) limits.
10. Implemented NMFS Habitat Policy.
11. Set season for hook and longline and pot sablefish fishery.

Amendment 15, implemented April 8, 1987:

1. Revised and expanded management goals and objectives.
2. Established a single OY range and an administrative framework procedure for setting annual harvest levels for each species category.
3. Established framework procedures for setting PSCs for fully utilized groundfish species applicable to joint ventures and foreign fisheries.
4. Revised reporting requirements for domestic at-sea processors.
5. Established time and area restrictions on non-pelagic trawling around Kodiak to protect king crab for three years, until December 31, 1989.
6. Established authority for the Regional Director to make in-season adjustments in the fisheries.

Amendment 16, implemented April 7, 1988:

1. Revised definition of "prohibited species" (to include an identical definition as in the BSAI groundfish FMP).
2. Updated the FMP's descriptive sections, reorganized chapters, and incorporated current Council policy.
3. Revised reporting requirements to include maintenance of at-sea transfer logs by catcher/processer vessels.

Amendment 17, implemented May 26, 1989:

Required all processing vessels receiving fish caught in the Exclusive Economic Zone (EEZ) to report to NMFS when fishing for or receiving groundfish will begin or cease, and to submit to NMFS weekly catch/receipt and product transfer reports.

Amendment 18, implemented November 1, 1989:

1. Established a procedure for annually setting fishing seasons using a regulatory amendment for implementation.
2. Established a Shelikof District in the Central regulatory area.
3. Continued the Type I and II trawl closure zones and added a Type III trawl closure zone around Kodiak Island to protect king and Tanner crab. This measure sunsets December 31, 1992.
4. Suspended the halibut PSC framework for 1990 only, substituting 2,000 mt trawl and 750 mt fixed gear halibut PSC caps; the halibut PSC framework, including halibut PSC apportionments by gear type, to be reinstituted January 1, 1991 by regulatory amendment.
5. Implemented an observer program.
6. Implemented a revised recordkeeping and data reporting system.
7. Clarified the Secretary's authority to split or combine species groups within the target species management category by a framework procedure.

Amendment 19, implemented November 15, 1990:

1. Prohibited the practice of pollock roe-stripping (defined as the taking of roe from female pollock and the subsequent discard of the female carcass and all male pollock).
2. Divided the pollock TAC into equal quarterly allowances in the Western and Central regulatory areas.

Amendment 20, approved by the Secretary on January 1, 1991:

Established an Individual Fishing Quota (IFQ) program for directed fixed gear sablefish fisheries in the GOA.

Amendment 21, implemented January 18, 1991:

1. Amended the definition of overfishing.
2. Established interim harvest levels until superseded by publication of final groundfish specifications in the Federal Register.
3. Provided limited authority to the State of Alaska to manage the demersal shelf rockfish fishery with Council oversight.
4. Provided for legal fishing gear to be defined by regulatory amendment.
5. Clarified and expanded the existing framework for managing halibut bycatch, including the adoption of an incentive program to impose sanctions on vessels with excessively high

halibut bycatch rates. The vessel incentive program originally adopted by the Council was disapproved by the Secretary. The Council adopted a revised incentive program which was submitted on November 30, 1990 to the Secretary for review and approval.

Amendment 22, implemented April 24, 1992:

1. Authorized the NMFS Regional Director to approve experimental fishing permits after consultation with the Council.
2. Rescinded GOA reporting area 68 (East Yakutat Area) and combined it with Area 65 (Southeast Outside).
3. Required groundfish pots to be identified by some form of tag (regulatory amendment).

Amendment 23, implemented June 1, 1992:

Established allocations of pollock and Pacific cod for the inshore and offshore components of the GOA groundfish fishery. 90 percent of the Pacific cod TAC and 100 percent of the pollock TAC for each fishing year, is allocated to the inshore component of the groundfish fishery. Ten percent of the Pacific cod TAC, and an appropriate percentage of the pollock TAC for bycatch purposes, is allocated to the offshore component.

Amendment 24, implemented September 23, 1992:

1. Established hot spot authority in the GOA that parallels a revised hotspot in the BSAI management area.
2. Established time/area closures to reduce bycatch rates of prohibited species.
3. Expanded the Vessel Incentive Program to include all trawl fisheries in the GOA. The new incentive program includes chinook salmon as well as halibut (regulatory amendment).
4. Delayed opening of all trawl fisheries in the GOA until January 20. The opening date for non-trawl fisheries, including hook-and-line, pot and jigging, continues to be January 1. Delayed the GOA rockfish opening date by six months until the beginning of the third quarter (regulatory amendment).
5. Homogenized the fishery definitions for both the Vessel Incentive Program and the PSC allowance limits. The definitions of fisheries for these programs are: Mid-water pollock if pollock is greater than or equal to 95 percent of the total catch, and other target fisheries would be determined by the dominate species in terms of retained catch (regulatory amendment).

Amendment 25, implemented January 19, 1992:

- Established three new districts in the combined Western and Central regulatory area for purposes of managing pollock, and rescinded the existing Shelikof Strait management district. The Western/Central regulatory area is divided into three districts by boundaries at 154° W. and 159° W longitudes.
- Limit the maximum amount of any quarterly pollock TAC allowance that may be carried over to subsequent quarters to 150 percent of the initial quarterly allowance.
- Prohibit trawling year round in the GOA within 10 nautical miles of 14 Steller sea lion rookeries.

Amendment 26, implemented December 17, 1992:

Reinstated King Crab Protective Zones around Kodiak Island on a permanent basis.

Amendment 27, implemented January 22, 1993:

Established legal zones for trawl testing when fishing is otherwise prohibited.

Amendment 28, implemented August 10, 1995 and effective on September 11, 1995:

Created a moratorium on harvesting vessels entering the BSAI groundfish fisheries other than fixed gear sablefish, after January 1, 1996. The vessel moratorium is to last until the Council replaces or rescinds the action, but is scheduled to sunset on December 31, 1998, unless the Council extends the moratorium.

Amendment 29, implemented July 24, 1996:

Established a Salmon Donation Program that authorizes the voluntary retention and distribution of salmon taken as bycatch in the groundfish trawl fisheries off Alaska to economically disadvantaged individuals.

Amendment 30, implemented October 6, 1994, superseded Amendment 18:

Implemented language changes to the FMP to indicate that observer requirements under the FMP are contained in the North Pacific Fisheries Research Plan.

Amendment 31, implemented October 18, 1993:

Created a separate target category for Atka mackerel in the FMP.

Amendment 32, implemented March 31, 1994:

Established a procedure for deriving the annual GOA TACs for Pacific Ocean perch. POP stocks are considered to be rebuilt when the total biomass of mature females is equal to, or greater than, BMSY.

Amendment 33 was not submitted.

Amendment 34, implemented September 23, 1994.

Corrected the inadvertent inclusion of the Community Development Quota (CDQ) program in the FMP by removing and reserving Section 4.4.1.1.8 on "Community Development Quotas".

Amendment 35, implemented November 7, 1994, revised Amendment 20:

Implemented the Modified Block plan to prevent excessive consolidation of the halibut and sablefish fisheries, and clarifies the transfer process for the IFQ program.

Amendment 36, implemented February 23, 1996, revised Amendment 20:

Established a one-time transfer of sablefish IFQ for CDQ.

Amendment 37, implemented July 26, 1996, revised Amendment 20:

Allowed freezing of non-IFQ species when fishing sablefish IFQ.

Amendment 38, implemented September 25, 1996, revised Amendment 32:

Revised the rebuilding plan formula for setting TAC for Pacific Ocean perch to allow the Council to recommend a POP TAC at or below the amount dictated by the formula.

Amendment 39, implemented April 16, 1998:

Defined a forage fish species category and authorized that the management of this species category be specified in regulations in a manner that prevents the development of a commercial directed fishery for forage fish which are a critical food source for many marine mammal, seabird and fish species.

Amendment 40, implemented January 1, 1996, superseded Amendment 23:

Extended provision of Amendment 23, inshore/offshore allocation.

Amendment 41, implemented January 1, 1999, except for some parts on January 1, 2000, replaces Amendment 28:

Created a license program for vessels targeting groundfish in the GOA, other than fixed gear sablefish that is pending regulatory implementation. The license program replaces the vessel moratorium and will last until the Council replaces or rescinds the action.

Amendment 42, implemented August 16, 1996, revised Amendment 20:

Increased sweep-up levels for small quota share blocks for sablefish managed under the sablefish and halibut IFQ program.

Amendment 43, implemented December 20, 1996, revised Amendment 20:

Established sweep-up provisions to consolidate very small quota share blocks for halibut and sablefish.

Amendment 44, implemented January 9, 1997, revised Amendment 21:

Established a more conservative definition of overfishing.

Amendment 45, implemented May 30, 1996:

Authorized the combining of the third and fourth quarter seasonal allowances of pollock TAC for the combined Western/Central regulatory areas.

Amendment 46, implemented April 6, 1998:

Removed black and blue rockfishes from the FMP.

Amendment 47 was not submitted.

Amendment 48was implemented December 8, 2004:

1. Revised the harvest specifications process.
2. Updated the FMP to reflect the current groundfish fisheries.

Amendment 49, implemented January 3, 1998:

Implemented an Increased Retention/Increased Utilization program for pollock and Pacific cod beginning January 1, 1998 and shallow water flatfish beginning January 1, 2003.

Amendment 50, implemented July 13, 1998, revised Amendment 29:

Established a Prohibited Species Donation Program that expands the Salmon Donation Program to include halibut taken as bycatch in the groundfish trawl fisheries off Alaska to economically disadvantaged individuals.

Amendment 51 was partially implemented on January 20, 1999, superseded Amendment 40:

Extended the inshore/offshore allocation established with Amendment 23.

Amendment 52 was not submitted.

Amendment 53 was not submitted.

Amendment 54, implemented April 29, 2002, revised Amendment 20:

Revised use and ownership provisions of the sablefish IFQ program.

Amendment 55, implemented April 26, 1999:

Implemented the Essential Fish Habitat (EFH) provisions contained in the Magnuson-Stevens Fishery Conservation and Management Act and 50 CFR 600.815. Amendment 55 describes and identifies EFH fish habitat for GOA groundfish and describes and identifies fishing and non-fishing threats to GOA groundfish EFH, research needs, habitat areas of particular concern, and EFH conservation and enhancement recommendations.

Amendment 56, implemented March 8, 1999, revised Amendment 44:

Revised the overfishing definition.

Amendment 57, implemented January 19, 1999, superseded Amendment 28:

Extended the vessel moratorium through December 31, 1999.

Amendment 58, implemented October 24, 2001 and January 1, 2002; superseded Amendment 57:

1. Required that the vessel would be a specific characteristic of the license and could not be severed from it.
2. Authorized license designations for the type of gear to harvest license limitation program (LLP) groundfish as either "trawl" or "non-trawl" gear (or both).
3. Rescinded the requirement that CDQ vessels hold a crab or groundfish license.
4. Added a crab recency requirement that requires one landing during 1/1/96-2/7/98 in addition to the general license and area endorsement qualifications.
5. Allowed limited processing (1 mt) for vessels less than 60 ft LOA with catcher vessel designations.

Amendment 59, implemented December 11, 2000:

Prohibited vessels holding a Federal fisheries permit from fishing for groundfish or anchoring in the Sitka Pinnacles Marine Reserve.

Amendment 60, implemented December 27, 2002.

Prohibited bottom trawling in Cook Inlet.

Amendment 61, implemented January 21, 2000:

1. Conformed the FMP with the American Fisheries Act (AFA) of 1998 that established sideboard measures to protect non-AFA (non-pollock) fisheries from adverse impacts resulting from AFA.
2. Extended the inshore/offshore allocations for the GOA.

Amendment 62, was approved by the Council in October 2002, reviewed by the Council in April 2008, revised Amendment 61:

Removed the sunset date for inshore/offshore allocations for the GOA.

Amendment 63, implemented May 12, 2004:

Moved skates from the 'other species' category to the 'target species' category.

Amendment 64, implemented in August 28, 2003:

Changed recordkeeping and reporting requirements for the IFQ program.

Amendment 65, implemented July 28, 2006:

Identified specific sites as HAPCs for the GOA groundfish fisheries and established management measures to reduce potential adverse effects of fishing on HAPCs. Specifically, Amendment 65 establishes the following HAPCs: the Alaska Seamount Habitat Protection Areas (fourteen sites in the GOA management area listed in Appendix B) and three sites of GOA coral HAPCs (two on the Fairweather Grounds and one off Cape Ommaney) within which five smaller areas comprise the GOA Coral Habitat Protection Areas.

Amendment 66, implemented April 20, 2004:

Established a community quota share purchase program for the IFQ sablefish fishery.

Amendment 67, implemented September 10, 2007, revised Amendment 42:

Removed restrictions on sablefish quota shares in Southeast Alaska.

Amendment 68 is not assigned.

Amendment 69, implemented April 12, 2006:

Revised the annual TAC for the "other species" complex to be less than or equal to 5% of the combined TACs for the GOA.

Amendment 70 was not submitted.

Amendment 71 is unassigned.

Amendment 72 was approved by the Council in April 2003, revised Amendment 49:

1. Removed shallow water flatfish from the improved retention/improved utilization program.
2. Created an annual review for fisheries that exceed a discard rate of 5 percent of shallow water flatfish.

Amendment 73, implemented July 28, 2006, revised Amendment 55:

1. Refined and updated the description and identification of EFH for managed species.
2. Revised approach for identifying Habitat Areas of Particular Concern within EFH, by adopting a site-based approach.
3. Established a new area (Aleutian Islands Habitat Conservation Area) in which non-pelagic trawling is prohibited, to protect sensitive habitats from potential adverse effects of fishing.

Amendment 74, implemented August 27, 2004, revised Amendment 15:

Revised the management policy and objectives.

Amendment 75, implemented June 13, 2005, revised Amendment 16:

1. Updated the FMP's descriptive sections, technically edited the language, and reorganized the content of the FMP.
2. Required the TAC for a species or species complex to be equal or less than ABC.

Amendment 76, implemented November 21, 2012 and effective on January 1, 2013, revised Amendment 18:

1. Modified the observer program to include vessels and processors of all sizes, including the commercial halibut sector.
2. Established two coverage categories for all vessels and processors: <100% observer coverage and ≥100% observer coverage.
3. Modified the observer program such that vessels in the <100% observer coverage category are subject to an ex-vessel value based fee not to exceed 2%, and are required to carry an observer as determined by NMFS. Vessels and processors in the ≥100% observer coverage category obtain observer coverage by contracting directly with observer providers, to meet coverage requirements in regulation.

Amendment 77 implemented December 31, 2008:

Removed dark rockfish (S. ciliatus) from the FMP, which allows the State of Alaska to manage this species.

Amendment 78 implemented on September 21, 2009:

Allowed unlimited post-delivery transfers of cooperative quota

Amendment 82 implemented on September 14, 2009, revised Amendment 58:

Revoked Western GOA and Central GOA area endorsements on trawl groundfish licenses unless the license met historical trawl groundfish landings criteria.

Amendment 83, was implemented on September 28, 2011:

Allocated the Western GOA and Central GOA Pacific cod TACs among gear (trawl, pot, longline, jig) and operation types.

Amendment 85, implemented on December 3, 2009, revised Amendment 68:

Removed the BSAI July stand down sideboard provision that applied to catcher processors participating in the Central GOA Rockfish Demonstration Program.

Amendment 86, implemented on April 21, 2011, revised Amendment 58:

Added gear-specific (pot, hook-and-line, and jig) Pacific cod endorsements to Western GOA and Central GOA fixed gear licenses that limit entry to the directed Pacific cod fishery.

Amendment 87, implemented on November 5, 2010:

1. Places species groups managed under the other species category into the target species category and removes the other species category from the FMP.
2. Places target species in the fishery which requires annual catch limits, accountability measures, and the description of essential fish habitat (EFH) and 5-year review of EFH information for listed species and species groups.
3. Revises the FMP to describe current practices for setting annual catch limits and the use of accountability measures to ensure annual catch limits are not exceeded, as required by National Standard 1 guidelines.
4. Removes the nonspecified species category from the FMP
5. Establishes an Ecosystem Component category and places Prohibited Species and Forage Fish Species in this category.

Amendment 88, implemented on October 24, 2011, replaced Amendment 68:

Implemented the Central Gulf of Alaska Rockfish Program. This program allocates quota share to LLP licenses for rockfish primary and secondary species based on legal landings associated with that LLP during particular qualifying years. Primary rockfish species are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish. Secondary rockfish species are Pacific cod, rougheye rockfish, shortraker rockfish, sablefish, and thornyhead rockfish.

Amendment 89, implemented July 17, 2013:

1. Established the Marmot Bay Tanner Crab Protection Area nonpelagic trawl gear closure area to protect Tanner crab. This closure applies to all trawl gear, except pelagic trawl gear used to directed fish for pollock.
2. Required the use of modified nonpelagic trawl gear by vessels directed fishing for flatfish in the Central GOA regulatory area.

Amendment 90, implemented on October 31, 2012, revised Amendment 73:

1. Revise EFH description and identification by species, and update life history, distribution, and habitat association information, based on the 2010 EFH 5-year review.
2. Update description of EFH impacts from non-fishing activities, and EFH conservation recommendations for non-fishing activities.
3. Revise the timeline associated with the HAPC process to a 5-year timeline.
4. Update EFH research priority objectives.

Amendment 91, implemented on August 14, 2014, effective on January 1, 2015:

Adds grenadiers to the ecosystem component category in section 3.2.1 and in Table 3-1.

Amendment 93, implemented, on February 17, 2012

1. Established PSC limits for Chinook salmon in the Central and Western GOA pollock fisheries.
2. Required full retention of salmon in the Central and Western GOA pollock fisheries.

Amendment 94, implemented on July 5, 2013

Revised the 50,000 pound vessel use cap for community quota entity (CQE) halibut and sablefish IFQ to not be inclusive of any halibut or sablefish IFQ that is non-CQE-held.

Amendment 95, implemented on March 24, 2014

1. Removed the annual determination of halibut prohibited species catch (PSC) limits for the federally managed groundfish fisheries under the harvest specification process.
2. Authorized the establishment of halibut PSC limits in regulations and sector allocations thereof. The PSC apportionments that reflect those regulations to each sector remain part of the annual harvest specifications.

Amendment 96, implemented on December 8, 2014

Removed the size restriction on blocks of sablefish quota share that may be owned by eligible communities.

Amendment 97, implemented January 1, 2015

1. Established annual and seasonal PSC limits for Chinook salmon in the Western and Central GOA non-pollock trawl fisheries.
2. Established a bycatch reduction incentive program in the Western and Central GOA non-pollock trawl fisheries, wherein certain operational type sectors that perform to a higher standard of Chinook salmon avoidance in one year may receive additional amounts of Chinook salmon PSC in the following year.
3. Required full retention of salmon intercepted in the Western and Central GOA non-pollock trawl fisheries.
4. Provided for the rollover of unused Chinook salmon PSC from the Central GOA Rockfish Program catcher vessel sector to the Non-Rockfish Program catcher vessel sector at certain times of the year.

Amendment 100, implemented on April 27, 2015:

This amendment corrects an omission in the FMP text that establishes vessel length limits for small vessels exempted from the license limitation program (LLP) in the Gulf of Alaska (GOA) groundfish fisheries. This amendment makes the FMP text consistent with the original intent of the LLP, operations in the fisheries, and Federal regulations.

Amendment 102, implemented on March 29, 2016:

Revised regulations governing the basis for NMFS to place small catcher/processors in the partial observer coverage category in the North Pacific Groundfish and Halibut Observer Program (Observer Program) in the Gulf of Alaska and the Bering Sea and Aleutian Islands Management Area.

Amendment 103, implemented on September 12, 2016:

1. Allows the Regional Administrator to make in-season reapportionments of Chinook salmon PSC between sectors of the GOA groundfish trawl fishery.
2. Caps the amount of reapportioned Chinook salmon PSC that any trawl sector may receive in a given year, based on that sector’s annual Chinook salmon PSC limit.
3. Provides the Regional Administrator with increased discretion regarding the timing and amount of the Chinook salmon PSC rollover from the Rockfish Program catcher vessel sector to the non-pollock Non-Rockfish Program trawl catcher vessel sector.

Amendment 104, implemented on September 7, 2017, revised Amendment 76:

Authorizes NMFS to place electronic monitoring systems for collecting at-sea data on vessels in the partial coverage category of the North Pacific Observer Program.

Amendment 105, implemented on July 5, 2018, revised Amendment 90:

1. Revise EFH description and identification by species, and update life history, distribution, and habitat association information, based on the 2016 EFH 5-year review.
2. Update the model used to determine fishing effects on EFH, and description of EFH impacts from fishing activities.
3. Update description of EFH impacts from non-fishing activities, and EFH conservation recommendations for non-fishing activities.

Amendment 106, implemented on Aug 6, 2018:

Adds squid to the ecosystem component category in section 3.1.2 and in Table 3-1. Removes squids from target species category “In the Fishery” in section 3.1.2 and in Table 3-1.

Amendment 107, implemented on Mar 23, 2020:

Requires that the operator of a catcher vessel using hook-and-line, pot, or jig gear participating in groundfish or halibut fisheries in Federal waters retain and land all rockfish. (Sebastes and Sebastolobus species) caught.

Amendment 108, implemented on January 20, 2020:

Prohibits all Amendment 80 vessels not designated on an Amendment 80 QS permit and an Amendment 80 LLP license or on an Amendment 80 LLP/QS license from receiving and processing Pacific cod harvested by a vessel directed fishing for Pacific cod in the GOA.

Amendment 109, implemented on January 1, 2021:

Revised the Western GOA and Central GOA Pacific cod trawl CV sector seasonal apportionments.

Amendment 110, implemented on August 10, 2020:

Adds sculpins to the ecosystem component category in section 3.1.2 and in Table 3-1. Removes sculpins from target species category “In the Fishery’ in section 3.1.2 and in Table 3-1.

Amendment 111, implemented March 31, 2021:

Rockfish Program Reauthorization

Amendment 112, implemented on February 27, 2023, and amends Amendment 20:

Revised fixed gear types to include jig gear as a separate category from longline gear to clarify jig gear as an authorized gear for the harvest of sablefish IFQ in the GOA.

Amendment 113, implemented on September 16, 2024:

Central Gulf of Alaska Rockfish Program Adjustments

Amendment 114, implemented on July 29, 2024, revising Amendment 76:

Allows the use of electronic monitoring systems to meet observer coverage requirements for vessels in the full observer coverage category. Specifies that tender vessels may be required to carry electronic monitoring to meet monitoring objectives aboard vessels in the full or partial coverage category.

Amendment 115, implemented on July 19, 2024, revised Amendment 114:

1. Revise EFH description and maps by species, and update life history, distribution, and habitat association information (EFH component 1), based on the 2023 EFH 5-year Review.
2. Update the model used to determine fishing effects on species' core EFH areas, and the evaluation of EFH impacts from fishing activities (EFH component 2).
3. Update description of EFH impacts from non-fishing activities and EFH conservation recommendations for non-fishing activities (EFH component 4).
4. Update the research and information needs (EFH component 9).

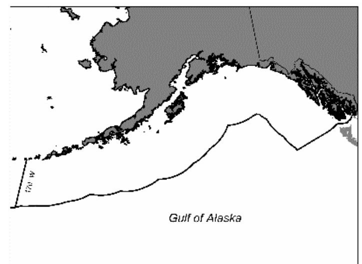
2 Appendix B Geographical Coordinates of Areas Described in the Fishery Management Plan

This appendix describes the geographical coordinates for the areas described in the Fishery Management Plan (FMP). This appendix divides the descriptions into two types: Gulf of Alaska (GOA) management area, regulatory areas, and districts (Section 2.1), and closed areas (Section 2.2).

2.1 Management Area, Regulatory Areas and Districts

2.1.1 Management Area

The GOA management area encompasses the United States (U.S.) exclusive economic zone (EEZ) of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170° W. longitude and Dixon Entrance at 132°40' W. longitude.



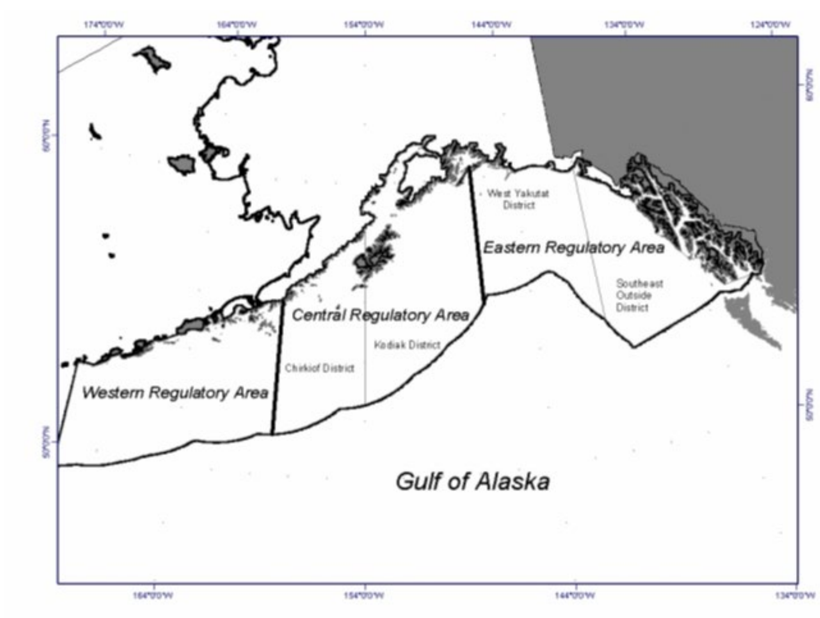
2.1.2 Regulatory Areas

Three regulatory areas are described in Section 3.1 of the FMP and are defined as follows:

Eastern regulatory area: that part of the GOA management area that is west of 147° W. longitude.

Central regulatory area: that part of the GOA management area that is east of 147° W. longitude and west of 159° W. longitude.

Western regulatory area: that part of the GOA management area that is east of 159° W. longitude and west of 170° W. longitude.



2.1.3 Districts

The Central regulatory area is divided into two districts, defined as follows:

Chirikof District:	that part of the Central regulatory area between 154° W. longitude and 159° W. longitude.
Kodiak District:	that part of the Central regulatory area between 147° W. longitude and 154° W. longitude.

The Eastern regulatory area is divided into two districts, defined as follows:

West Yakutat District:	That part of the Eastern regulatory area between 140° W. longitude and 147° W. longitude.
Southeast Outside District:	That part of the Eastern regulatory area between 132°40' W. longitude and 140° W. longitude, and north of 54°30' N. latitude.

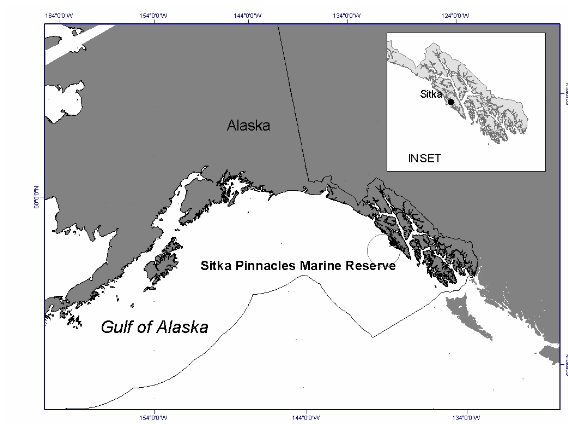
2.2 Closed Areas

Specific areas of the GOA are closed to some or all fishing during certain times of the year and are described in Section 3.5.2 of the FMP.

2.2.1 Sitka Pinnacles Marine Reserve

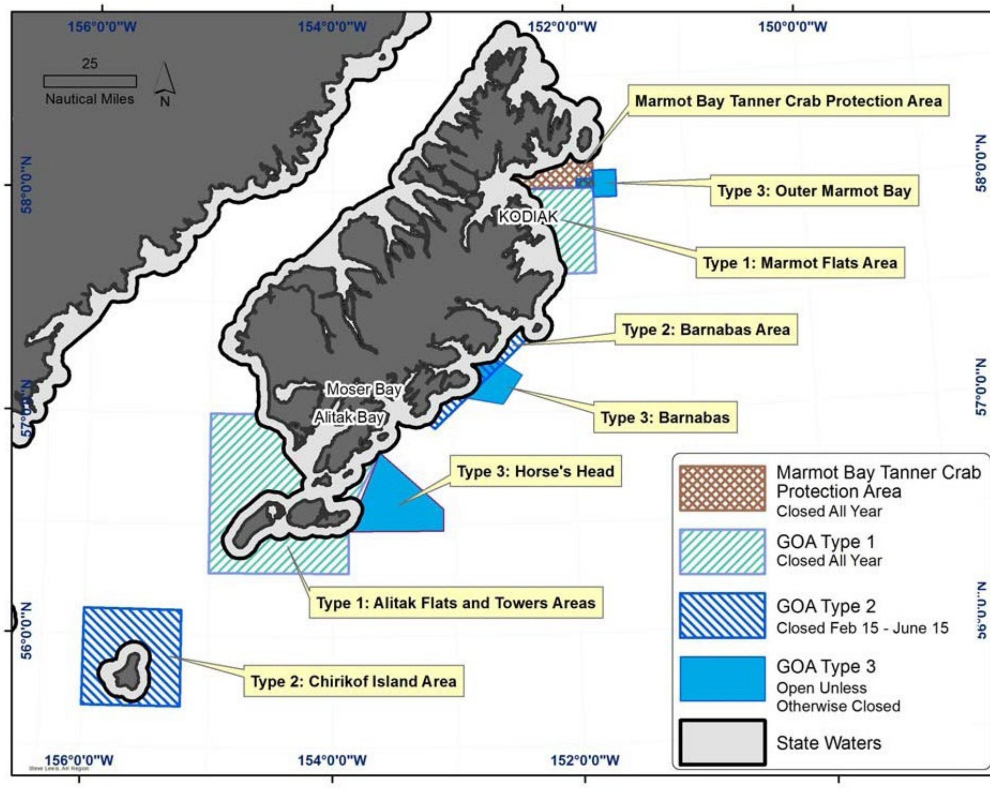
The Sitka Pinnacles Marine Reserve encompasses an area totaling 2.5 square nautical miles off Cape Edgecumbe. Vessels holding a Federal fisheries permit are prohibited at all times from fishing for groundfish or anchoring in the Sitka Pinnacles Marine Reserve. The area is defined by straight lines connecting the following pairs of coordinates in a counter-clockwise manner:

(56°55.5' N., 135°54.0' W.)
(56°57.0' N., 135°54.0' W.)
(56°57.0' N., 135°57.0' W.)
(56°55.5' N., 135°57.0' W.)



2.2.2 Marmot Bay Tanner Crab Protection Area

The use of trawl gear, except pelagic trawl gear used for directed fishing for pollock, is prohibited in the Marmot Bay Tanner Crab Protection Area.

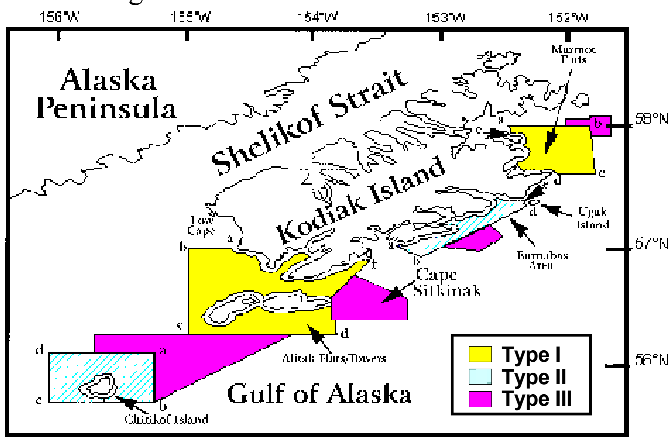


Marmot Bay Tanner Crab Protection Area: The area is defined by all waters of the EEZ enclosed by straight lines across EEZ waters and following the boundary of the State of Alaska waters connecting the following six points clockwise in the order listed:

58°15.0'N, 152°30.0'W
58°15.0'N, 151°47.0'W
58°00.0'N, 151°47.0'W
58°00.0'N, 152°30.0W
58°15.0'N, 152°30.0'W

2.2.3 King Crab Closures around Kodiak Island

The reference points described in the Type I and II areas can be found on the Kodiak Island King Crab Closures figure below.



Type I Areas

Alitak Flats and Towers Areas: All waters of Alitak Flats and the Towers Areas enclosed by a line connecting the following 7 points in the order listed:

a	(56°59.4' N.,	154°31.1' W.)	Low Cape
b	(57°00.0' N.,	155°00.0' W.)	
c	(56°17.0' N.,	155°00.0' W.)	
d	(56°17.0' N.,	153°52.0' W.)	
e	(56°33.5' N.,	153°52.0' W.)	Cape Sitkinak
f	(56°54.5' N.,	153°32.5' W.)	East Point of Twoheaded Island
g	(56°56.0' N.,	153°35.5' W.)	Kodiak Island, then along coastline until
a	(56°59.4' N.,	154°31.1' W.)	Low Cape

Marmot Flats Area: All waters enclosed by a line connecting the following five points in the clockwise order listed:

a	(58°00.0' N.,	152°30.0' W.)	
b	(58°00.0' N.,	151°47.0' W.)	
c	(57°37.0' N.,	151°47.0' W.)	
d	(57°37.0' N.,	152°10.1' W.)	Cape Chiniak, then along the coastline of Kodiak Island
e	(57°54.5' N.,	152°30.0 W.)	North Cape
a	(58°00.0' N.,	152°30.0 W.)	

Type II Areas

Chirkof Island Area: All waters surrounding Chirikof Island enclosed by a line connecting the following four points in the counter-clock wise order listed:

a	(56°07' N.,	155°13' W.)
b	(56°07' N.,	156°00' W.)
c	(55°41' N.,	156°00' W.)
d	(55°41' N.,	155°13' W.)
a	(56°07' N.,	155°13' W.)

Barnabas Area: All waters enclosed by a line connecting the following six points in the counter clockwise order listed:

a	(57°00.0' N.	153°18.0' W.)	Black Point
b	(56°56.0' N.	153°09.0' W.)	
c	(57°22.0' N.	152°18.5' W.)	South Tip of Ugak Island
d	(57°23.5' N.	152°17.5' W.)	North Tip of Ugak Island
e	(57°25.3' N.	152°20.0' W.)	Narrow Cape, then along the coastline of Kodiak Island
f	(57°04.2' N.	153°30.0' W.)	Cape Kasick
a	(57°00.0' N.	153°18.0' W.)	Black Point, including inshore waters

Type III Areas

Outer Marmot Bay: All waters bounded by lines connecting the following coordinates in the order listed:

(58°00.0' N., 151°55.4' W.)
(58°02.3' N., 151°55.4' W.)
(58°02.3' N., 151°47.0' W.)
(58°4.53' N., 151°47.0' W.)
(58°4.53' N., 151°35.25' W.)
(57°57.4' N., 151°35.25' W.)
(57°57.4' N., 151°47.0' W.)
(58°00.0' N., 151°47.0' W.)
(58°00.0' N., 151°55.4' W.)

Barnabas: All waters bounded by lines connecting the following coordinates in the order listed:

(57°14.3' N., 152°37.5' W.)
(57°10.0' N., 152°25.3' W.)
(57°02.32' N., 152°35.02' W.), then following the 3 mile limit to
(57°04.25' N., 152°54.15' W.), then following the 3 mile limit to
(57°14.3' N., 152°37.5' W.)

Horse's Head: All waters bounded by lines connecting the following coordinates in the order listed:

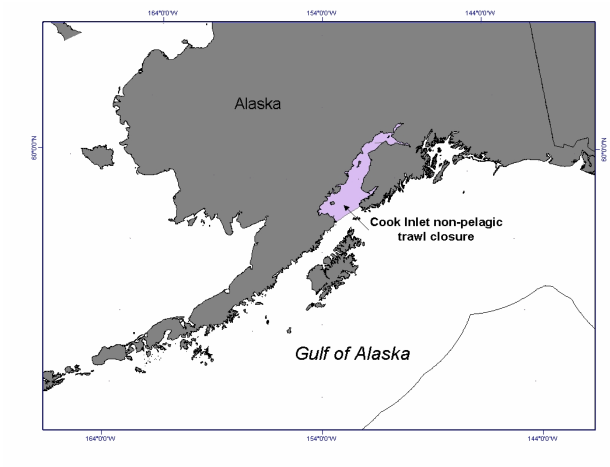
(56°49.55' N., 153°36.3' W.)
(56°34.35' N., 153°05.37' W.)
(56°28.35' N., 153°05.37' W.)
(56°28.35' N., 153°52.05' W.), then following the 3 mile limit to
(56°49.55' N., 153°36.3' W.)

Chirikof: All waters bounded by lines connecting the following coordinates in the order listed:

(56°16.45' N., 155°39.0' W.)
(56°16.45' N., 154°11.45' W.)
(55°41.0' N., 155°13.0' W.)
(56°07.1' N., 155°13.0' W.)
(56°07.1' N., 155°39.0' W.)
(56°16.45' N., 155°39.0' W.)

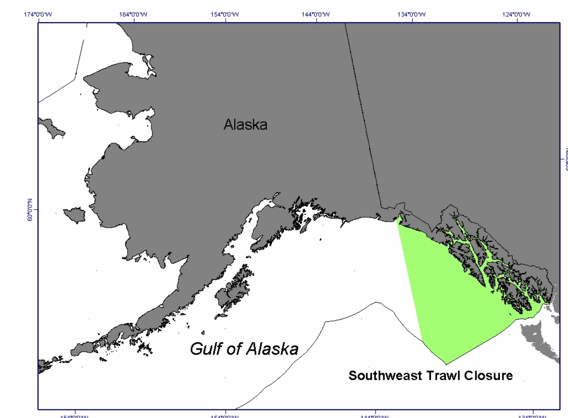
2.2.4 Cook Inlet non-Pelagic Trawl Closure Area

The use of non-pelagic trawl gear in Cook Inlet north of a line extending between Cape Douglas (58°51.10' N. latitude) and Point Adam (59°15.27' N. latitude) is prohibited.



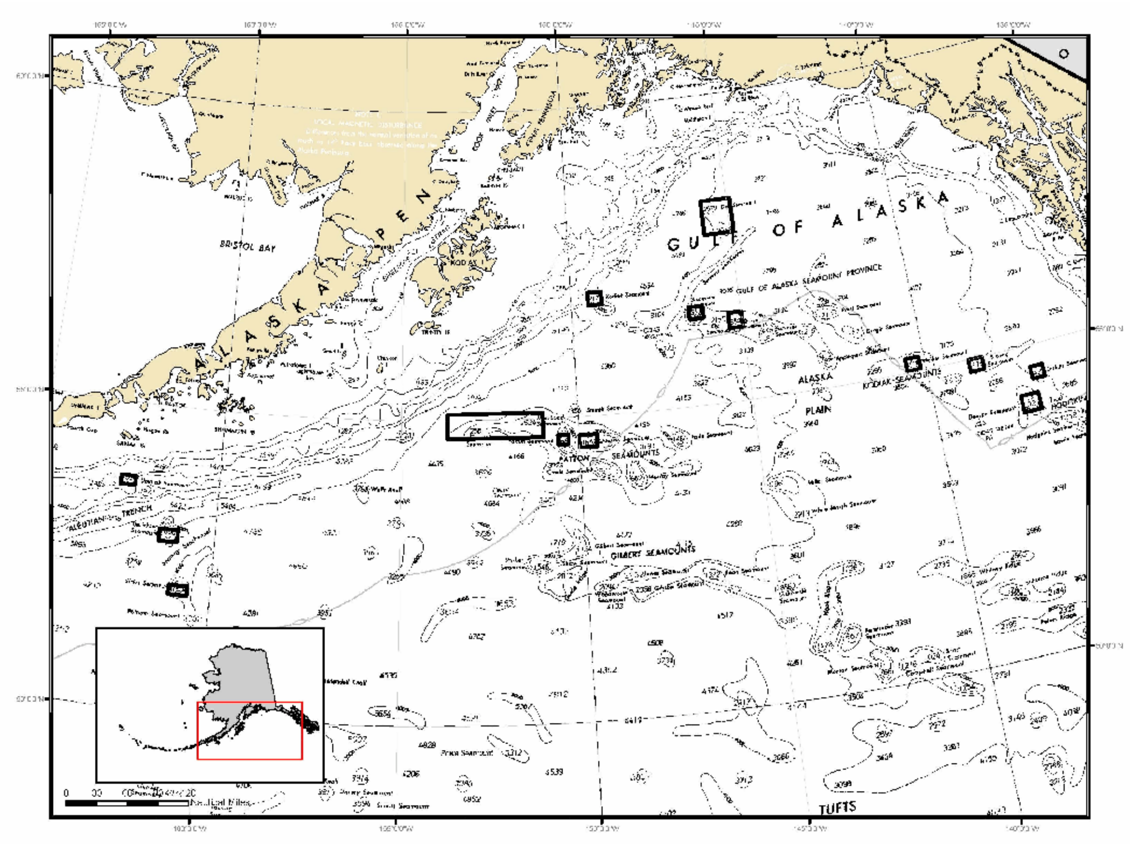
2.2.5 Southeast Outside Trawl Closure

The use of trawl gear in Southeast Outside district (defined under Section 2.1 above) is prohibited.



2.2.6 Alaska Seamount Habitat Protection Area (ASHPA)

Bottom contact gear fishing and anchoring is prohibited in the portion of the ASHPA located in the GOA. Coordinates for the ASHPA are listed in the table below. Note: Each area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates for each area is connected to the first set of coordinates for the area by a straight line. Projected coordinate system is North American Datum 1983, Albers.

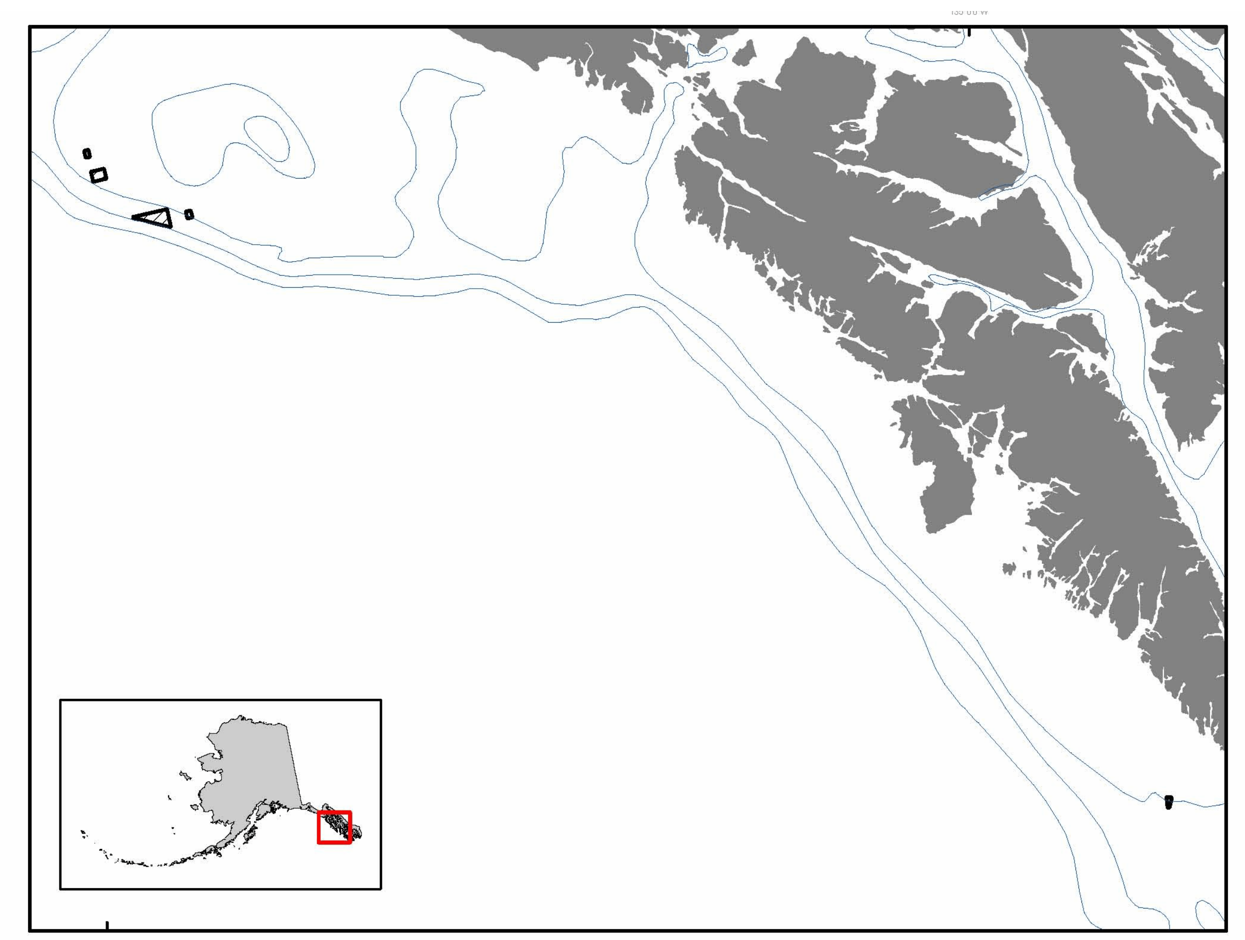


Area Number	Name	Latitude			Longitude		
1	Dickins Seamount	54	39.00	N	136	48.00	W
		54	39.00	N	137	9.00	W
		54	27.00	N	137	9.00	W
		54	27.00	N	136	48.00	W
2	Denson Seamount	54	13.20	N	137	6.00	W
		54	13.20	N	137	36.00	W
		53	57.00	N	137	36.00	W
		53	57.00	N	137	6.00	W
3	Brown Seamount	55	0.00	N	138	24.00	W
		55	0.00	N	138	48.00	W
		54	48.00	N	138	48.00	W
		54	48.00	N	138	24.00	W
4	Welker Seamount	55	13.80	N	140	9.60	W
		55	13.80	N	140	33.00	W
		55	1.80	N	140	33.00	W
		55	1.80	N	140	9.60	W
5	Dall Seamount	58	18.00	N	144	54.00	W
		58	18.00	N	145	48.00	W
		57	45.00	N	145	48.00	W
		57	45.00	N	144	54.00	W
6	Quinn Seamount	56	27.00	N	145	0.00	W
		56	27.00	N	145	24.00	W
		56	12.00	N	145	24.00	W
		56	12.00	N	145	0.00	W
7	Giacomini Seamount	56	37.20	N	146	7.20	W
		56	37.20	N	146	31.80	W
		56	25.20	N	146	31.80	W
		56	25.20	N	146	7.20	W
8	Kodiak Seamount	57	0.00	N	149	6.00	W
		57	0.00	N	149	30.00	W
		56	48.00	N	149	30.00	W
		56	48.00	N	149	6.00	W
9	Odessey Seamount	54	42.00	N	149	30.00	W
		54	42.00	N	150	0.00	W
		54	30.00	N	150	0.00	W
		54	30.00	N	149	30.00	W
10	Patton Seamount	54	43.20	N	150	18.00	W
		54	43.20	N	150	36.00	W
		54	34.20	N	150	36.00	W
		54	34.20	N	150	18.00	W
11	Chirikof & Marchand Seamounts	55	6.00	N	151	0.00	W
		55	6.00	N	153	42.00	W
		54	42.00	N	153	42.00	W
		54	42.00	N	151	0.00	W
12	Sirius Seamount	52	6.00	N	160	36.00	W
		52	6.00	N	161	6.00	W

Area Number	Name	Latitude			Longitude		
		51	57.00	N	161	6.00	W
		51	57.00	N	160	36.00	W
13	Derickson Seamount	53	0.00	N	161	0.00	W
		53	0.00	N	161	30.00	W
		52	48.00	N	161	30.00	W
		52	48.00	N	161	0.00	W
14	Unimak Seamount	53	48.00	N	162	18.00	W
		53	48.00	N	162	42.00	W
		53	39.00	N	162	42.00	W
		53	39.00	N	162	18.00	W

2.2.7 Gulf of Alaska Coral Habitat Protection Area

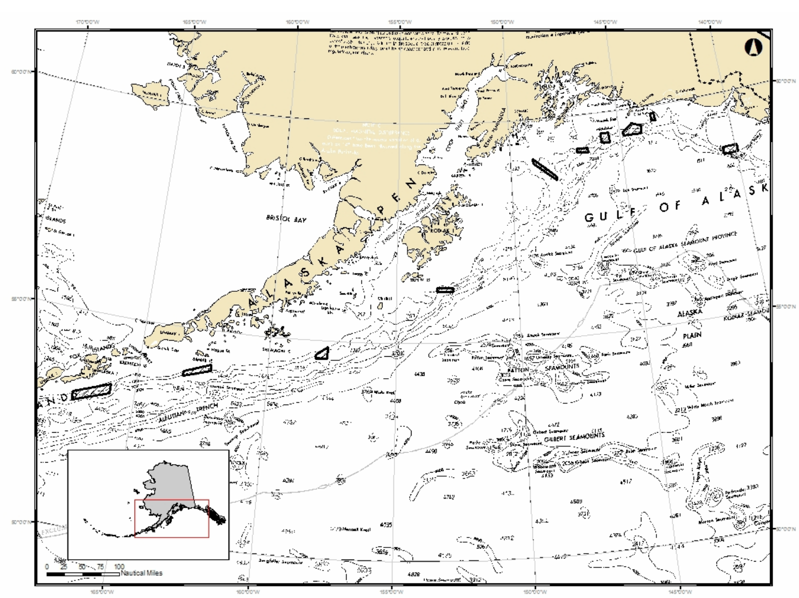
Bottom contact gear fishing and anchoring is prohibited in the Gulf of Alaska Coral Habitat Protection Area. Coordinates are listed in the table below. Note: Each area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates for each area is connected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



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

2.2.8 Gulf of Alaska Slope Habitat Conservation Area

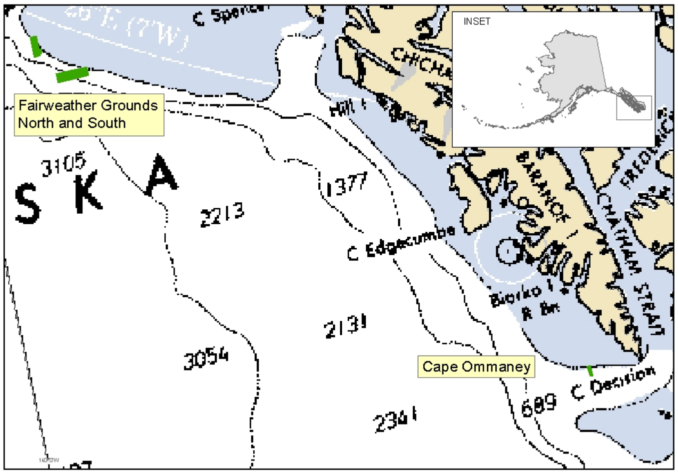
Nonpelagic trawl gear fishing is prohibited in the Gulf of Alaska Slope Habitat Conservation Area. Coordinates are listed in the table below. Note: Each area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates for each area is connected to the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



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

2.2.9 Gulf of Alaska Coral Habitat Areas of Particular Concern

Gulf of Alaska HAPC designation Cape Ommaney and Fairweather Grounds



The coordinates for the Gulf of Alaska Coral Habitat Areas of Particular Concern are listed in the table below.

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

3 Appendix C Section 211 of the American Fisheries Act

3.1 American Fisheries Act, Section 211

SEC. 211. PROTECTIONS FOR OTHER FISHERIES; CONSERVATION MEASURES.

(a) General. The North Pacific Council shall recommend for approval by the Secretary such conservation and management measures as it determines necessary to protect other fisheries under its jurisdiction and the participants in those fisheries, including processors, from adverse impacts caused by this Act or fishery cooperatives in the directed pollock fishery.

(b) Catcher/Processor Restrictions.

(1) General. The restrictions in this subsection shall take effect on January 1, 1999 and shall remain in effect thereafter except that they may be superseded (with the exception of paragraph (4)) by conservation and management measures recommended after the date of the enactment of this Act by the North Pacific Council and approved by the Secretary in accordance with the Magnuson-Stevens Act.

(2) Bering Sea Fishing. The catcher/processors eligible under paragraphs (1) through (20) of section 208(e) are hereby prohibited from, in the aggregate –

(A) exceeding the percentage of the harvest available in the offshore component of any Bering Sea and Aleutian Islands groundfish fishery (other than the pollock fishery) that is equivalent to the total harvest by such catcher/processors and the catcher/processors listed in section 209 in the fishery in 1995, 1996, and 1997 relative to the total amount available to be harvested by the offshore component in the fishery in 1995, 1996, and 1997;

(B) exceeding the percentage of the prohibited species available in the offshore component of any Bering Sea and Aleutian Islands groundfish fishery (other than the pollock fishery) that is equivalent to the total of the prohibited species harvested by such catcher/processors and the catcher/processors listed in section 209 in the fishery in 1995, 1996, and 1997 relative to the total amount of prohibited species available to be harvested by the offshore component in the fishery in 1995, 1996, and 1997.

(C) fishing for Atka mackerel in the eastern area of the Bering Sea and Aleutian Islands and from exceeding the following percentages of the directed harvest available in the Bering Sea and Aleutian Islands Atka mackerel fishery –

(i) 11.5 percent in the central area; and

(ii) 20 percent in the western area.

(3) Bering Sea Processing. The catcher/processors eligible under paragraphs (1) through (20) of section 208(e) are hereby prohibited from –

(A) processing any of the directed fishing allowances under paragraphs (1) or (3) of section 206(b); and

(B) processing any species of crab harvested in the Bering Sea and Aleutian Islands Management Area.

(4) Gulf of Alaska. The catcher/processors eligible under paragraphs (1) through (20) of section 208(e) are hereby prohibited from –

(A) harvesting any fish in the Gulf of Alaska;

(B) processing any groundfish harvested from the portion of the exclusive economic zone off Alaska known as area 630 under the fishery management plan for Gulf of Alaska groundfish; or

(C) processing any pollock in the Gulf of Alaska (other than as by catch in non-pollock groundfish fisheries) or processing, in the aggregate, a total of more than 10 percent of the cod harvested from areas 610, 620, and 640 of the Gulf of Alaska under the fishery management plan for Gulf of Alaska groundfish.

(5) Fisheries Other than North Pacific. The catcher/processors eligible under paragraphs (1) through (20) of section 208(e) and motherships eligible under section 208(d) are hereby prohibited from harvesting fish in any fishery under the authority of any regional fishery management council established under section 302(a) of the Magnuson-Stevens Act (16 U.S.C. 1852(a)) other than the North Pacific Council, except for the Pacific whiting fishery, and from processing fish in any fishery under the authority of any such regional fishery management council other than the North Pacific Council, except in the Pacific whiting fishery, unless the catcher/processor or mothership is authorized to harvest or process fish under a fishery management plan recommended by the regional fishery management council of jurisdiction and approved by the Secretary.

(6) Observers and Scales. The catcher/processors eligible under paragraphs (1) through (20) of section 208(e) shall –

(A) have two observers onboard at all times while groundfish is being harvested, processed, or received from another vessel in any fishery under the authority of the North Pacific Council; and

(B) weight its catch on a scale onboard approved by the National Marine Fisheries Service while harvesting groundfish in fisheries under the authority of the North Pacific Council.

This paragraph shall take effect on January 1, 1999 for catcher/processors eligible under paragraphs (1) through (20) of section 208(e) that will harvest pollock allocated under section 206(a) in 1999, and shall take effect on January 1, 2000 for all other catcher/processors eligible under such paragraphs of section 208(e).

(c) Catcher Vessel and Shoreside Processor Restrictions.

(1) Required Council Recommendations. By not later than July 1, 1999, the North Pacific Council shall recommend for approval by the Secretary conservation and management measures to –

(A) prevent the catcher vessels eligible under subsections (a), (b), and (c) of section 208 from exceeding in the aggregate the traditional harvest levels of such vessels in other fisheries under the authority of the North Pacific Council as a result of fishery cooperatives in the directed pollock fisheries; and

(B) protect processors not eligible to participate in the directed pollock fishery from adverse effects as a result of this Act or fishery cooperatives in the directed pollock fishery.

If the North Pacific Council does not recommend such conservation and management measures by such date, or if the Secretary determines that such conservation and management measures recommended by the North Pacific Council are not adequate to fulfill the purposes of this paragraph, the Secretary may by regulation restrict or change the authority in section 210(b) to the extent the Secretary deems appropriate, including by preventing fishery cooperatives from being formed pursuant to such section and by providing greater flexibility with respect to the shoreside processor or shoreside processors to which catcher vessels in a fishery cooperative under section 210(b) may deliver pollock.

(2) Bering Sea Crab and Groundfish.

(A) Effective January 1, 2000, the owners of the motherships eligible under section 208(d) and the shoreside processors eligible under section 208(f) that receive pollock from the directed pollock fishery under a fishery cooperative are hereby prohibited from processing, in the aggregate for each calendar year, more than the percentage of the total catch of each species of crab in directed fisheries under the jurisdiction of the North Pacific Council than facilities operated by such owners processed of each such species in the aggregate, on average, in 1995, 1996, and 1997. For the purposes of this subparagraph, the term facilities means any processing plant, catcher/processor, mothership, floating processor, or any other operation that processes fish. Any entity in which 10 percent or more of the interest is owned or controlled by another individual or entity shall be considered to be the same entity as the other individual or entity for the purposes of this subparagraph.

(B) Under the authority of section 301(a)(4) of the Magnuson-Stevens Act (16 U.S.C. 1851(a)(4)), the North Pacific Council is directed to recommend for approval by the Secretary conservation and management measures to prevent any particular individual or entity from harvesting or processing an excessive share of crab or of groundfish in fisheries in the Bering Sea and Aleutian Islands Management Area.

(C) The catcher vessels eligible under section 208(b) are hereby prohibited from participating in a directed fishery for any species of crab in the Bering Sea and Aleutian Islands Management Area unless the catcher vessel harvested crab in the directed fishery for that species of crab in such Area during 1997 and is eligible to harvest such crab in such directed fishery under the license limitation program recommended by the North Pacific Council and approved by the Secretary. The North Pacific Council is directed to recommend measures for approval by the Secretary to eliminate latent licenses under such program, and nothing in this subparagraph shall preclude the Council from recommending measures more restrictive than under this paragraph.

(3) Fisheries Other than North Pacific.

(A) By not later than July 1, 2000, the Pacific Fishery Management Council established under section 302(a)(1)(F) of the Magnuson-Stevens Act (16 U.S.C. 1852 (a)(1)(F)) shall recommended for approval by the Secretary conservation and management measures to protect fisheries under its jurisdiction and the participants in those fisheries from adverse impacts caused by this Act or by any fishery cooperatives in the directed pollock fishery.

(B) If the Pacific Council does not recommend such conservation and management measures by such date, or if the Secretary determines that such conservation and management measures recommended by the Pacific Council are not adequate to fulfill the purposes of this paragraph, the Secretary may by regulation implement adequate measures including, but not limited to, restrictions on vessels which harvest pollock under a fishery cooperative which will prevent such vessels from harvesting Pacific groundfish, and restrictions on the number of processors eligible to process Pacific groundfish.

(d) Bycatch Information. Notwithstanding section 402 of the Magnuson-Stevens Act (16 U.S.C. 1881a), the North Pacific Council may recommend and the Secretary may approve, under such terms and conditions as the North Pacific Council and Secretary deem appropriate, the public disclosure of any information from the groundfish fisheries under the authority of such Council that would be beneficial in the implementation of section 301(a)(9) or section 303(a)(11) of the Magnuson-Stevens Act (16 U.S.C. 1851(a)(9) and 1853(a)(11)).

(e) Community Development Loan Program. Under the authority of title XI of the Merchant Marine Act, 1936 (46 U.S.C. App. 1271 et seq.), and subject to the availability of appropriations, the Secretary is authorized to provide direct loan obligations to communities eligible to participate in the western Alaska community development quota program established under section 304(i) of the Magnuson-Stevens Act (16 U.S.C. 1855(i)) for the purposes of purchasing all or part of an ownership interest in vessels and shoreside processors eligible under subsections (a), (b), (c), (d), (e), or (f) of section 208. Notwithstanding the eligibility criteria in section 208(a) and section 208(c), the LISA MARIE (United States official number 1038717) shall be eligible under such sections in the same manner as other vessels eligible under such sections.

4 Appendix D Life History Features and Habitat Requirements of Fishery Management Plan Species

This appendix describes habitat requirements and life histories of the groundfish species managed by this fishery management plan. Each species or species group is described individually, however, summary tables that denote habitat associations (Table 4-1), biological associations (Table 4-2), and predator-prey associations (Table 4-3) are also provided.

In each individual section, a species-specific table summarizes habitat. The following abbreviations are used in these habitat tables to specify location, position in the water column, bottom type, and other oceanographic features.

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

Life Stage

A	=	adult
S	=	subadult
SEJ	=	settled early juvenile
L	=	larvae
E	=	eggs

Table 4-1 Summary of habitat associations for groundfish of the GOA.

GOA Groundfish Species	LIFE STAGE	Nearshore				Shelf			Slope						Stratum Reference							Location							Physical Oceanography				
						Inner	Middle	Outer	Upper		Intermediate		Lower	Basin												Pelagic							
		Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully	Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)
Arrowtooth Flounder	A					x	x	x	x	x	x														x								
	S					x	x	x																	x								
	SEJ					x	x																		x								
	L					x	x	x	x	x																x					x		
	E					x	x	x	x	x															x								
Atka Mackerel	A					x	x	x	x							x							x	x	x				x			x	x
	S																					x	x										
	L																					x	x										
	E					x	x	x								x									x								
Deepwater Flatfish Complex (Dover Sole)	A					x	x	x	x	x	x	x	x												x								
	S					x	x	x	x	x															x								
	SEJ					x	x																		x								
	L					x	x	x	x	x																x					x		
	E					x	x	x	x	x																x							
Dusky Rockfish	A							x	x									x		x	x				x								
	S						x	x										x		x					x								
	SEJ																																
	L																																
Flathead Sole	A					x	x	x	x																x								
	S					x	x	x																	x								
	SEJ					x	x																		x								
	L					x	x	x																		x					x		
	E					x	x	x																		x							
Northern Rockfish	A						x	x										x							x								
	S						x	x										x	x						x								
	SEJ																									x							
	L																																
Octopus	A			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x				x	x	x						
	S																																
	SEJ																																
	L																																
	E																																
Other Rockfish Complex	A					x	x	x	x	x	x					x	x								x				x				
	S					x	x	x								x	x								x				x				
	SEJ					x	x	x								x	x								x				x				
	L					x	x																	x	x	x			x				
	E																																

GOA Groundfish Species	LIFE STAGE	Substrate													Structure										Community Associations													Oceanographic Properties			LIFE STAGE
		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)	
Arrowtooth Flounder	A		x	x	x			x																																	A
	S		x	x	x			x																																	S
	SEJ		x	x	x			x																																	SEJ
	L																																								L
	E																																								E
Atka Mackerel	A			x	x								x	x								x							x			x						3-5	>17		A
	S																																					3-12			S
	L																																					2-12			L
	E				x								x	x																		x						3-10			E
Deepwater Flatfish Complex (Dover Sole)	A		x	x			x																																		A
	S		x	x			x																																		S
	SEJ		x	x			x																																		SEJ
	L																																								L
	E																																								E
Dusky Rockfish	A				x								x	x																											A
	S																												x												S
	SEJ																																								SEJ
	L																																								L
Flathead Sole	A		x	x	x			x		x																															A
	S		x	x	x			x		x																															S
	SEJ		x	x																																					SEJ
	L							x																																	L
	E																																								E
Northern Rockfish	A												x	x																											A
	S																																								S
	SEJ																																								SEJ
	L																																								L
Octopus	A																																								A
	S																																								S
	SEJ																																								SEJ
	L																																								L
	E																																								E
Other Rockfish Complex	A			x									x	x					x	x		x	x			x		x							x						A
	S													x					x	x		x	x			x		x							x						S
	SEJ													x					x	x		x	x			x		x							x						SEJ
	L													x					x	x		x	x																		L
	E																																								E

Table 4.1 (cont) Summary of habitat associations for groundfish of the GOA.

GOA Groundfish Species	LIFE STAGE	Nearshore				Shelf			Slope						Stratum Reference							Location						
		Freshwater	Estuarine	Intertidal	Subtidal	Inner 1-50m	Middle 51-100m	Outer 101-200m	Upper 201-300m	301-500m	Intermediate 501-700m	701-1000m	Lower 1001-3000m	Basin >3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully	Surface	Near surface	Semi-demersal	Demersal	Pelagic 1-200m (epi)	201-1000m (meso)	>1000m (bathy)
Other Rockfish Complex, Demersal Subgroup	A					x	x	x	x	x						x	x								x			
	S					x	x	x								x	x								x			
	SEJ					x	x	x								x	x								x			
	L					x	x																	x	x	x		
	E																											
Other Rockfish Complex, Slope Subgroup	A					x	x	x	x	x	x					x	x								x			
	S					x	x	x								x	x								x			
	SEJ					x	x	x								x	x								x			
	L					x	x																	x	x	x		
	E																											
Pacific Cod	A					x	x	x	x	x					x	x	x	x	x	x					x			
	S					x	x								x	x	x	x	x	x					x			
	SEJ				x	x									x		x							x	x			
	L					x	x	x																		x		
	E					x	x	x																	x			
Pacific Ocean Perch	A							x	x	x								x	x	x	x			x	x	x		
	S					x	x	x	x																			
	SEJ					x	x	x																x	x	x	x	x
	L																						x	x		x	x	
Rex Sole	A					x	x	x	x	x															x			
	S					x	x	x	x																x			
	SEJ					x	x																		x			
	L					x	x	x	x																	x		
	E					x	x	x	x																	x		
Rougheye/ Blackspotted Rockfish	A								x	x								x	x	x	x				x			
	S							x	x								x		x									
	SEJ												x	x									x	x		x		
	L																						x			x		
Sablefish	A								x	x	x	x	x				x				x				x			
	S							x	x	x	x						x				x				x			
	SEJ					x	x	x							x		x						x	x	x	x	x	
	L						x	x	x	x	x	x	x	x								x	x					
	E								x	x	x	x	x	x												x	x	
Shallow Water Flatfish Complex	A					x	x	x																	x			
	S					x	x	x																	x			
	SEJ					x	x																		x			
	L					x	x	x																		x		
	E					x	x	x																	x	x		

GOA Groundfish Species	LIFE STAGE	Physical Oceanography					Substrate													Structure										Community Associations													Oceanographic Properties			LIFE STAGE
		Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock	Bars	Sinks	Slumps/Rockfalls/Debris	Channels	Ledges	Pinnacles	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)	
Other Rockfish Complex, Demersal Subgroup	A	x							x									x	x					x	x			x			x		x													A
	S	x																	x					x	x			x			x		x													S
	SEJ	x																	x					x	x			x			x		x													SEJ
	L	x																	x					x	x			x																		L
	E																																													E
Other Rockfish Complex, Slope Subgroup	A	x							x									x	x					x	x		x	x			x		x							x						A
	S	x																	x					x	x		x	x			x		x							x						S
	SEJ	x																	x					x	x		x	x			x		x							x						SEJ
	L	x																	x					x	x		x	x																		L
	E																																													E
Pacific Cod	A							x	x	x	x	x	x	x	x	x	x	x	x				x	x			x				x	x	x	x	x						x	x				A
	S							x	x	x	x	x	x	x	x	x	x	x	x				x	x			x				x	x	x	x	x						x	x				S
	SEJ							x	x	x	x	x	x	x	x	x	x													x	x	x			x		x									SEJ
	L																																													L
	E							x	x	x	x	x	x	x	x	x	x	x	x																								3-6	13-23	2-3	E
Pacific Ocean Perch	A	x					x	x	x	x	x	x	x	x	x	x	x	x	x														x													A
	S	x																x	x																											S
	SEJ	x								x								x	x																											SEJ
	L	x																																												L
Rex Sole	A							x	x				x																																	A
	S							x	x				x																																	S
	SEJ							x	x				x																																	SEJ
	L							x	x																																					L
	E																																													E
Rougheye/ Blackspotted Rockfish	A							x	x	x	x	x	x	x	x	x	x	x	x							x								x												A
	S																	x	x																											S
	SEJ																																													SEJ
	L																																													L
Sablefish	A	x						x	x	x								x	x							x																				A
	S	x						x	x	x								x	x																											S
	SEJ	x																																												SEJ
	L	x																																												L
	E	x																																												E
Shallow Water Flatfish Complex	A							x	x				x																																	A
	S							x	x				x																																	S
	SEJ							x	x				x																																	SEJ
	L			x																																										L
	E																																													E

Table 4.1 (cont) Summary of habitat associations for groundfish of the GOA.

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
Shark Complex (Spiny Dogfish)	A			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	S																				
	SEJ																				
	E																				
Shortraker Rockfish	A								x	x										x	
	S																				
	SEJ												x	x							
	L																				
Skate Complex	A			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x
	S																				
	SEJ																				
	E																				
Thornyhead Rockfish Complex (Shortspine Thornyhead)	A								x	x	x	x	x								
	S						x	x	x												
	SEJ																				
	L																				
	E																				
Walleye Pollock	A						x	x	x	x				x		x	x	x	x	x	x
	S					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

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
Shark Complex (Spiny Dogfish)	A	x	x	x	x	x	x																			
	S																									
	SEJ																									
	E																									
Shortraker Rockfish	A				x								x		x	x	x	x	x	x	x	x	x	x	x	x
	S				x																					
	SEJ		x																							
	L					x																				
Skate Complex	A			x	x																					
	S																									
	SEJ																									
	E																									
Thornyhead Rockfish Complex (Shortspine Thornyhead)	A				x										x		x								x	x
	S				x										x		x									x
	SEJ					x																				
	L					x																				
	E					x																				
Walleye Pollock	A		x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	
	S		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														

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	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)	
Shark Complex (Spiny Dogfish)	A																											A
	S																											S
	SEJ																											SEJ
	E																											E
Shortraker Rockfish	A							x								x												A
	S																											S
	SEJ																											SEJ
	L																											L
Skate Complex	A																											A
	S																											S
	SEJ																											SEJ
	E																											E
Thornyhead Rockfish Complex (Shortspine Thornyhead)	A							x																				A
	S																											S
	SEJ																											SEJ
	L																											L
	E																											E
Walleye Pollock	A																								2-10			A
	S																								2-10			S
	L																											L
	E																											E

Table 4-2 Summary of reproductive traits 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
Arrowtooth Flounder	A	5		4		x												x	x	x	x							x	x
Atka Mackerel	A	3.6		3.6		x						x			x	x							x	x	x	x	x		
Deepwater Flatfish: Dover Sole	A	6.7	11			x						x							x	x	x	x							
Dusky Rockfish	A	11					x				x	x																	
Flathead Sole	A	8.7				x						x								x	x	x	x						
Northern Rockfish	A	13					x				x	x								x	x	x							
Octopus	A						x					x			x	x													
Other Rockfish	A						x		x	x							x												
Other Rockfish, Demersal Subgroup	A	22		18			x		x												x	x	x	x					
Other Rockfish, Slope Subgroup	A						x		x	x							x												
Pacific Cod	A	5		5		x							x					x	x	x	x	x							
Pacific Ocean Perch	A	10.5	20.0				x				x	x														x	x	x	x
Rex Sole	A	352 mm		352 mm		x													x	x	x	x	x	x					
Rougheye/ Blackspotted Rockfish	A	19+					x				x	x						x	x	x	x								x
Sablefish	A	585 mm		585 mm		x							x					x	x	x									
Shallow Water Flatfish	A	6-10.5				x						x						x	x	x	x	x	x	x					x
Sharks: Spiny Dogfish	A	35		21			x	x	x	x	x						x	x	x	x						x	x	x	x
Shortraker Rockfish	A	20+					x				x	x							x	x	x	x	x	x	x				
Skates	A						x	x						x															
Thornyhead Rockfish	A	215 mm		215 mm					x			x									x	x	x	x					
Walleye Pollock	A	4-5		4-5		x							x						x	x	x	x							

Table 4-3 Summary of predator and 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)	Bivalves	Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishe	Cottidae (sculpins)	Arrowtooth	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Arrowtooth Flounder	A												x	x				x	x	x			x	x						x	
	S												x					x	x	x			x	x						x	
	SEJ				x																										
	L	x		x																											
	E																														
Atka Mackerel	A							x			x													x							
	S							x			x																				
	L										x																				
	E																														
Deepwater Flatfish Complex (Dover Sole)	A												x						x												
	S												x						x												
	SEJ																														
	L	x		x																											
	E																														
Dusky Rockfish	A							x		x	x							x		x	x										
	S							x		x	x							x		x	x										
	SEJ																														
	L																														
Flathead Sole	A							x					x			x		x	x	x											
	S							x					x					x	x	x											
	SEJ				x			x					x					x	x	x											
	L	x		x																											
	E																														
Northern Rockfish	A				x			x			x																				
	S																														
	SEJ																														
	L																														
	E																														
Octopus	A															x	x	x	x	x	x				x		x		x		x
	S																														
	SEJ																														
	L																														
	E																														
Other Rockfish Complex	A																	x		x	x	x	x	x			x				
	S																														
	SEJ										x																				
	L																														
	E																														

Prey of

GOA Groundfish Species	Life Stage	Jellyfish	Starfish	Chaetognaths (arrowworm)	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
Arrowtooth Flounder	A																														
	S							x	x																						
	SEJ																														
	L																														
	E																														
Atka Mackerel	A								x						x	x		x	x	x	x			x							
	S																	x		x							x	x			
	L																														
	E																														
Deepwater Flatfish Complex (Dover Sole)	A							x								x															
	S							x								x															
	SEJ																														
	L																														
	E																														
Dusky Rockfish	A								x	x	x				x	x															
	S								x	x	x				x	x															
	SEJ																														
	L																														
Flathead Sole	A							x	x						x	x				x											
	S							x							x																
	SEJ							x	x						x																
	L																														
	E																														
Northern Rockfish	A																														
	S																														
	SEJ																														
	L																														
	E																														
Octopus	A							x	x	x	x					x	x	x	x	x		x									
	S																														
	SEJ																														
	L																														
	E																														
Other Rockfish Complex	A						x			x	x					x	x														
	S						x			x	x					x	x														
	SEJ																														
	L																														
	E																														

Table 4.3 (cont) Summary of predator and 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)	Bivalves	Mollusks	Crustaceans	Ophiuroids (brittle stars	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishe	Cottidae (sculpins)	Arrowtooth	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Other Rockfish Complex, Demersal Subgroup	A																	x		x	x		x				x				
	S																														
	SEJ										x																				
	L																														
	E																														
Other Rockfish Complex, Slope Subgroup	A																	x		x	x	x	x	x			x				
	S																														
	SEJ										x																				
	L																														
	E																														
Pacific Cod	A							x		x			x							x										x	
	S							x		x			x							x										x	
	SEJ							x		x			x							x											
	L			x	x						x																				
	E																														
Pacifc Ocean Perch	A							x		x	x									x											
	S							x		x	x									x											
	SEJ																														
	L			x	x																										
Rex Sole	A							x		x			x					x													
	S							x		x			x					x													
	SEJ																														
	L	x		x																											
	E																														
Rougheye/ Blackspotted Rockfish	A							x			x			x				x		x				x							
	S									x										x											
	SEJ																														
	L																														
Sablefish	A							x	x	x	x		x	x				x		x		x	x		x	x		x	x	x	
	S							x	x	x	x		x	x				x		x		x	x		x	x		x	x	x	
	SEJ							x		x	x		x	x	x			x		x			x					x			
	L				x						x																				
	E																														
Shallow Water Flatfish Complex	A							x		x			x			x	x	x		x					x					x	
	S							x		x			x			x	x	x		x					x						
	SEJ				x																										
	L	x		x																											
	E																														

Prey of

GOA Groundfish Species	Life Stage	Jellyfish	Starfish	Chaetognaths (arrowworm	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
Other Rockfish Complex, Demersal Subgroup	A						x			x	x					x															
	S						x			x	x					x															
	SEJ																														
	L																														
	E																														
Other Rockfish Complex, Slope Subgroup	A						x			x	x					x	x														
	S						x			x	x					x	x														
	SEJ																														
	L																														
	E																														
Pacific Cod	A															x	x	x		x		x	x	x							
	S															x	x	x		x		x	x	x							
	SEJ															x	x	x				x	x	x				x			
	L																														
	E																														
Pacifc Ocean Perch	A									x						x															
	S									x						x															
	SEJ						x			x	x					x															
	L																														
Rex Sole	A														x																
	S														x																
	SEJ																														
	L																														
	E																														
Rougheye/ Blackspotted Rockfish	A								x							x															
	S								x						x	x															
	SEJ																														
	L																														
Sablefish	A																														
	S						x									x									x						
	SEJ																														
	L																														
	E																														
Shallow Water Flatfish Complex	A																														
	S							x	x					x		x															
	SEJ								x							x															
	L																														
	E																														

Table 4.3 (cont) Summary of predator and 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)	Bivalves	Mollusks	Crustaceans	Ophiuroids (brittle stars	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishe	Cottidae (sculpins)	Arrowtooth	Rockfish	Salmon	Pacific cod	Pollock	Halibut
Shark Complex (Spiny Dogfish)	A						x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	S						x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	SEJ						x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						
	E																														
Shortraker Rockfish	A													x						x				x							
	S																														
	SEJ																														
	L																														
Skate Complex	A								x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	S																														
	SEJ																														
	E																														
Thornyhead Rockfish Complex (Shortspine Thornyhead)	A				x					x								x		x											
	S				x					x								x		x											
	SEJ																														
	L																														
	E																														
Walleye Pollock	A				x			x			x			x						x	x	x	x	x		x			x	x	x
	S				x			x			x			x						x	x	x	x	x		x			x	x	x
	SEJ				x			x			x									x	x	x									
	L				x			x			x																				
	E																														

Prey of

GOA Groundfish Species	Life Stage	Jellyfish	Starfish	Chaetognaths (arrowworm	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
Shark Complex (Spiny Dogfish)	A																x	x		x			x		x						
	S																x	x		x			x		x						
	SEJ									x					x	x	x	x		x			x		x						
	E																														
Shortraker Rockfish	A																														
	S																														
	SEJ																														
	L																														
Skate Complex	A																		x												
	S																														
	SEJ																														
	E																														
Thornyhead Rockfish Complex (Shortspine Thornyhead)	A														x																
	S														x																
	SEJ																														
	L																														
	E																														
Walleye Pollock	A								x						x	x	x	x	x	x											
	S							x	x						x	x		x	x	x				x			x	x	x		
	SEJ							x	x						x	x		x	x	x				x			x	x	x		
	L							x	x						x	x								x			x	x	x		
	E																														

4.1 Arrowtooth flounder (*Atheresthes stomias*)

4.1.1 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 100 to 150 mm range (Martin and Clausen 1995). The approximate upper size limit of juvenile fish is 270 mm in males and 460 mm in females. The estimated length at maturity is 460 mm, though length at age varies (Stark 2012, Spies et al. 2019). 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).

4.1.2 Relevant Trophic Information

Arrowtooth flounder are very important as a large, aggressive and abundant predator of other groundfish species. They feed maily on walleye pollock and other fish species when they reach lengths greater than 300 mm. Groundfish predators include Pacific cod and pollock, mostly on small fish.

4.1.3 Habitat and Biological Associations

Larvae: Larvae are planktonic for at least 2 to 3 months until metamorphosis occurs.

Settled Early Juveniles: Juveniles usually inhabit shallow areas and coastal bays up to two years old once settled. The covariates contributing the most to the final SDM EFH map for this life stage were tidal maximum current, terrain aspect, bottom depth, and bathymetric position index (BPI) (Pirtle et al. 2023). Suitable habitat is broadly distributed across the continental shelf in the Yakutat and southeastern Alaska management areas in 150 m depths with tidal current speeds around 25 cm/s over relatively flat seafloor terrain.

Subadults: The covariates contributing the most to the final SDM EFH map for the subadult life stage were bottom depth, geographic location, and bottom temperature (Pirtle et al. 2023). Their highest abundances were predicted in the Shelikof Strait and over the continental shelf to the west at depths around 200 m and in cooler bottom temperatures.

Adults: The covariates contributing the most to the final SDM EFH map for the adult life stage were bottom depth, geographic location, bottom temperature, slope, and rockiness (Pirtle et al. 2023). Adult ATF distribution and abundance were related to depths around 200 m with cooler bottom temperatures in sloping and non-rocky terrain. They migrate in the winter 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	up to 7 years	euphausiids, crustaceans, amphipods, pollock	all year	ICS, OCS, USP	D	G,M,S		
Adults	7+ years[a]	pollock, Gadidae sp., misc. fish, euphausiids	spawning Jan-April, non-spawning April–Oct	ICS, OCS, USP, BAY	D	G,M,S		

[a] Age at 50% maturity based on a logistic curve from the stock assessment model (Shotwell et al. 2021).

4.1.4 Literature

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4.2 Atka mackerel (*Pleurogrammus monopterygius*)

4.2.1 Life History and General Distribution

Atka mackerel are distributed from the GOA to the Kamchatka Peninsula, and they are most abundant along the Aleutian Islands. 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. Spawning is demersal in moderately shallow waters of the western GOA (down to bottom depths of 144 m) and peaks in June through September, but may occur intermittently throughout the year. Female Atka mackerel deposit eggs in nests built and guarded by males on rocky substrates or on kelp in shallow water. Eggs develop and hatch at depth in 40 to 45 days, releasing planktonic larvae that have been found up to 800 km from shore. Little is known of the distribution of young Atka mackerel before their appearance in trawl surveys and the fishery at about age 2 to 3 years. R-traits are as follows: young age at maturity (approximately 50 percent are mature at age 3.6), fast growth rates, high natural mortality (mortality equals 0.3), and young average and maximum ages (about 5 and 14 years, respectively). K-selected traits indicate low fecundity (only about 30,000 eggs/female/year, large egg diameters [1 to 2 mm] and male nest-guarding behavior). The average length at 50% maturity for Atka mackerel is 344 mm, though that was observed in the Aleutian Islands (McDermott and Lowe 1997).

4.2.2 Relevant Trophic Information

Atka mackerel are important food for Steller sea lions in the Aleutian Islands, particularly during summer, and for other marine mammals (minke whales, Dall's porpoise, and northern fur seals). Juveniles are eaten by thick billed murres, tufted puffins, and short-tailed shearwaters. The main groundfish predators are Pacific halibut, arrowtooth flounder, and Pacific cod. Adult Atka mackerel consume a variety of prey, but principally calanoid copepods and euphausiids. Predation on Atka mackerel eggs by cottids and other hexagrammids is prevalent during the spawning season as is cannibalism by other Atka mackerel.

4.2.3 Habitat and Biological Associations

Eggs: Adhesive eggs are deposited in nests built and guarded by males on rocky substrates or on kelp in moderately shallow water.

Larvae: Planktonic larvae have been found up to 800 km from shore, usually in the upper water column (neuston).

Settled Early Juveniles: 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.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and sponge presence (Pirtle et al. 2023). In general, higher subadult abundance was at shallower depths with low presence of sponges.

Adults: Adults occur in localized aggregations usually at depths less than 250 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 Atka mackerel, albeit in the Aleutian Islands region. 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. The covariates contributing the most to the final SDM EFH map for this life stage were geographic location and bottom depth (Pirtle et al. 2023).

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	D	GR, R, K	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
Settled Early Juveniles /Subadults	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 (May–Oct) non-spawning (Nov–Apr) 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

4.2.4 Literature

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4.3 Deepwater Flatfish complex: Dover sole (*Microstomus pacificus*)

Deepwater flatfish complex species:
Deepsea sole
Dover sole (primary, described below)
Greenland turbot

4.3.1 Life History and General Distribution

Dover sole are distributed in deep waters of the continental shelf and upper slope from northern Baja California to the 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 100 mm (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 (440 mm) than their southern counterparts (330 mm) at 50 percent maturity (Abookire and Macewicz 2003). Juveniles less than 250 mm are rarely found with the adult population from bottom trawl surveys (Martin and Clausen 1995). The natural mortality rate used in recent stock assessments is 0.085 yr-1 based on a maximum observed age in the GOA of 54 years (Stockhausen et al. 2007).

4.3.2 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).

4.3.3 Habitat and Biological Associations

Larvae: Dover sole are planktonic larvae for up to 2 years until metamorphosis occurs.

Settled Early Juveniles: Settled early juvenile distribution is unknown.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location and bottom depth (Pirtle et al. 2023). The highest abundances of subadult Dover sole occurred in the glacial troughs of the Yakutat and southeastern Alaska management areas of the GOA.

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. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth and geographic location (Pirtle et al. 2023). Adult Dover sole abundance was highest from the Kodiak management area into southeastern Alaska in the glacial troughs extending down the slope at depths around 400 m.

Habitat and Biological Associations: Dover sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	spring, summer	ICS?, MCS, OCS, USP	P			
Larvae	up to 2 years	U phyto/zooplankton?	all year	ICS?, MCS, OCS, USP	P			
Settled Early Juveniles	to 3 years	polychaetes, amphipods, annelids	all year	MCS?, ICS?	D	S, M		
Subadults	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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4.4 Dusky rockfish (*Sebastes variabilis*)

Previously it was thought that there were two varieties of dusky rockfish, a dark colored variety inhabiting inshore, shallow waters, and a lighter colored variety inhabiting deeper water offshore. In 2004 these two varieties were designated as distinct species, the dark colored variety is now recognized as dark rockfish (Sebastes ciliatus) and the lighter colored variety is now recognized as dusky rockfish (Sebastes variabilis) (Orr and Blackburn 2004). In 2009 dark rockfish were removed from the GOA FMP to allow for more responsive management by the State of Alaska.

4.4.1 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 250 mm 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. They become mature around 365 mm, and they can grow as large as 590 mm (Chilton 2010).

4.4.2 Relevant Trophic Information

Although no comprehensive food study of dusky rockfish has been done, one smaller study in the GOA showed euphausiids to be the predominant food item of adults. Larvaceans, cephalopods, pandalid shrimp, and hermit crabs were also consumed.

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

4.4.3 Habitat and Biological Associations

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

Larvae: No information is known.

Settled Early Juveniles: No information is known for small juveniles less than 250 mm fork length.

Subadults: 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 400 mm) dusky rockfish associated with Primnoa spp. coral. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, tidal current speed, and sponge presence (Pirtle et al. 2023). Higher subadult dusky rockfish abundance was predicted at less than 250 m depth with low occurrence of sponges, including the banks and glacial trough edges on the continental shelf and upper slope of the GOA from Portlock Bank and west.

Adults: Commercial fishery and research survey data indicate that adult dusky rockfish are primarily found on offshore banks of the outer continental shelf at depths of 100 to 200 m. Type of substrate in this habitat has not been documented, but it may be rocky. During submersible dives on the outer shelf (40 to 50 m) in the eastern Gulf, adult dusky rockfish were observed in association with rocky habitats and in areas with extensive sponge beds where the fish were observed resting in large vase sponges (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.

The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, rockiness, and geographic location (Pirtle et al. 2023). Higher adult dusky rockfish abundance was predicted at < 250 m depth with rocky substrate present, including on the banks along the continental shelf and in areas of the outer continental shelf and upper slope from Portlock Bank and west, with some areas of higher abundance at the Fairweather Grounds in the eastern GOA.

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
Subadults	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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4.5 Flathead sole (*Hippoglossoides elassodon*)

4.5.1 Life History and General Distribution

Flathead sole are distributed from northern California, off Point Reyes, northward along the west coast of North America and throughout the GOA and the 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 (200 mm fish) to almost 600,000 (380 mm 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). 50 percent of GOA flathead sole females are mature at 8.7 years or 333 mm (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 for both sexes (Turnock et al. 2017).

4.5.2 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 and age-0 walleye pollock (3 percent and less than 0.5 percent by weight, respectively).

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.

4.5.3 Habitat and Biological Associations

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

Settled Early Juveniles: Usually inhabit shallow areas (less than 100 m depth), preferring muddy habitats. The covariates contributing the most to the final SDM EFH map for this life stage were BPI, bottom depth, tidal current, and seafloor aspect (Pirtle et al. 2023). They were predicted to occur in nearshore areas along the Alaska Peninsula, around Kodiak Island, and along the mainland in the southeastern Alaska management area over relatively flat, non-rocky bottom at shallower depths.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, tidal current, and BPI (Pirtle et al. 2023). The highest subadult flathead sole abundances were predicted in upper Shelikof Strait, in nearshore waters around Kodiak Island, and along the coast of the western Alaska Peninsula in shallower waters with slower maximum tidal currents over submarine channels or valleys.

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. The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, BPI, and bottom depth (Pirtle et al. 2023). Adult flathead sole predicted abundance was highest in Shelikof Strait, in coastal waters around Kodiak Island, and the shallower, nearshore waters of the Alaska Peninsula over submarine channels or valleys with relatively non-rocky seafloor.

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			
Settled Early Juveniles/Subadults	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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4.6 Northern rockfish (*Sebastes polyspinis*)

4.6.1 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 (12.8 years for females in the GOA), and an old maximum age of 67 years in the GOA (Heifetz et al. 2007). Size at 50 percent maturity has been estimated to be 310 mm (Chilton 2007).

4.6.2 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.

4.6.3 Habitat and Biological Associations

Eggs: 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.

Settled Early Juveniles: No information known for small juveniles (less than 200 mm), 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.

Subadults: 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. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and rockiness (Pirtle et al. 2023). Subadult northern rockfish abundance was generally higher at depths less than 250 m in areas with rocky substrate.

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.

The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, bottom current, and rockiness (Pirtle et al. 2023). Higher adult northern rockfish abundance peaked at 190 m depth on bathymetric rises with rocky substrate and moderate bottom current exposure, including at Portlock Bank and along the outer continental shelf from Kodiak Island through the western GOA.

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
Settled Early Juveniles	From end of larval stage to ?	U	summer to ?	U	P?	U	U	U
Subadults	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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4.7 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.

4.7.1 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 200 mm (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 400 mm. 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 100 mm. 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 600 mm. 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 400 mm 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.

4.7.2 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.

4.7.3 Habitat and Biological Associations

Eggs: Spawning occurs on the shelf; *E. dofleini* lays strings of eggs in cave or den in boulders or rubble, which are guarded by the female until hatching. The exact habitat needs and preferences for denning are unknown.

Larvae: Pelagic for *Enteroctopus dofleini*, demersal for other octopus species.

Settled Early Juveniles: Early juveniles are semi-demersal and are widely dispersed on shelf, upper slope. Settled early juveniles become demersal and are also widely dispersed on the shelf and upper slope, preferring cobble and rock substrates.

Subadults/Adults: Adult octopus are demersal; are widely dispersed on shelf and upper slope, preferentially among rocks, cobble, but also on sand/mud. The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, sponge presence, and bottom (Pirtle et al. 2023). Giant Pacific octopus abundance was predicted to be higher in the central and western GOA, with peak depths between 300-600 m.

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
Settled Early Juveniles	U	zooplankton	summer–fall	U (ICS, MCS, OCS, USP?)	D, SD	U	U	euhaline waters
Subadults 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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4.8 Other Rockfish complex, demersal subgroup

Species Complex Summary

In the GOA, the Other Rockfish complex includes the demersal subgroup comprised of canary, China, copper, quillback, rosethorn, tiger, and yelloweye rockfishes (Tribuzio et al. 2021). There were enough catches of quillback, rosethorn, and yelloweye rockfishes in the GOA RACE-GAP summer bottom trawl survey (1993-2019) to support individual species life stage SDMs of habitat-related abundance to map EFH. Because of that, the three species have their own sections, and the rest of the species in the complex will be represented by the demersal subgroup information. The demersal subgroup of the Other Rockfish complex has higher abundance on the continental shelf of the eastern GOA. EFH of the demersal subgroup patchy areas in the central GOA south of the Kenai Peninsula, Kodiak Island, and the Shumagin Islands.

Habitat and Biological Associations: Other Rockfishes, Demersal Subgroup. Yelloweye rockfish has a separate table under Appendix D.4.8.3 for habitat and biological associations.

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=300 mm	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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4.8.1 Quillback rockfish (*Sebastes mailger)*

4.8.1.1 Life History and General Distribution

These species are distributed from Anacapa Passage in southern California to the central GOA, and are most common from southeast Alaska to northern California (Love et al. 2002). Life history data for this species is based on studies from waters off Alaska and British Columbia, where quillback are reported mature at 290 mm length and 11 years age and live to a maximum of 95 years (Munk 2001, Love et al. 2002, Rooper 2008). Quillback rockfish are associated with the seafloor and prefer rocky, high-relief habitats with kelp cover, where they form a home site association (Love et al. 2002).

4.8.1.2 Relevant Trophic Information

The main prey of quillback rockfish are crustaceans, herring, and sandlance.

4.8.1.3 Habitat and Biological Associations

Settled Early Juveniles/Subadults: Juvenile and subadult quillback rockfish have been observed at the margins of kelp beds.

Adults: The EFH area mainly occurs on the continental shelf and inshore areas of the southeastern GOA. Otherwise, EFH for adult quillback rockfish is patchy throughout their range in the GOA. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, bottom temperature, and bottom current speed (Pirtle et al. 2023). Higher abundance of adult quillback rockfish occurred at shallower depths throughout the survey area.

4.8.1.4 Literature

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4.8.2 Rosethorn rockfish (Sebastes helvomaculatus)

4.8.2.1 Life History and General Distribution

Rosethorn rockfish are distributed from Baja California to near Sitkinak Island in the western GOA (Love et al. 2002). Life history data for this species is based on studies from waters off Alaska and British Columbia, where rosethorn rockfish are reported to mature at 215 mm length, living to a maximum age of 87 years (Munk 2001, Love et al. 2002, Rooper 2008). Rosethorn rockfish associate with seafloor structure, often in transitions between habitats of soft unconsolidated and rocky substrates (Love et al. 2002).

4.8.2.2 Relevant Trophic Information

There is insufficient information on rosethorn rockfish predator or prey relationships at this time.

4.8.2.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, bottom temperature, and sponge presence (Pirtle et al. 2023). Higher abundance of subadult rosethorn rockfish occurred along the outer continental shelf of the eastern GOA in depths around 250 m in areas of low sponge presence.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom current, bottom temperature, and sponge presence (Pirtle et al. 2023). Similar to subadults, a higher abundance of adult rosethorn rockfish was predicted along the outer continental shelf of the eastern GOA at depths around 250 m in areas of low sponge presence.

4.8.2.4 Literature

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4.8.3 Yelloweye rockfish (*Sebastes ruberrimus*)

4.8.3.1 Life History and General Distribution

Yelloweye rockfish 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 25 and 100 mm 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 910 mm and growth slows considerably after age 30 years. Approximately 50 percent of females are mature at 450 mm and 22 years (Tribuzio et al. 2021). 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.

4.8.3.2 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.

4.8.3.3 Habitat and Biological Associations

Settled early juveniles: Young juveniles between 25 (1 inch) and 100 mm (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).

Subadults: Subadult 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). The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, sponge presence, geographic position, and BPI (Pirtle et al. 2023). Higher abundance of subadult yelloweye was predicted around 125 m depth on bathymetric rises (BPI highs) in areas of low sponge presence on the GOA continental shelf.

Adults: Adults are similarly solitary and associate with habitat components listed for subadults. 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. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and seafloor rockiness (Pirtle et al. 2023). Higher abundance of adult yelloweye rockfish in the GOA was predicted around 125 m depth on bathymetric rises (BPI highs) with rocky substrate present.

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	
Settled Early Juveniles	to 10 years	U		ICS, MCS, OCS, BAY, IP	D	R, C	U	
Subadults	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	

4.8.3.4 Literature

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4.9 Other Rockfish complex, slope subgroup

4.9.1 Species Complex Summary

The slope subgroup of the GOA Other Rockfish (OR) stock complex includes the following species: aurora, blackgill, darkblotched, greenstriped, harlequin, northern, pygmy, redbanded, redstripe, sharpchin, shortbelly, silvergray, splitnose, stripetail, vermilion, widow, yellowmouth, yellowtail rockfishes, boccacio, and chilipepper (Tribuzio et al 2021). Northern rockfish are only included in this complex in the eastern GOA, and their EFH is described and mapped separately from the GOA OR complex. Greenstriped, harlequin, pygmy, redbanded, redstripe, sharpchin, and silvergray rockfishes were common enough (N > 50) in GOA RACE-GAP summer bottom trawl survey catches (1993–2019) to support individual species life stage SDMs of habitat-related abundance to map EFH and are included here in the complex. Adult Other Rockfish complex species have high abundances on the outer continental shelf and upper slope of the eastern GOA. EFH hot spots were along the eastern and central GOA continental shelf and extended on the outer continental shelf and upper slope westward.

4.9.1.1 Literature

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4.9.2 Greenstriped rockfish (*Sebastes elongatus*)

4.9.2.1 Life History and General Distribution

Greenstriped rockfish (*Sebastes elongatus*) are distributed from southern California to Chirikof Island in the western GOA (Love et al. 2002). This species was not caught by the GOA RACE-GAP summer bottom trawl survey west of Kayak Island. Based on data from Washington and Oregon, greenstriped rockfish reach maturity at 220 mm length andlive up to 54 years (Love et al. 2002). They have an ontogenetic shift to deeper habitats where they are observed solitary and resting near a variety of benthic habitats (Love et al. 2002). Their adult distribution is concentrated in the eastern GOA off southeast Alaska.

4.9.2.2 Relevant Trophic Information

There is insufficient information on greenstriped rockfish predator or prey relationships at this time.

4.9.2.3 Habitat and Biological Associations

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and bottom temperature (Pirtle et al. 2023). Higher abundance of adult greenstriped rockfish occurred on the eastern GOA continental shelf off southeast Alaska with peak at depths < 200m.

4.9.2.4 Literature

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4.9.3 Harlequin rockfish (*Sebastes variegatus*)

4.9.3.1 Life History and General Distribution

Harlequin rockfish (*Sebastes variegatus*) are found from the Oregon coast to the western Aleutian Islands (Love et al. 2002). They one of the six most common Other Rockfish complex species by survey catch or biomass, although uncommon in the BSAI (Tribuzio et al. 2021, Sullivan et al. 2022). Life history data collected in waters off Alaska describes harlequin rockfish as a relatively small species in the complex, becoming mature at a length of 188 mm and age of 4.5 years, but they can live as long as 72 years (Tribuzio et al. 2021, Tenbrink and Helser 2021). Harlequin rockfish associate with the seafloor in both trawlable and untrawlable habitats, and they have a associate with rocky and rugged habitats (Rooper et al. 2012a, Jones et al. 2021).

Subadult harlequin rockfish are distributed in the eastern and central GOA with some found on the outer continental shelf south of Kodiak Island through the western GOA. Adults are distributed along the outer continental shelf and upper slope.

4.9.3.2 Relevant Trophic Information

There is insufficient information on harlequin rockfish predator or prey relationships at this time.

4.9.3.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and sponge presence (Pirtle et al. 2023). Subadult harlequin rockfish abundance was higher in the central and eastern GOA at shallower depths on the continental shelf.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and seafloor rockiness (Pirtle et al. 2023). Adult harlequin rockfish abundance was higher around 200 m depth along the outer continental shelf and upper slope in the eastern and central GOA and west of Kodiak Island. They associate with rocky substrates.

4.9.3.4 Literature

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4.9.4 Pygmy rockfish (*Sebastes wilsoni*)

4.9.4.1 Life History and General Distribution

Pygmy rockfish (*Sebastes wilsoni*) are distributed from southern California to the central GOA (Love et al. 2002). Life history data is limited, but observations note a maximum observed size of 260 mm and a maximum age of 26 years based on studies south of Alaska (Love et al. 2002). Pygmy rockfish are thought to be most closely related to harlequin and Puget Sound rockfishes, with lengths at maturity of 190 mm and 130 mm, respectively. This species is often observed in large schools over rocky habitat and closely associated with structural invertebrate cover such as crinoids, sponges, and soft corals (Love et al. 2002, Pirtle 2005). Their distribution is primarily east of Kodiak Island. Hot spots of their distribution are on the continental shelf south of the Kenai Peninsula, Portlock bank, the Fairweather grounds and off southeast Alaska (Pirtle et al. 2023).

4.9.4.2 Relevant Trophic Information

There is insufficient information on pygmy rockfish predator or prey relationships at this time.

4.9.4.3 Habitat and Biological Associations

Subadults: Because length at maturity information for pygmy rockfish is insufficient, all subadults and adults were combined in SDMs of habitat-related abundance to map EFH. The model results are reported with the adult pygmy rockfish, below.

Adults: The covariates contributing the most to the final SDM EFH map for the combined life stages of subadult and adult pygmy rockfish were seafloor rockiness and geographic location (Pirtle et al. 2023). Pygmy rockfish abundance was higher at depths < 250 m with rocky substrate present on the continental shelf of the eastern GOA off southeast Alaska and some higher abundance areas in the central GOA.

4.9.4.4 Literature

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4.9.5 Redbanded rockfish *(Sebastes babcocki)*

4.9.5.1 Life History and General Distribution

Redbanded rockfish (*Sebastes babcocki*) are distributed from southern California to the Aleutian Islands and Bering Sea canyons (Love et al. 2002). Redbanded rockfish mature at a length of 420 mm and 19 years age and can live as long as 106 years (Love et al. 2002, Munk 2001, Tribuzio et al. 2021). This species associates with the seafloor in rocky or mixed substrate type habitats (Love et al. 2002).

4.9.5.2 Relevant Trophic Information

There is insufficient information on redbanded rockfish predator or prey relationships at this time.

4.9.5.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, slope, and seafloor rockiness (Pirtle et al. 2023). Subadult redbanded rockfish abundance was higher around 250 m depth in and around glacial troughs, as well as along the outer continental shelf and upper slope of the eastern GOA.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic position, and bottom temperature (Pirtle et al. 2023). Adult redbanded rockfish abundance was higher around 250 m depth with moderate current exposure in the eastern GOA off southeast Alaska in and around glacial troughs. Abundance was also high on the outer continental shelf and upper slope.

4.9.5.4 Literature

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4.9.6 Redstriped rockfish (*Sebastes proriger*)

4.9.6.1 Life History and General Distribution

Redstripe rockfish (*Sebastes proriger*) are distributed from southern California to the western Aleutian Islands and to Pribilof Island in the Bering Sea (Love et al. 2002). Representative life history data report juvenile female maximum length as 290 mm (Rooper 2008). The maximum age for redstripe rockfish is 41 years (Tribuzio et al. 2021). Redstripe rockfish usually occur in high-relief and rugged seafloor habitats, where they associate with complex physical and biogenic structure (Love et al. 2002). Subadult and adults distributions as from southeast Alaska to the western GOA, with higher abundances off southeast Alaska. Subadult EFH hotspots were in the eastern GOA while adult EFH hotspots were prevalent on the outer continental shelf of the eastern GOA, central GOA south of the Kenai Peninsula, and some areas in the western GOA (Pirtle et al. 2023).

4.9.6.2 Relevant Trophic Information

There is insufficient information on redstriped rockfish predator or prey relationships at this time.

4.9.6.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic position, bottom depth, and rockiness (Pirtle et al. 2023). Subadult redstripe rockfish abundance was higher around 200 m depth with rocky substrate present on the continental shelf of the southeastern GOA. The central GOA south of the Kenai Peninsula and areas on the outer continental shelf further west also contain patchy areas of high subadult abundance.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and rockiness (Pirtle et al. 2023). Adult redstripe rockfish abundance was higher around 200 m depth with rocky substrate present on the continental shelf of the southeastern GOA (Fig. 234). However, patchy areas of high abundance occurred in the central GOA south of the Kenai Peninsula and areas on the outer continental shelf of the western GOA.

4.9.6.4 Literature

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4.9.7 Sharpchin rockfish (*Sebastes zacentrus*)

4.9.7.1 Life History and General Distribution

Sharpchin rockfish (Sebastes *zacentrus*) are distributed from southern California to the western Aleutian Islands and to Pribilof Island in the Bering Sea (Love et al. 2002). Representative life history data describes sharpchin rockfish maturing at 265 mm and 10 years of age, and living as long as 58 years (Malecha et al. 2007, Tribuzio et al. 2021). Sharpchin rockfish are often observed in groups within sponge-covered boulder fields and habitats of scattered cobbles and boulders with sponges (Love et al. 2002, Pirtle 2005). Both subadults and adults are primarily distributed in the eastern and central GOA (Pirtle et al. 2023).

4.9.7.2 Relevant Trophic Information

There is insufficient information on sharpchin rockfish predator or prey relationships at this time.

4.9.7.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, sponge presence, and rockiness (Pirtle et al. 2023). Subadult sharpchin rockfish abundance was higher around 200 m depth with rocky substrate and low presence of sponges on the outer continental shelf of the GOA east of Kodiak Island.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and rockiness (Pirtle et al. 2023). Adult sharpchin rockfish abundance was highest at around 200 m depth on the outer continental shelf of the GOA east of Kodiak Island.

4.9.7.4 Literature

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4.9.8 Silvergray rockfish (*Sebastes brevispinis*)

4.9.8.1 Life History and General Distribution

Silvergray rockfish (*Sebastes brevispinis*) are found from Baja California to around Sanak Island in the western GOA (Love et al. 2002). Silvergray rockfish were recorded with an average maximum juvenile length of 405 mm and a maximum age of 75 years (Rooper 2008, Tribuzio et al. 2021). Silvergray rockfish associate with various high-relief and rugged rocky habitats generally off the seafloor and are often observed with species that have similar behavior, such as canary, dusky, widow, and yellowtail rockfishes (Love et al. 2002, Bosley et al. 2004, Jones et al. 2012). Subadults occur from southeast Alaska west to the Shumagin Islands; adult silvergray rockfish have a similar distribution and their highest abundance catches are off southeast Alaska (Pirtle et al. 2023).

4.9.8.2 Relevant Trophic Information

There is insufficient information on silvergray rockfish predator or prey relationships at this time.

4.9.8.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and rockiness (Pirtle et al. 2023). Subadult silvergray rockfish abundance was highest around 200 m depth in areas with rocky substrate present in the eastern GOA off southeast Alaska.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and bottom current variability (Pirtle et al. 2023). Higher adult silvergray rockfish abundance occurred around 200 m depth in the eastern GOA off southern southeast Alaska.

4.9.8.4 Literature

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4.10 Pacific cod (*Gadus macrocephalus*)

4.10.1 Life History and General Distribution

Pacific cod is a transoceanic species, occurring at depths from shoreline to 500 m. The southern limit of the species' distribution is about 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 100 mm 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 0.47 in the GOA, as opposed to 0.34 in the BSAI. Approximately 50 percent of Pacific cod are mature by age 4 in the GOA, compared to age 5 in the BSAI. The maximum recorded age of a Pacific cod in the GOA is 14 years. Subadults and adults are delineated at 503 mm length (Stark 2007).

4.10.2 Relevant Trophic Information

Pacific cod are omnivorous. In terms of percent occurrence, the most important items in the diet of Pacific cod in the GOA are polychaetes, crangonid shrimp, and pandalid shrimp. In terms of numbers of individual organisms consumed, the most important dietary items are euphausiids, cumacea shrimp, and walleye pollock. In terms of weight of organisms consumed, the most important dietary items are walleye pollock, Tanner crabs, and pandalid shrimp. 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.

4.10.3 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.

Settled Early Juveniles: Juveniles occur mostly over the inner continental shelf at depths of 60 to 150 m. The covariate contributing the most to the final SDM EFH map for this life stage was bottom depth (Pirtle et al. 2023). The highest probabilities of suitable habitat for early juvenile Pacific cod in the GOA were predicted to occur in nearshore areas and around islands throughout the GOA. Habitat-related growth potential for this life stage is greater at inshore and coastal areas as well as on banks and bathymetric rises on the GOA continental shelf.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and tidal currents (Pirtle et al. 2023). The highest subadult Pacific cod abundances were predicted west of the Kenai Peninsula on bathymetric rises in the central and western GOA, with hot spots on the banks south of Kodiak and the Shumagin islands.

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, however mature fish are not limited to a specific depth range and their distribution is thought to change seasonally. Preferred substrate is soft sediment, from mud and clay to sand. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and bottom temperature (Pirtle et al. 2023). Adult Pacific cod abundance predicted from the ensemble was highest at depths less than 175 m on bathymetric rises west of the Kenai Peninsula.

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 Pelagic	to 2 years	small invertebrates (euphausiids, mysids, shrimp)	all year	ICS, MCS	D	M, SM, MS, S	U	
Early Juveniles Settled/Subadults	to 5 years	crab, shrimp, euphausiids	all year	ICS, MCS, OCS	D	M, SM, MS, S	U	
Adults	5+ yr	pollock, crab, pandalid shrimp, and other fish	spawning (Jan–May) non-spawning (Jun–Dec)	ICS, MCS, OCS ICS, MCS, OCS	D	M, SM, MS, S,G	U	

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4.11 Pacific ocean perch (*Sebastes alutus*)

4.11.1 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. Commercial fishing data in the GOA since 1995 show that pelagic trawls fished off-bottom have accounted for as much as 20 percent of the annual harvest of this species.

There is much uncertainty about the life history of Pacific ocean perch, although generally more is known than for other rockfish species (Kendall and Lenarz 1986). The species appears to be viviparous (the eggs develop internally and receive at least some nourishment from the mother), with internal fertilization and the release of live young. Insemination occurs in the fall, and sperm are retained within the female until fertilization takes place approximately 2 months later. The eggs hatch internally, and parturition (release of larvae) occurs in April and May. Information on early life history is very sparse, especially for the first year of life. Pacific ocean perch larvae are thought to be pelagic and drift with the current. Oceanic conditions may sometimes cause advection to suboptimal areas (Ainley et al. 1993), resulting in high recruitment variability. However, larval studies of rockfish have been hindered by difficulties in species identification since many larval rockfish species share the same morphological characteristics (Kendall 2000). Genetic techniques using allozymes (Seeb and Kendall 1991) and mitochondrial DNA (Li 2004) are capable of identifying larvae and juveniles to species, but are expensive and time-consuming. Post-larval and early young-of-the-year Pacific ocean perch have been positively identified in offshore, surface waters of the GOA (Gharrett et al. 2002), which suggests this may be the preferred habitat of this life stage. Transformation to a demersal existence may take place within the first year (Carlson and Haight 1976). Small juveniles probably reside inshore in very rocky, high relief areas and begin to migrate to deeper offshore waters of the continental shelf by age 3 (Carlson and Straty 1981). As they grow, they continue to migrate deeper, eventually reaching the continental slope, where they attain adulthood.

Pacific ocean perch is a slow growing species, with a low rate of natural mortality (estimated at 0.06), a relatively old age at 50 percent maturity (10.5 years for females in the GOA), and a very old maximum age of 98 years in Alaska (84 years maximum age in the GOA) (Hanselman et al. 2007a). Age at 50 percent recruitment to the commercial fishery has been estimated to be between 7 and 8 years in the GOA. Despite their viviparous nature, the fish is relatively fecund with number of eggs per female in Alaska ranging from 10,000 to 300,000, depending upon size of the fish (Leaman 1991). Adult Pacific ocean perch are estimated at > 250 mm length (Rooper 2008).

4.11.2 Relevant Trophic Information

Pacific ocean perch are mostly planktivorous (Carlson and Haight 1976, Yang 1993, 1996, Yang and Nelson 2000, Yang 2003). In a sample of 600 juvenile perch stomachs, Carlson and Haight (1976) found that juveniles fed on an equal mix of calanoid copepods and euphausiids. Larger juveniles and adults fed primarily on euphausiids and, to a lesser degree, on copepods, amphipods, and mysids (Yang and Nelson 2000). In the Aleutian Islands, myctophids have increasingly comprised a substantial portion of the Pacific ocean perch diet, which also compete for euphausiid prey (Yang 2003). It has been suggested that Pacific ocean perch and walleye pollock compete for the same euphausiid prey. Consequently, the large removals of Pacific ocean perch by foreign fishermen in the GOA in the 1960s may have allowed walleye pollock stocks to greatly expand in abundance.

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

4.11.3 Habitat and Biological Associations

Eggs: 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.

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

Settled Early 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. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, bottom temperature, tidal current speed, and BPI (Pirtle et al. 2023). The highest probabilities of suitable habitat for early juvenile Pacific ocean perch in the GOA were predicted in offshore waters at depths around 250 m, with bottom temperatures around 6°C, lower tidal current exposure, on bathymetric highs (BPI). Habitat-related growth potential for this life stage is greater in the eastern GOA and lowest westward of Kodiak.

Subadults: Juvenile Pacific ocean perch move to progressively deeper waters of the continental shelf as they age and grow. Older juveniles are often found together with adults at shallower locations of the continental slope in the summer months. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and rockiness (Pirtle et al. 2023). The highest abundances of subadult Pacific ocean perch were predicted to occur at depths around 250 m over increasingly rocky bottom.

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.

The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, tidal current speed, and BPI (Pirtle et al. 2023). The highest predicted abundances of adult Pacific ocean perch were along the edge of the continental shelf in depths around 250 m over seafloor features of increasing vertical relief.

Habitat and Biological Associations: Pacific ocean perch

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	Internal incubation; ~90 d	NA	winter–spring	NA	NA	NA	NA	NA
Larvae	U; 2 months?	U; assumed to be micro-zooplankton	spring–summer	ICS, MCS, OCS, USP, LSP, BSN	P	NA	U	U
Pelagic Early Juveniles	U; 2 months to ?	U	summer to ?	LSP, BSN	Epipelagic	NA	U	U
Settled Early Juveniles/ Subadults	<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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4.12 Rex sole (*Glyptocephalus zachirus*)

4.12.1 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 240 to 590 mm (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 240 mm, females in the GOA achieve 50 percent maturity at larger size (352 mm) 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 150 mm are rarely found with the adult population. The natural mortality rate used in recent stock assessments is 0.17 (Stockhausen et al. 2007).

4.12.2 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.

4.12.3 Habitat and Biological Associations

Larvae: Rex sole larvae are planktonic for an unknown time until metamorphosis occurs.

Settled Early Juveniles: The covariates contributing the most to the final SDM EFH map for this life stage were tidal current speed, terrain aspect, BPI, and rockiness (Pirtle et al. 2023). The highest predicted probabilities of suitable habitat for early juvenile rex sole in the GOA occurred along the Alaska Peninsula from the western GOA through the Shelikof Strait and into southeast Alaska, including areas of low-lying terrain such as channels and glacial troughs with low occurrence of rocky substrate.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, tidal current speed, and BPI (Pirtle et al. 2023). Subadult rex sole abundance was highest in the Yakutat and southeastern Alaska management areas at depths around 350 m with reduced tidal current speeds.

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. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and tidal current speed (Pirtle et al. 2023). Adult rex sole abundance was highest in glacial troughs south and west of the outlet to Shelikof Strait and south and east of Kodiak Island.

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			
Settled Early Juveniles/ Subadults	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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4.13 Rougheye rockfish (*Sebastes aleutianus*) and Blackspotted rockfish (*Sebastes melanostictus)*

4.13.1 Life History and General Distribution

Orr and Hawkins (2008) formally verified the presence of two species, rougheye rockfish (*Sebastes aleutianu*s) and blackspotted rockfish *(S. melanostictus*), in what was once considered a single variable species with light and dark color morphs. They used combined genetic analyses of 339 specimens from Oregon to Alaska to identify the two species and formulated general distribution and morphological characteristics for each. Rougheye rockfish is typically pale with spots absent from the dorsal fin and possible mottling on the body. Blackspotted rockfish is darker with spotting almost always present on the dorsal fin and body. The two species occur in sympatric distribution with rougheye extending farther south along the Pacific Rim and blackspotted extending into the western Aleutian Islands. The overlap is quite extensive (Gharrett et al. 2005, 2006). At present there is difficulty in field identification between the two species. Scientists and observers are currently evaluating new techniques to determine whether rapid and accurate field identification can occur. Ongoing research in this area may distinguish particular habitat preference that might be useful for separating the species and determine whether the two species have significantly different life history traits (i.e., age of maturity and growth). Until such information is available, it will be difficult to undertake distinct population assessments. In the stock assessment, rougheye and blackspotted rockfish are referred together as the rougheye rockfish complex.

Rougheye and blackspotted rockfish inhabit the outer continental shelf and upper continental slope of the northeastern Pacific. Their distribution extends around the arc of the North Pacific from Japan to Point Conception, California, and includes the Bering Sea (Kramer and O'Connell 1988). The center of abundance appears to be Alaskan waters, particularly the eastern 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. Recent work in the GOA has informed length at 50% maturity for both species: 450 mm for rougheye and 453 mm for blackspotted rockfish (Conrath 2017). Rougheye is considered the oldest of the Sebastes spp. with a maximum age of 205 years (Chilton and Beamish 1982, Munk 2001). It is also considered one of the larger rockfish attaining sizes of up to 38 inches (980 mm) (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).

4.13.2 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 [300 mm] 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*).

4.13.3 Habitat and Biological Associations

Eggs: 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.

Pelagic Early Juveniles: 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.

Settled Early Juveniles: There is no information on when juvenile fish become demersal. Juvenile rougheye rockfish 6 to 16 inches (150 to 400 mm) 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.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and seafloor slope (Pirtle et al. 2023). Higher subadult abundance peaked around 300 m depth, including the glacial troughs on the continental shelf and a narrow depth range along the slope.

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).

The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, seafloor slope, and geographic location (Pirtle et al. 2023). Higher adult abundance for these species was predicted to peak around 375 m depth and within a relatively small depth range that included the glacial troughs on the continental shelf and areas along the outer continental shelf and slope of the GOA.

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	
Pelagic Early Juveniles	U	U	summer to ?	LSP, BSN	Epipelagic	NA	U	
Settled Early Juveniles/ Subadults	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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4.14 Sablefish (*Anoplopoma fimbria*)

4.14.1 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 apparently released near the bottom where they incubate. After hatching and yolk adsorption, the larvae rise to the surface, where they have been collected with neuston nets. Larvae are oceanic through the spring and by late summer, small pelagic juveniles (10 to 15 cm) have been observed along the outer coasts of Southeast Alaska, where they 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 apparently leave the nearshore bays. One or two years later, they begin appearing on the continental shelf and move to their adult distribution as they mature (Hanselman et al. 2015).

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 a myriad of factors that determine their ability to grow, compete for food, avoid predation, and otherwise survive to adulthood. A potential driver of recruitment is sea surface temperature (SST) using short-term projections (1-5 years) (Shotwell et al. 2014). 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). Evaluating the overlap of fisheries can provide predictors of sablefish recruitment as well. When evaluating predictors of sablefish recruitment for the Ecosystem and Socioeconomic Profile of the Sablefish stock in Alaska, the highest ranked variables were the summer juvenile sablefish CPUE from the ADF&G large mesh survey and the catch from the arrowtooth flounder fishery in the GOA (Shotwell et al. 2021). Sablefish recruitment has a weak relationship with spawning stock biomass, some of these factors may help explain and predict recruitment by determining the quality instead of the quantity of the annual spawning stock (Shotwell et al. 2021).

The estimated productivity and sustainable yield of the combined EBS, AI, and GOA sablefish stock have declined steadily since the late 1970s, but has rebuilt rapidly since the mid-2010s. There were episodic years of strong recruitment in the current physical regime starting in 1977. Over the last decade, there have been at least three extremely large and well above average year classes (i.e., in 2014, 2016, and 2017). The recent period of high recruitment could be related to environmental conditions, particularly marine heatwaves, which may provide an advantage to fast growing sablefish larvae that exhibit opportunistic feeding strategies during early life history stages (Shotwell et al. 2021).

Size ranges for GOA sablefish life history stages are 150 - 399 mm fork length for settled early juveniles, 400 - 585 mm for subadults, and > 585 mm for adults (size at 50% maturity being 585 mm) (Sasaki 1985, Rodgveller et al. 2016, Pirtle et al. 2019).

4.14.2 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).

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 diet (Laidig et al. 1997). Off the southwest coast of Vancouver Island, euphausiids dominated sablefish diets (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).

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

4.14.3 Habitat and Biological Associations

Settled Early Juveniles: The covariates contributing the most to the final SDM EFH map for this life stage were tidal current speed, terrain aspect, bottom temperature, and terrain curvature (Pirtle et al. 2023). Suitable habitat for settled early juvenile sablefish was predicted in nearshore areas (< 125 m depth) and extensively on the continental shelf of the eastern GOA. Habitat-related growth potential for this life stage is greater at the shallowest depths, inshore and along the coast.

Subadults: The covariate contributing the most to the final SDM EFH map for this life stage was bottom depth alone (Pirtle et al. 2023). The highest subadult sablefish abundances were predicted to occur at > 250 m depth in the glacial troughs on the continental shelf, in particular from Shelikof Strait through the eastern GOA, and along the GOA shelf break and slope.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and bottom current speed (Pirtle et al. 2023). The highest adult sablefish abundances occurred at depths > 250 m in areas with relatively low bottom current exposure along the outer continental shelf and slope, with higher abundances also intruding into the seaward entrances of the glacial troughs.

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		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	
Subadults	3 to 5 years	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	all year	continental slope, and deep shelf gullies and fjords.	Presumably D	varies	U	
Adults	5 to 35+ years	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	apparently year around, spawning movements (if any) are undescribed	continental slope, and deep shelf gullies and fjords.	Presumably D	varies	U	

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4.15 Shallow Water Flatfish complex

Species Complex Summary

In the GOA, the shallow water flatfish stock complex is comprised of Alaska plaice, butter sole, English sole, northern and southern rock soles, sand sole, starry flounder, and yellowfin sole (Turncock et al. 2017). Additional "other flatfish" species with relatively low biomass are also included in this group; Pacific sanddab, petrale sole, and slender sole. In GOA RACE-GAP summer bottom trawl survey catches (1993–2019) and mixed gear-type summer surveys (1989–2019), all member species except sand sole were common enough (N > 50) to support SDMs of probability of suitable habitat or habitat-related abundance to map EFH. Of all the species, there were higher abundance catches on the continental shelf of the GOA, and the probability of encountering shallow water flatfish was low along the slope and deep glacial troughs (Pirtle et al. 2023).

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4.15.1 Alaska plaice *(Pleuronectes quadrituberculatus*)

4.15.1.1 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).

Fecundity estimates (Fadeev 1965) indicate female fish produce an average of 56,000 eggs at lengths of 280 to 300 mm and 313,000 eggs at lengths of 480 to 500 mm. Subadults have a size range of 141 – 319 mm and adults are > 319 mm (Tenbrink and Wilderbuer 2015). The approximate upper size limit of settled early juvenile fish is 140 mm. Natural mortality rate estimates range from 0.19 to 0.22 (Wilderbuer and Zhang 1999).

4.15.1.2 Relevant Trophic Information

Groundfish predators include Pacific halibut (Novikov 1964) yellowfin sole, beluga whales, and fur seals (Salveson 1976). Adult Alaska plaice feed on sandy substrates during the summer and target polychaetes, amphipods, and echiurids (Livingston and DeReynier 1996

4.15.1.3 Habitat and Biological Associations

Larvae: Larvae are planktonic for at least 2 to 3 months until metamorphosis occurs.

Pelagic Early Juveniles: After metamorphosis, juveniles usually inhabit shallow areas.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, tidal maximum, and BPI (Pirtle et al. 2023). Higher subadult Alaska plaice abundance occurred in nearshore areas in Kachemak Bay and along the Alaska Peninsula and western Kodiak Island.

Adults: EFH for adult Alaska plaice shifts seasonally, with adults feeding on sandy substrates in the summer and migrating to deeper waters of the shelf margin in winter to avoid extreme cold water temperatures. The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and current metrics (Pirtle et al. 2023). Similar to subadults, higher adult Alaska plaice abundance was predicted to occur in nearshore areas in Kachemak Bay and along the Alaska Peninsula and western Kodiak Island

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	ice edge	

4.15.1.4 Literature

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4.15.2 Butter sole (*Isopsetta isolepis*)

4.15.2.1 Life History and General Distribution

Butter sole (*Isopsetta isolepis*) range from the southeastern Bering Sea and Aleutian Islands at Amchitka Island to southern California over soft bottom habitats in relatively shallow (< 150 m) water (Mecklenburg et al. 2002). Although butter sole are one of five species that account for most of the current biomass of the Shallow Water Flatfish complex, little is known about their life history. Doyle et al. (2019) reported a maximum observed transformation length from pelagic larvae to early juveniles of 15–20 mm TL in the GOA, and settled individuals as small as 11 mm FL were captured in summer beach seine surveys, yet not in sufficient numbers to model (N < 50).

4.15.2.2 Relevant Trophic Information

There is insufficient information on butter sole predator or prey relationships at this time

4.15.2.3 Habitat and Biological Associations

Subadults/Adults: Length-based information was not available so subadult and adult butter sole were modeled in composite to map EFH. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth and rockiness (Pirtle et al. 2023). Higher butter sole abundance was predicted in nearshore areas at less than 200 m depth with low presence of rocky substrate and at bathymetric rises on the GOA continental shelf.

4.15.2.4 Literature

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4.15.3 English sole (*Parophrys vetulus*)

4.15.3.1 Life History and General Distribution

Little is known about English sole life history in the GOA. The smallest settled early juvenile English sole caught by beach seine gear in summer surveys in the GOA was 17 mm FL (mean 31 mm FL; Nearshore Fish Atlas of Alaska). Subadults and adults are distinguished by a length break using L50 = 230 mm FL (Sampson and Al-Jufaily 1999). For mapping, these length breaks were used to separate English sole demersal life stages, including settled early juveniles (20–140 mm), subadults (141–230 mm), and adults (> 230 mm) (Pirtle et al. 2023). Settled early juvenile EFH is in nearshore areas and at shallow depths in the GOA. Subadult EFH occurred inshore in the GOA and adult English sole EFH was extensive across the GOA continental shelf (Pirtle et al. 2023). English sole may demonstrate ontogenetic migrations to deeper depths with increasing size or age.

4.15.3.2 Relevant Trophic Information

There is insufficient information on English sole predator or prey relationships at this time

4.15.3.3 Habitat and Biological Associations

Settled Early Juveniles: The covariate contributing the most to the final SDM EFH map for this life stage was bottom depth (Pirtle et al. 2023). The highest predicted probabilities of suitable habitat for settled early juvenile English sole occurred at locations less than 100 m depth.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, tidal maximum speed, and geographic location (Pirtle et al. 2023). The highest abundances were predicted in inshore areas east of 148°W and in western Cook Inlet.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth and geographic location (Pirtle et al. 2023). The highest abundances were in inshore areas east of 148°W and off southeast Alaska.

4.15.3.4 Literature

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4.15.4 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.

4.15.4.1 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 420 mm 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 330 mm). The length-based life stage break used for modeling EFH was > 328 mm for adult northern rock sole (Stark 2012, Pirtle et al. 2023). The natural mortality rate is believed to range from 0.18 to 0.20 (Turnock et al. 2002).

4.15.4.2 Relevant Trophic Information

Groundfish predators to rock sole include Pacific cod, walleye pollock, skates, Pacific halibut, and yellowfin sole, mostly on fish ranging from 50 to 150 mm standard length. Adult northern rock sole feed on bivalves, polychaetes, amphipods, and miscellaneous crustaceans.

4.15.4.3 Habitat and Biological Associations

Larvae: Larval northern rock sole are planktonic for at least 2 to 3 months until metamorphosis occurs.

Pelagic Early Juveniles: Juveniles inhabit shallow areas at least until age 1.

Settled Early Juveniles: The covariate contributing the most to the final SDM EFH map for this life stage, which was modeled combining both northern and southern rock sole, was bottom depth (Pirtle et al. 2023). The highest predicted probabilities of suitable habitat for settled early juvenile rock sole were nearshore or less than 125 m depth on the GOA continental shelf, including Cook Inlet and the bathymetric rises south and west of Kodiak Island. Habitat-related growth potential for this life stage is greater at shallower, inshore depths and on banks and bathymetric rises on the GOA continental shelf.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth and geographic location (Pirtle et al. 2023). Bathymetric rises less than 125 m depth and shallow nearshore locations on the continental shelf had high predicted abundances or high probability of encountering northern rock sole, particularly west of the Kenai Peninsula.

Adults: The covariate contributing the most to the final SDM EFH map for this life stage was bottom depth (Pirtle et al. 2023). The highest abundances of adult northern rock sole were predicted at less than 125 m depth on bathymetric rises, such as the banks south of Kodiak Island. Abundance increases westward in the GOA around the Shumagin Islands and the Alaska Peninsula.

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		
Subadults	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	

4.15.4.4 Literature

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4.15.5 Pacific sanddab *(Citharichthys sordidus)*

4.15.5.1 Life History and General Distribution

Pacific sanddab (*Citharichthys sordidus*) is a shallow-water flatfish species ranging from Baja California to southeast Alaska (Lamb and Edgell 2010). Little is known about Pacific sanddab life history in the GOA, which encompasses the northern part of their range. Their EFH is in shallower depths of the continental shelf in the eastern GOA off southeast Alaska (Pirtle et al. 2023).

4.15.5.2 Relevant Trophic Information

There is insufficient information on Pacific sanddab predator or prey relationships at this time.

4.15.5.3 Habitat and Biological Associations

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location and bottom temperature (Pirtle et al. 2023). Higher Pacific sanddab abundance was predicted to occur at shallower depths on the continental shelf of the eastern GOA. The SDM used all individual Pacific sanddabs caught by RACE-GAP summer bottom trawl surveys in the GOA because there is no length-based information for this species to distinguish between life history stages (Pirtle et al. 2023).

4.15.5.4 Literature

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4.15.6 Petrale sole *(Eopsetta jordani)*

4.15.6.1 Life History and General Distribution

Petrale sole *(Eopsetta jordani)* is a right-eyed flounder ranging from Baja California to the western GOA (Wetzel 2019). Little is known about petrale sole life history in the GOA, which is the northern extent of their range. However, maturity studies of individuals from the US West Coast estimated L50 = 331 mm FL (Hannah et al. 2002), which is used to distinguish the subadult (< 331 mm FL) and adult (> 331 mm FL) life stages. Adults have a larger EFH area than subadults, extending into the central GOA and the eastern GOA continental shelf, while subadults were prevalent off southeast Alaska (Pirtle et al. 2023).

4.15.6.2 Relevant Trophic Information

There is insufficient information on petrale sole predator or prey relationships at this time.

4.15.6.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom temperature, and tidal current accounted (Pirtle et al. 2023). The highest abundances were predicted less than 100 m depth in the eastern GOA off southeast Alaska.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and bottom temperature (Pirtle et al. 2023). The highest abundances were predicted less than 125 m depth in the eastern GOA off southeast Alaska.

4.15.6.4 Literature

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4.15.7 Slender sole *(Lyopsetta exilis)*

4.15.7.1 Life History and General Distribution

Slender sole (*Lyopsetta exilis)* range from Baja California to the eastern Bering Sea (Mecklenburg et al. 2002). Little is known about slender sole life history in the GOA. Slender sole were primarily caught on the continental shelf off southeast Alaska in the GOA RACE-GAP summer bottom trawl surveys (1993 - 2019). Their core EFh area is found in glacial troughs and along the outer continental shelf and upper slope (Pirtle et al. 2023).

4.15.7.2 Relevant Trophic Information

There is insufficient information on slender sole predator or prey relationships at this time.

4.15.7.3 Habitat and Biological Associations

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location and bottom depth (Pirtle et al. 2023). Higher slender sole abundance for their demersal life history stages was around 250 m depth on the outer continental shelf and glacial troughs of the eastern GOA. The SDM used all individual Pacific sanddabs caught by RACE-GAP summer bottom trawl surveys in the GOA because there is no length-based information for this species to distinguish between life history stages (Pirtle et al. 2023).

4.15.7.4 Literature

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Pirtle, J. L., Laman, E. A., Harris, J., Siple, M. C., Rooper, C. N., Hurst, T. P., Conrath, C. L., and Gibson, G. A. 2023. Advancing model-based essential fish habitat descriptions for North Pacific species in the Gulf of Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-468, 541 p. https://doi.org/10.25923/ygdf-5f65

4.15.8 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.

4.15.8.1 Life History and General Distribution

Southern rock sole are distributed from Baja California waters north into the GOA and the eastern Aleutian Islands. Centers of abundance occur off the Kamchatka Peninsula (Shubnikov and Lisovenko 1964), British Columbia (Forrester and Thompson 1969), the central GOA, and to a lesser extent in the extreme southeastern 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). Kamchatka 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 (Armistead and Nichol 1993). The movement from winter/spring to summer grounds may be a response to warmer temperatures in the shallow waters and the distribution of prey on the shelf seafloor (Shvetsov 1978). In September, with the onset of cooling in the northern latitudes, southern rock sole begin the return migration to the deeper wintering grounds. Fecundity varies with size and was reported to be 450,000 eggs for fish 420 mm 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 347 mm length (Stark and Somerton 2002). The natural mortality rate is believed to range from 0.18 to 0.20 (Turnock et al. 2002).

4.15.8.2 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 50 to 150 mm standard length.

4.15.8.3 Habitat and Biological Associations

Larvae: Larval southern rock sole are planktonic for at least 2 to 3 months before metamorphosis occurs.

Settled Early Juveniles: The covariate contributing the most to the final SDM EFH map for this life stage, which was modeled combining both northern and southern rock sole, was bottom depth (Pirtle et al. 2023). The highest predicted probabilities of suitable habitat for settled early juvenile rock sole were nearshore or less than 125 m depth on the GOA continental shelf, including Cook Inlet and the bathymetric rises south and west of Kodiak Island. Habitat-related growth potential for this life stage is greater at shallower, inshore depths and on banks and bathymetric rises on the GOA continental shelf.

Subadults: The covariate contributing the most to the final SDM EFH map for this life stage was bottom depth (Pirtle et al. 2023). The highest abundances were predicted at less than 125 m depth on bathymetric rises, such as the banks south of Kodiak Island and west in the GOA. Nearshore areas along the outer coast of southeast Alaska were also areas of predicted high abundance for subadult southern rock sole.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth (Pirtle et al. 2023). The highest abundances were predicted at less than 125 m depth on bathymetric rises, such as the banks south of Kodiak Island, around the Shumagin Islands, and the Alaska Peninsula. Inshore areas along the outer coast of southeast Alaska were also areas of predicted high abundance for adult southern rock sole.

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			
Settled Early Juveniles	to 3.5 years	polychaetes, bivalves, amphipods, misc. crustaceans	all year	BAY, ICS, OCS, MCS	D	S, G		
Subadults	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	ice edge	

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4.15.9 Starry flounder *(Platichthys stellatus)*

4.15.9.1 Life History and General Distribution

Starry flounder (*Platichthys stellatus*) range from the Beaufort Sea to Southern California, typically over soft bottom habitats in relatively shallow (< 100 m) water (Mecklenburg et al. 2002). This euryhaline species can tolerate a wide range of salinities and has been collected from marine to essentially freshwater environments (Orcutt 1950, Ralston 2005). The length ranges to separate starry flounder demersal life stages are settled early juveniles (20–150 mm), subadults (151–369 mm), and adults (> 369 mm) (Pirtle et al. 2023). They are distributed on the continental shelf across the GOA from southeast Alaska westward. Settled early juvenile and subadults had EFH hotspots inside Cook Inlet and offshore of the Copper and Bering Rivers (Pirtle et al. 2023).

4.15.9.2 Relevant Trophic Information

There is insufficient information on starry flounder predator or prey relationships at this time.

4.15.9.3 Habitat and Biological Associations

Settled Early Juveniles: The covariate contributing the most to the final SDM EFH map for this life stage was bottom depth (Pirtle et al. 2023). The highest predicted probabilities of suitable habitat for settled early juvenile starry flounder occurred at locations less than 100 m depth in nearshore areas throughout the GOA.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth and geographic location (Pirtle et al. 2023). Their highest abundances were predicted in nearshore areas and at shallow depths on the GOA continental shelf.

Adults: The covariate contributing the most to the final SDM EFH map for this life stage was bottom depth (Pirtle et al. 2023). The highest abundances were predicted in nearshore areas and at shallow depths on the GOA continental shelf.

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4.15.10 Yellowfin sole (*Limanda aspera*)

4.15.10.1 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 250 to 450 mm 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 subadult and adult population, remaining in shallow areas until they reach approximately 140 mm. The estimated age of 50 percent maturity is 296 mm (Tenbrink and Wilderbuer 2015). Natural mortality rate is believed to range from 0.12 to 0.16.

4.15.10.2 Relevant Trophic Information

Groundfish predators include Pacific cod, skates, and Pacific halibut, mostly on fish ranging from 70 to 250 mm standard length. Adults feed over sandy substrates typically nearshore in shallow shelf areas on bivalves, polychaetes, amphipods and echiurids.

4.15.10.3 Habitat and Biological Associations

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

Settled Early Juveniles: The covariate contributing the most to the final SDM EFH map for this life stage was bottom depth (Pirtle et al. 2023). The highest predicted probabilities of suitable habitat for settled early juvenile yellowfin sole were less than 100 m depth on the GOA continental shelf. Habitat-related growth potential for this life stage is greater at shallower, inshore depths in the GOA.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and tidal maximum (Pirtle et al. 2023). The highest abundances of subadult yellowfin sole were predicted in inshore areas of the central and western GOA west of the Kenai Peninsula.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and tidal maximum (Pirtle et al. 2023). Higher abundances of adult yellowfin sole were predicted in inshore areas of the central and western GOA west of the Kenai Peninsula

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		
Subadults	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	ice edge	

4.15.10.4 Literature

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4.16 Shark complex

The species representatives for sharks are:

Lamnidae: Salmon shark *(Lamna ditropis*)
Squalidae: Sleeper shark *(Somniosus pacificus)*
Spiny dogfish *(Squalus suckleyi)*

4.16.1 Life History and General Distribution

Sharks of the order Squaliformes (which includes the two families *Lamnidae* and *Squalidae)* are the higher sharks with five gill slits and two dorsal fins. Spiny dogfish are widely distributed throughout the North Pacific Ocean and are the representative species for the GOA shark complex. In the North Pacific, spiny dogfish may be most abundant in the GOA, with southeast Alaska the center of their abunance; 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.

Salmon sharks 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 5 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 GOA groundfish fishery and survey data, salmon sharks occur near the coast to the outer shelf, particularly near Kodiak Island.

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. They occur often in near shore and shallow waters in the GOA. Tagging data suggests that they spend a significant amount of time moving vertically through 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 GOA groundfish fishery and survey data, Pacific sleeper sharks are found along the coast to the outer shelf, particularly near Kodiak Island in Shelikof Strait, inside waters of Southeast Alaska, and Prince William Sound.

4.16.2 Relevant Trophic Information

Sharks are top level predators in the GOA. The only likely predator would be larger fish, including larger sharks, or mammals preying on young/small sharks. Spiny dogfish are 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, herring, sculpins, and gadids. Pacific sleeper shark are predators of flatfish, cephalopods, rockfish, crabs, seals, and salmon and may also prey on pinnipeds.

4.16.3 Habitat and Biological Associations

Pelagic early juveniles: 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.

Subadults and Adults: Spiny dogfish are widely dispersed throughout the water column on shelf in the GOA. They are not common at depths greater than 200 m. The covariates contributing the most to the final SDM EFH map for these combined life stages were geographic location, bottom temperature, and bottom current velocity (Pirtle et al. 2023). Higher abundance of spiny dogfish was predicted to occur in southern Cook Inlet, east of Kodiak Island, and areas of the central and eastern GOA.

Salmon sharks are found throughout the GOA, as well as the eastern Bering Sea and Aleutian Islands; they are epipelagic, primarily found over shelf/slope waters in the GOA. Salmon sharks exhibit seasonal abundances in areas with high densities of salmon returns, such as Prince William Sound.

Pacific sleeper sharks are widely dispersed on shelf/upper slope in the GOA; 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
Neonates								
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								
Salmon shark	30+ years	fish (salmon, sculpins, and gadids)	all year	ICS, MCS, OCS, USP in GOA	P	NA	U	4-24°C
Pacific sleeper shark	U	flatfish, cephalopods, rockfish, crabs, seals, salmon, pinnipeds	all year	ICS, MCS, OCS, USP in GOA	D	U	U	

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
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	P/D	U	U	4–16°C

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4.17 Shortraker rockfish (*Sebastes borealis*)

4.17.1 Life History and General Distribution

Shortraker rockfish are found around the arc of the north Pacific from southern California to northern Japan, including the Bering Sea and the Sea of Okhotsk (Mecklenburg et al. 2002). They also occur on seamounts in the GOA (Maloney 2004). Except for the adult stage, information on the life history of shortraker rockfish is extremely limited. Similar to other Sebastes, the fish appear to be viviparous; fertilization is internal and the developing eggs receive at least some nourishment from the mother. Parturition (release of larvae) may occur from February through August (McDermott 1994). Larvae can be positively identified only by using genetic techniques (Gray et al. 2006), which greatly hinders study of this life stage. Based on genetic identification, a few larval shortraker rockfish have been found in coastal waters of Southeast Alaska (Gray et al. 2006). Post-larvae are also difficult to identify, but genetic identification confirmed the presence of two specimens in epipelagic offshore waters of the GOA over depths 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 350-mm 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 449 mm (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 (1200 mm; 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).

4.17.2 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.

4.17.3 Habitat and Biological Associations

Eggs: 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.

Pelagic Early Juveniles: 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.

Subadults: Subadult shortraker rockfish were caught in summer bottom trawl surveys from Yakutat Trough to the weather GOA. The covariate contributing the most to the final SDM EFH map for this life stage was bottom depth alone (Pirtle et al. 2023). Higher subadult shortraker rockfish abundance was predicted to peak around 375 m depth, occurring over a relatively narrow depth range that included the outer extent of glacial troughs on the continental shelf and areas along the continental slope of the GOA.

Adults: Adult shortraker rockfish are demersal and in the GOA are concentrated at depths of 300 to 500 m (984 to 1,640 feet) along the continental slope. Much of 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.

The covariates contributing the most to the final SDM EFH map for adult shortraker rockfish were bottom depth, bottom current speed, and geographic location (Pirtle et al. 2023). Higher adult shortraker rockfish abundance was predicted to peak around 375 m depth along increasingly sloping terrain with relatively moderate bottom current exposure, within a relatively narrow depth range that included the outer extent of glacial troughs on the continental shelf and areas along the continental slope of the GOA.

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	
Pelagic Early Juveniles	U	U	summer to ?	LSP, BSN	probably D	NA	U	
Subadults	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

4.17.4 Literature

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4.18 Skate complex (Rajidae)

The skate complex is described below and the species in the complex are:

Alaska skate
Aleutian skate
Bering skate
Big skate
Longnose skate

Species Complex Summary

Skates (Rajidae) that occur in the BSAI and GOA are grouped into two genera: Bathyraja sp., or soft-nosed species (rostral cartilage slender and snout soft and flexible), and Raja sp., or hard-nosed species (rostral cartilage is thick making the snout rigid). In the GOA, the Skate stock complex is managed as three units with big skate and longnose skate each having separate harvest specifications, and all remaining skates are managed as an “other skates” group (Ormseth 2019). Skates are oviparous; fertilization is internal, and eggs (one to five or more in each case) are deposited in horny cases for incubation. Big skates (*Raja binoculata)* and longnose skates (*Raja rhina*) are the most abundant skates in the GOA. Most of the biomass for these two species is located in the Central GOA (NMFS statistical areas 620 and 630). Depth distributions from surveys show that big skates are found primarily from 0 to 100 m; longnose skates are found primarily from 100 to 200 m, although they are found at all depths shallower than 300 m. Below 200 m depth, Bathyraja sp. skates are dominant. Little is known of their habitat requirements for growth or reproduction, nor of any seasonal movements. BSAI skate biomass estimate more than doubled between 1982 and 1996 from bottom trawl surveys; it may have decreased in the GOA and remained stable in the Aleutian Islands in the 1980

Relevant Trophic Information

Adults and juveniles are demersal and feed on bottom invertebrates (crustaceans, molluscs, and polychaetes) and fish.

Habitat and Biological Associations

Eggs: Skates deposit eggs in horny cases on the shelf and slope.

Juveniles: After hatching, juveniles probably remain in shelf and slope waters, but distribution is unknown.

Adults: Adults found across wide areas of shelf and slope; surveys found most skates at depths less than 500 m in the GOA and eastern Bering Sea, but greater than 500 m in the Aleutian Islands. In the GOA, most skates found between 4 and 7 °C, but data are limited.

Habitat and Biological Associations: Skates

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	NA	U	MCS, OCS, USP	D	U	U	
Larvae	NA	NA	NA	NA	NA	NA	NA	
Juveniles	U	invertebrates, small fish	all year	MCS, OCS, USP	D	U	U	
Adults	U	invertebrates, small fish	all year	MCS,OCS, USP	D	U	U	

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4.18.1 Alaska skate *(Bathyraja parmifera)*

4.18.1.1 Life History and General Distribution

The Alaska skate *(Bathyraja parmifera)* is a large, shallow water skate (Ebert 2005, Stevenson et al. 2007) that ranges from the eastern Bering Sea and Aleutian Islands to the eastern Gulf of Alaska (Mecklenberg et al. 2002). Subadult Alaska skates (≤ 920 mm TL) are distinguished from adults (> 920 mm TL) based on length at 50% maturity (Matta and Gunderson 2007). EFH for both subadult and adult Alaska skates is similar and primarily in Shelikof Strait, off southwestern Kodiak Island, and near Unimak Pass (Pirtle et al. 2023).

4.18.1.2 Relevant Trophic Information

There is insufficient information on Alaska skate predator or prey relationships at this time.

4.18.1.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and BPI (Pirtle et al. 2023). The highest abundances of subadult Alaska skate were predicted in the central GOA in Shelikof Strait and near the western end of the Alaska Peninsula at depths around 250 m.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and bottom current velocity variability (Pirtle et al. 2023). Their predicted numerical abundance was higher in the western half of GOA.

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4.18.2 Aleutian skate *(Bathyraja aleutica)*

4.18.2.1 Life History and General Distribution

The Aleutian skate *(Bathyraja aleutica)* is a large species (1,500 mm TL maximum length) that ranges from the Bering Sea and Aleutian Islands into the Gulf of Alaska over a wide range of depths (29–950 m; Stevenson et al. 2007). In RACE-GAP summer bottom trawl surveys of the GOA, they are generally found in the outer domain on the GOA shelf (> 200 m depths) and on the upper continental slope (Hoff 2009). The spatial distribution of subadult (≤ 1,320 mm TL) and adult (> 1,320 mm TL) life stages (Ebert et al. 2007, Haas et al. 2016) overlaps in the GOA.

4.18.2.2 Relevant Trophic Information

There is insufficient information on Alaska skate predator or prey relationships at this time.

4.18.2.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and bottom temperature (Pirtle et al. 2023). Higher subadult Aleutian skate abundance occurred in Shelikof Strait and to the southwest in depths around 300 m.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and bottom temperature (Pirtle et al. 2023), which predicted adult Aleutian skate abundance to be highest in the Shelikof Strait and into the Chirikof region in depths around 250 m.

4.18.2.4 Literature

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4.18.3 Bering skate *(Bathyraja interrupta)*

4.18.3.1 Life History and General Distribution

The Bering skate *(Bathyraja interrupta)* is distributed from California to the Bering Sea over a wide range of depths (37–1372 m; Mecklenberg et al. 2002) and reaches a maximum length of 800 mm TL (Stevenson et al. 2007). Bering skate subadult and adult life stages are separated at 690 mm TL (Ainsley et al. 2011). Subadults are distributed across the GOA continental shelf from Dixon Entrance to Unimak Pass while adult Bering skates are more common between the Yakutat region through to the western GOA (Pirtle et al. 2023).

4.18.3.2 Relevant Trophic Information

There is insufficient information on Alaska skate predator or prey relationships at this time.

4.18.3.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and bottom temperature (Pirte et al. 2023). Higher abundances of subadult Bering skates occurred in Shelikof Strait and to the southwest in depths around 300 m.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and bottom temperature (Pirtle et al. 2023). Adult Bering skate abundance was highest in Shelikof Strait in depths around 250 m with relatively little bottom current.

4.18.3.4 Literature

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4.18.4 Big skate *(Beringraja binoculata)*

4.18.4.1 Life History and General Distribution

The big skate *(Beringraja binoculata)* is a large skate (maximum reported TL ~ 2.4 m) that ranges from the eastern Bering Sea and Aleutians Islands to Baja California (Mecklenberg et al. 2002). They inhabit a wide depth range (3–800 m) but are more commonly encountered in the GOA in waters shallower than 200 m. Big skate subadult and adult life stages are separated using L50 = 1,486 mm (Ebert et al. 2008). Subadult big skate distribution in the GOA is in shallower waters of the continental shelf from southeast Alaska to Unimak Pass; adult big skates are widely distributed across the GOA with concentrations around Kodiak Island and in Cook Inlet (Pirtle et al. 2023).

4.18.4.2 Relevant Trophic Information

There is insufficient information on Alaska skate predator or prey relationships at this time.

4.18.4.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, BPI, and geographic location (Pirtle et al. 2023). Subadult big skate abundance was highest in shallower depths (< 100 m) over high bathymetric rises in the Yakutat region, Cook Inlet, and around Kodiak Island.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and bottom temperature (Pirtle et al. 2023). Adult big skate abundance was highest in Cook Inlet and off southwestern Kodiak Island in the Chirikof region at shallower depths and warmer bottom temperature.

4.18.4.4 Literature

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4.18.5 Longnose skate *(Raja rhina)*

4.18.5.1 Life History and General Distribution

The longnose skate *(Raja rhina)* is a relatively large skate (maximum reported TL ~ 1.4 m) that ranges from the southeastern Bering Sea through the eastern Pacific Ocean to Baja California at depths of 20 m to more than 600 m (Mecklenberg et al. 2002). Longnose skate subadult and adult life stages are separated using female length at the onset of maturity (1,331 mm TL; Ebert et al. 2008). In the GOA, subadult longnose skates are distributed from the Shumagin region towards southeast Alaska and adult longnose skates are distributed over the continental shelf from southeast Alaska to Unimak Pass (Pirtle et al. 2023).

4.18.5.2 Relevant Trophic Information

There is insufficient information on Alaska skate predator or prey relationships at this time.

4.18.5.3 Habitat and Biological Associations

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and bottom temperature (Pirtle et al. 2023). Subadult longnose skate abundance was highest in the Kodiak and Yakutat regions in depths around 250 m in the glacial troughs.

Adults: The covariates contributing the most to the final SDM EFH map for this life stage were geographic location, bottom depth, and BPI (Pirtle et al. 2023). Adult longnose skate abundance was highest in the northern portion of Shelikof Strait and the eastern portion of the Kodiak region over depths around 250 m in the glacial troughs.

4.18.5.4 Literature

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4.19 Thornyhead Rockfish complex *(Sebastolobus spp.)*

4.19.1 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 750 mm 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 215 mm.

4.19.2 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.

4.19.3 Habitat and Biological Associations

Egg/Spawning: Eggs float in masses of various sizes and shapes. Frequently the masses are bilobed with the lobes 150 mm to 610 mm 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.

Pelagic/Settled Early 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.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and sponge presence (Pirtle et al. 2023). Higher subadult shortspine thornyhead abundance was predicted to peak around 375 m depth with a low presence of sponges. Predicted abundance was highest within a relatively small depth range that included the outer extent of glacial troughs on the continental shelf and areas along the continental slope of the GOA.

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)*.

The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and bottom current (Pirtle et al. 2023). Higher adult shortspine thornyhead abundance was predicted to peak around 300 m depth with relatively low bottom current exposure within a relatively small depth range, including glacial troughs on the continental shelf and areas along the continental slope of the GOA.

Habitat and Biological Associations: Thornyhead Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	U	spawning: late winter and early spring	U	P	U	U	
Larvae	<15 months	U	early spring through summer	U	P	U	U	
Settled Early Juveniles/ Subadults	> 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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4.20 Walleye pollock *(Gadus chalcogrammus)*

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.

4.20.1 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.

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. Length-based life stage breaks divide pollock subadults and adults at 410 mm (Williams et al. 2016).

4.20.2 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.

4.20.3 Habitat and Biological Associations

Eggs: 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.

Settled Early 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. The covariates contributing the most to the final SDM EFH map for this life stage were bathymetric position index (BPI), bottom depth, and terrain aspect covariates (Pirtle et al. 2023). The highest probabilities of suitable habitat for early juvenile pollock in the GOA were predicted to occur < 125 m depth, inshore, and on the continental shelf. Habitat-related growth potential for this life stage is greater at inshore and coastal areas as well as in glacial troughs on the GOA continental shelf, such as Shelikof Strait.

Subadults: The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and tidal current speed (Pirtle et al. 2023). The highest subadult pollock abundances were predicted relatively inshore in the RACE-GAP GOA survey area.

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. The covariates contributing the most to the final SDM EFH map for this life stage were bottom depth, geographic location, and rockiness (Pirtle et al. 2023). Adult pollock abundance was predicted to be highest near 250 m depth in the glacial troughs (BPI lows), including Shelikof Strait.

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
Settled Early Juveniles/ Subadults	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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5 Appendix E Maps of Essential Fish Habitat

5.1 Outline

Maps of essential fish habitat are included in this section for the following species (life stage is indicated in parentheses) and EFH information levels (L) 1-3 (see Pirtle et al. 2023 for mapping methods):

Figure 5-1- Figure 5-7	Arrowtooth flounder (larvae, settled early juvenile, subadult, adult) • settled early juvenile summer L1 E-1, subadult summer L2 E-2, adult summer L2 E-3; • larvae summer L1 E-4, adult fall L1 E-5, adult winter L1 E-6, adult spring L1 E-7.
Figure 5-8 Figure 5-12	Atka mackerel (subadult, adult) • subadult summer L2 E-8, adult summer L2 E-9; • adult fall L1 E-10, adult winter L1 E-11, adult spring L1 E-12.
Figure E-13 to E-19	Deepwater flatfish complex: Dover sole (egg, larvae, subadult, adult) • subadult summer L2 E-13, adult summer L2 E-14; • egg summer L1 E-15, larvae summer L1 E-16, adult fall L1 E-17, adult winter L1 E-18, adult spring L1 E-19
Figure E-20 to E-24	Dusky rockfish (subadult, adult) • subadult summer L2 E-20, adult summer L2 E-21; • adult fall L1 E-22, adult winter L1 E-23, adult spring L1 E-24.
Figure E-25 to E-32	Flathead sole (egg, larvae, settled early juvenile, subadult, adult) • settled early juvenile summer L1 E-25, subadult summer L2 E-26, adult summer L2 E-27; • egg summer L1 E-28, larvae summer L1 E-29, adult fall L1 E-30, adult winter L1 E-31, adult spring L1 E-32.
Figure E-33 to E-37	Northern rockfish (subadult, adult) • subadult summer L2 E-33, adult summer L2 E-34; • adult fall L1 E-35, adult winter L1 E-36, adult spring L1 E-37.
Figure E-38 to E-41	Octopuses (subadult/adult, adult) • subadult/adult summer L2 E-38; • adult fall L1 E-39, adult winter L1 E-40, adult spring L1 E-41.
Figure E-42 to E-49	Other rockfish complex, demersal subgroup (subadult/adult) • subadult/adult summer L2 E-42.

Figure E-43	Quillback rockfish (adult) • adult summer L2 E-43.
Figure E-44 to E-45	Rosethorn rockfish (subadult, adult) • subadult summer L2 E-44, adult summer L2 E-45.
Figure E-46 to E-49	Yelloweye rockfish (subadult, adult) • subadult summer L2 E-46, adult summer L2 E-47; • adult fall L1 E-48, adult spring L1 E-49.
Figure E-50 to E-62	Other rockfish complex, slope subgroup (subadult/adult) • subadult/adult summer L2 E-50.
Figure E-51	Greenstriped rockfish (adult) • adult summer L2 E-51.
Figure E-52 to E-54	Harlequin rockfish (subadult, adult) • subadult summer L2 E-52, adult summer L2 E-53; • adult spring L1 E-54.
Figure E-55	Pygmy rockfish (subadult/adult) • subadult/adult summer L2 E-55.
Figure E-56 to E-58	Redbanded rockfish (subadult, adult) • subadult summer L2 E-56, adult summer L2 E-57; • adult spring L1 E-58.
Figure E-59 to E-60	Redstripe rockfish (subadult, adult) • subadult summer L2 E-59, adult summer L2 E-60
Figure E-61 to E-63	Sharpchin rockfish (subadult, adult) • subadult summer L2 E-61, adult summer L2 E-62; • adult spring L1 E-63.
Figure E-64 to E-65	Silvergray rockfish (subadult, adult) • subadult summer L2 E-64, adult summer L2 E-65.
Figure E-66 to E-83	Pacific cod (egg, larvae yolk sac, larvae feeding preflexion, larvae feeding postflexion, pelagic early juvenile, settled early juvenile, subadult, adult) • egg summer L2 E-66, larvae yolk sac summer L2 E-67, larvae feeding preflexion summer L2 E-68, larvae feeding postflexion summer L2 E-69, early juvenile pelagic summer L2 E-70; settled early juvenile summer L1 E-71, subadult summer L2 E-72, adult summer L2 E-73; • adult fall L1 E-74, adult winter L1 E-75, adult spring L1 E-76; • egg summer L3 growth E-77, larvae yolk sac summer L3 growth E-78, larvae feeding preflexion summer L3 growth E-79, larvae feeding postflexion summer L3 growth E-80, early juvenile pelagic summer L3 growth E-81, settled early juvenile summer L3 growth E-82, settled early juvenile summer L3 condition E-83.

Figure E-84 to E-91	Pacific ocean perch (larvae, settled early juvenile, subadult, adult) • settled early juvenile summer L1 E-84, subadult summer L2 E-85, adult summer L2 E-86; • larvae summer L1 E-87, adult fall L1 E-88, adult winter L1 E-89, adult spring L1 E-90; • settled early juvenile summer L3 growth E-91.
Figure E-92 to E-99	Rex sole (egg, larvae, settled early juvenile, subadult, adult) • settled early juvenile summer L1 E-92, subadult summer L2 E-93, adult summer L2 E-94; • egg summer L1 E-95, larvae summer L1 E-96, adult fall L1 E-97, adult winter L1 E-98, adult spring L1 E-99.
Figure E-100 to E-104	Rougheye/blackspotted rockfish (subadult, adult) • subadult summer L2 E-100, adult summer L2 E-101; • adult (rougheye rockfish) fall L1 E-102, adult (rougheye rockfish) winter L1 E-103, adult (rougheye rockfish) spring L1 E-104.
Figure E-105 to E-121	Sablefish (egg, larvae yolk sac, larvae feeding, early juvenile epipelagic, early juvenile pelagic, settled early juvenile, subadult, adult) • egg summer L2 E-105, larvae yolk sac summer L2 E-106, larvae feeding summer L2 E-107, early juvenile epipelagic summer L2 E-108, early juvenile pelagic summer L2 E-109, settled early juvenile summer L1 E-110, subadult summer L2 E-111, adult summer L2 E-112; • adult fall L1 E-113, adult winter L1 E-114, adult spring L1 E-115; • egg summer L3 growth E-116, larvae yolk sac summer L3 growth E-117, larvae feeding summer L3 growth E-118, early juvenile epipelagic summer L3 growth E-119, early juvenile pelagic summer L3 growth E-120, settled early juvenile summer L3 growth E-121.
Figure E-122 to E-154	Shallow water flatfish complex (subadult/adult) • subadult/adult summer L2 E-122.
Figure E-123 to E-126	Alaska plaice (egg, larvae, subadult, adult) • subadult summer L2 E-123, adult summer L2 E-124; • egg summer L1 E-125, larvae summer L1 E-126.
Figure E-127	Butter sole (subadult/adult) • subadult/adult summer L2 E-127.
Figure E-128 to E-130	English sole (settled early juvenile, subadult, adult) • settled early juvenile summer L1 E-128, subadult summer L2 E-129, adult summer L2 E-130.

Figure E-131 to E-138	Northern rock sole (larvae, settled early juvenile, subadult, adult) • settled early juvenile (rock soles) summer L1 E-131, subadult summer L2 E-132, adult summer L2 E-133; • larvae summer L1 E-134, adult fall L1 E-135, adult winter L1 E-136, adult spring L1 E-137; • settled early juvenile (rock soles) summer L3 growth E-138.
Figure E-136	Pacific sanddab (subadult/adult) • subadult/adult summer L2 E-139.
Figure E-137 to E-141	Petrale sole (subadult, adult) • subadult summer L2 E-140, adult summer L2 E-141.
Figure E-142	Sand sole (adult) • adult summer L2 E-142.
Figure E-143	Slender sole (subadult/adult) • subadult/adult summer L2 E-143.
Figure E-144 to E-146	Southern rock sole (larvae, subadult, adult) • subadult summer L2 E-144, adult summer L2 E-145; • larvae summer L1 E-146.
Figure E-147 to E-149	Starry flounder (settled early juvenile, subadult, adult) • settled early juvenile summer L1 E-147, subadult summer L2 E-148, adult summer L2 E-149.
Figure E-150 to E-154	Yellowfin sole (egg, settled early juvenile, subadult, adult) • settled early juvenile summer L1 E-150, subadult summer L2 E-151, adult summer L2 E-152; • egg summer L1 E-153; • settled early juvenile summer L3 growth E-154.
Figure E-155	Shark complex: Spiny dogfish (subadult/adult) • subadult/adult summer L2 E-155.
Figure E-156 to E-159	Shortraker rockfish (subadult, adult) • subadult summer L2 E-156, adult summer L2 E-157; • adult fall L1 E-158, adult spring L1 E-159.
Figure E-160 to E-177	Skate complex (subadult, adult) • subadult summer L2 E-160, adult summer L2 E-161.
Figure E-162 to E-166	Alaska skate (subadult, adult) • subadult summer L2 E-162, adult summer L2 E-163; • adult fall L1 E-164, adult winter L1 E-165, adult spring L1 E-166.

Figure E-167 to E-171	Aleutian skate (subadult, adult) • subadult summer L2 E-167, adult summer L2 E-168; • adult fall L1 E-169, adult winter L1 E-170, adult spring L1 E-171.
Figure E-172 to E-173	Bering skate (subadult, adult) • subadult summer L2 E-172, adult summer L2 E-173.
Figure E-174 to E-175	Big skate (subadult, adult) • subadult summer L2 E-174, adult summer L2 E-175.
Figure E-176 to E-177	Longnose skate (subadult, adult) • subadult summer L2 E-176, adult summer L2 E-177.
Figure E-178 to E-183	Thornyhead rockfish complex
Figure E-178	Longspine thornyhead rockfish (adult) • adult spring L1 E-178.
Figure E-179 to E-183	Shortspine thornyhead rockfish (subadult, adult) • subadult summer L2 E-179, adult summer L2 E-180; • adult fall L1 E-181, adult winter L1 E-182, adult spring L1 E-183.
Figure E-184 to E-192	Walleye pollock (egg, settled early juvenile, subadult, adult) • settled early juvenile summer L1 E-184, subadult summer L2 E-185, adult summer L2 E-186; • egg summer L1 E-187, adult fall L1 E-188, adult winter L1 E-189, adult spring L1 E-190; • settled early juvenile summer L3 growth E-191, settled early juvenile summer L3 condition E-192.

5.2 Essential Fish Habitat (EFH) Maps

The mapping requirements for EFH component 1 descriptions and identification are that some or all portions of the geographic range of the species are mapped (50 CFR 600.815(a)(1)). The EFH regulations provide an approach to organize the information necessary to describe and identify EFH, which should be designated at the highest level possible—

> Level 1: Distribution data are available for some or all portions of the geographic range of the species.
> Level 2: Habitat-related densities or relative abundance of the species are available.
> Level 3: Growth, reproduction, or survival rates within habitats are available.
> Level 4: Production rates by habitat are available. [Not available at this time.]

New maps of species' habitat-related abundance predicted from species distribution model (SDM) ensembles were used to map EFH Level 2 information for the 2023 EFH 5-year Review for subadults and adults in the summer from their distribution and abundance in 1993-2019 (Pirtle et al. 2023). New maps of habitat-related species distribution from SDMs for the settled early juvenile life stage were used to map EFH Level 1 information for the first time in the 2023 EFH 5-year Review from their distribution and abundance in 1989-2019 (Pirtle et al. 2023). The new EFH Level 2 maps have replaced the summer SDM

EFH maps for species' life stages from the 2017 EFH 5-year Review. EFH maps for other seasons (fall, winter, and spring) from the 2017 5-year Review will remain.

The definition of EFH area in Alaska is the area containing 95% of the occupied habitat (NMFS 2005). Occupied habitat was defined as all locations where a species' life stage had an encounter probability greater than 5%, where encounter rates were derived from the SDM predictions and used to remove locations that had low encounter probabilities from inclusion in the EFH area (Pirtle et al. 2023). For settled early juveniles, the cloglog probability of suitable habitat was used in place of encounter probability. The new 2023 EFH maps are presented using percentile areas containing 95%, 75%, 50%, and 25% of the occupied habitat. Each of the EFH subareas describes a more focused partition of the total EFH area. The area containing 75% of the occupied habitat based on SDM predictions is referred to as the "principal EFH area". For the fishing effects analysis (EFH component 2), the area containing 50% of the occupied habitat is termed the "core EFH area". The areas containing the top 25% of the occupied area are referred to as "EFH hot spots". Mapping habitat percentiles for EFH subareas like these helps demonstrate the heterogeneity of fish distributions over available habitat within the larger area identified as EFH.

While EFH must be designated for each managed species, EFH may be designated for assemblages of species with justification or scientific rationale provided (50 CFR 600.815(a)(1)(iv)(E)). EFH maps from the 2023 5-year Review are presented for the first time for multi-species stock complexes using aggregated single species SDMs to serve as proxies for individual species in the stock complex where an SDM EFH map was not possible due to data limitations. In the following sections the EFH maps for the stock complex are presented first, followed by individual species in the stock complex where an EFH map was possible.

EFH Level 3 maps of habitat-related vital rates for settled early juveniles were mapped for the first time in the 2023 EFH 5-year Review by combining spatial projections of temperature dependent growth and lipid accumulation (condition) rates with SDMs (Pirtle et al. 2023).

EFH Level 2 maps of habitat-related density for pelagic early life stages were mapped for the first time in the 2023 EFH 5-year Review by combining biophysical individual-based models (IBMs) and SDMs for Pacific cod and sablefish as case studies (Hinckley et al. 2019, Gibson et al. 2023, Shotwell et al. In preperation). EFH Level 3 maps of habitat-related vital rates were also developed for each pelagic early life stage mapped by the combined IBM and SDM approach.

5.3 Figures

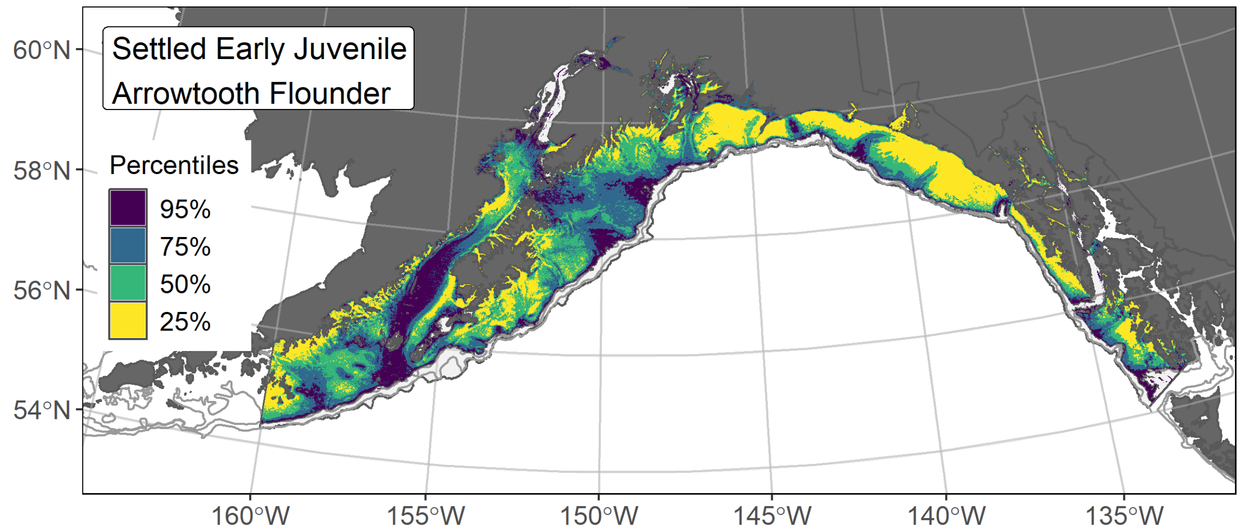

Figure 5-1 EFH area of settled early juvenile arrowtooth flounder, summer

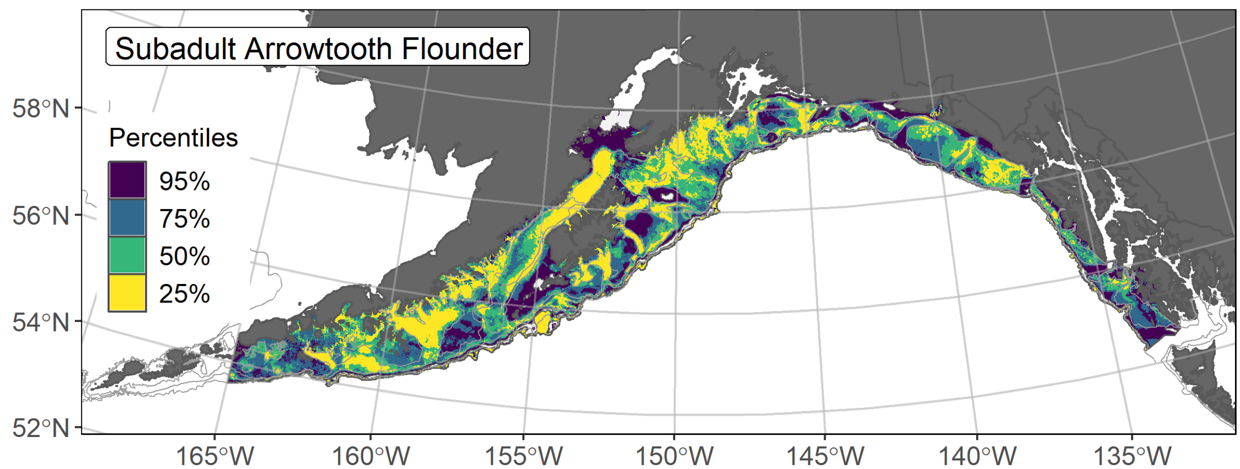

Figure 5-2 EFH area of subadult arrowtooth flounder, summer

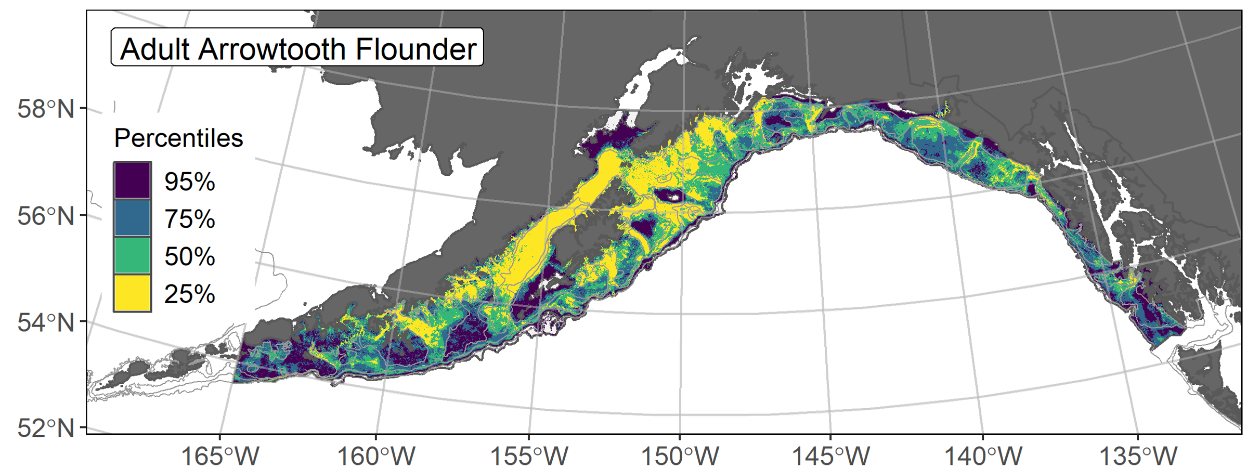

Figure 5-3 EFH area of adult arrowtooth flounder, summer

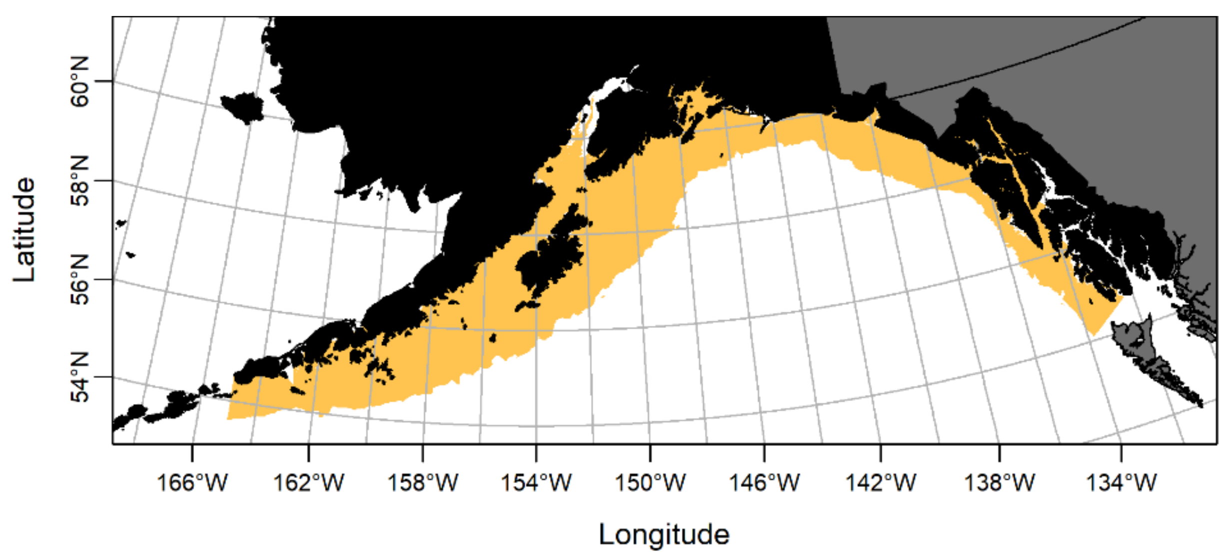

Figure 5-4 EFH area of arrowtooth flounder larvae, summer

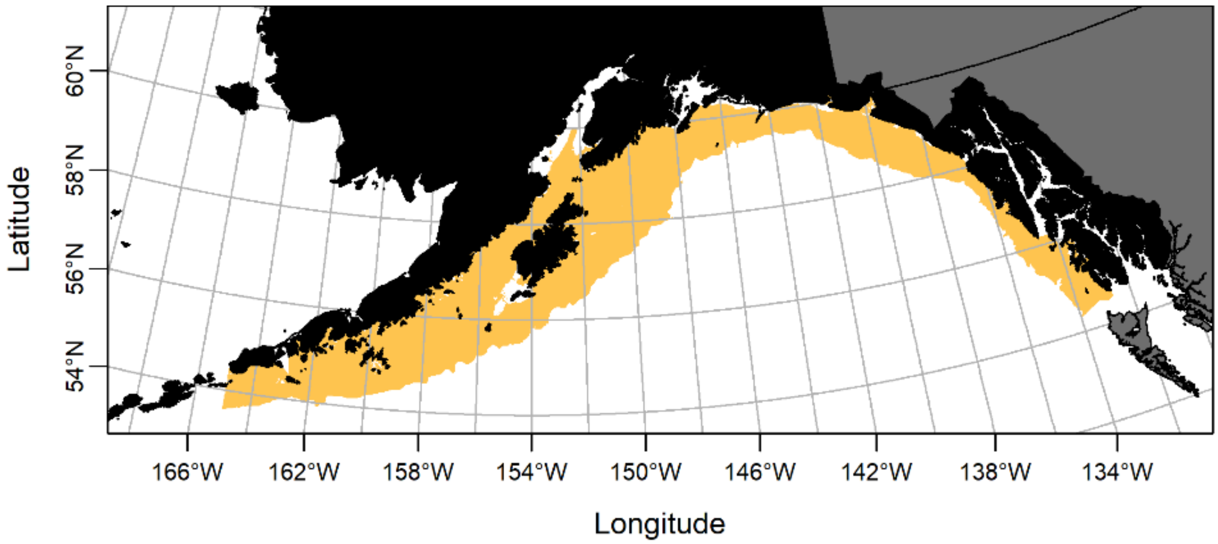

Figure 5-5 EFH area of adult arrowtooth flounder, fall

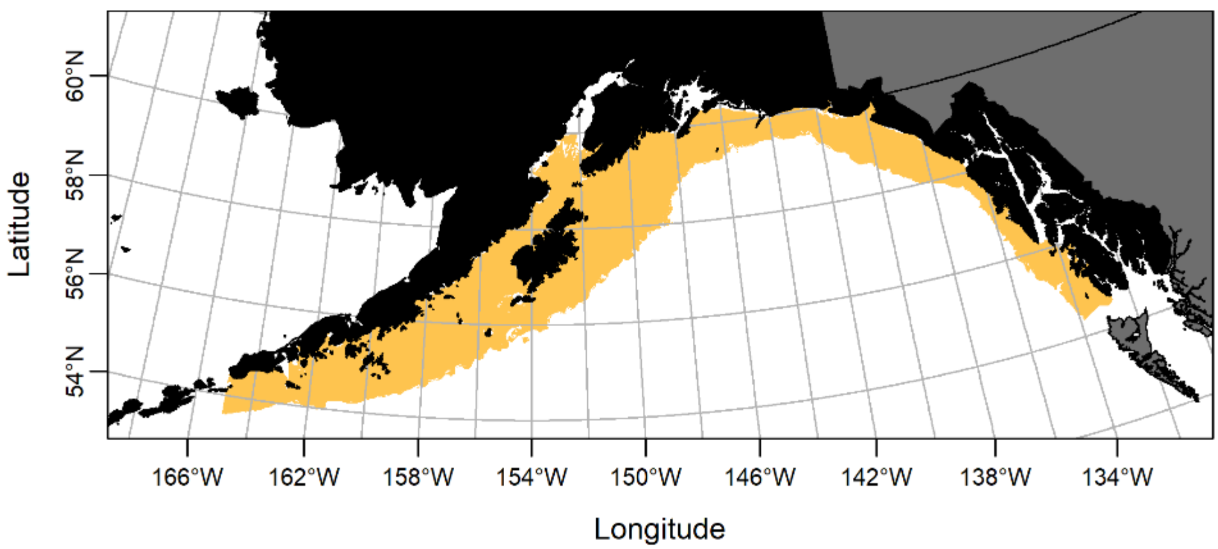

Figure 5-6 EFH area of adult arrowtooth flounder, winter

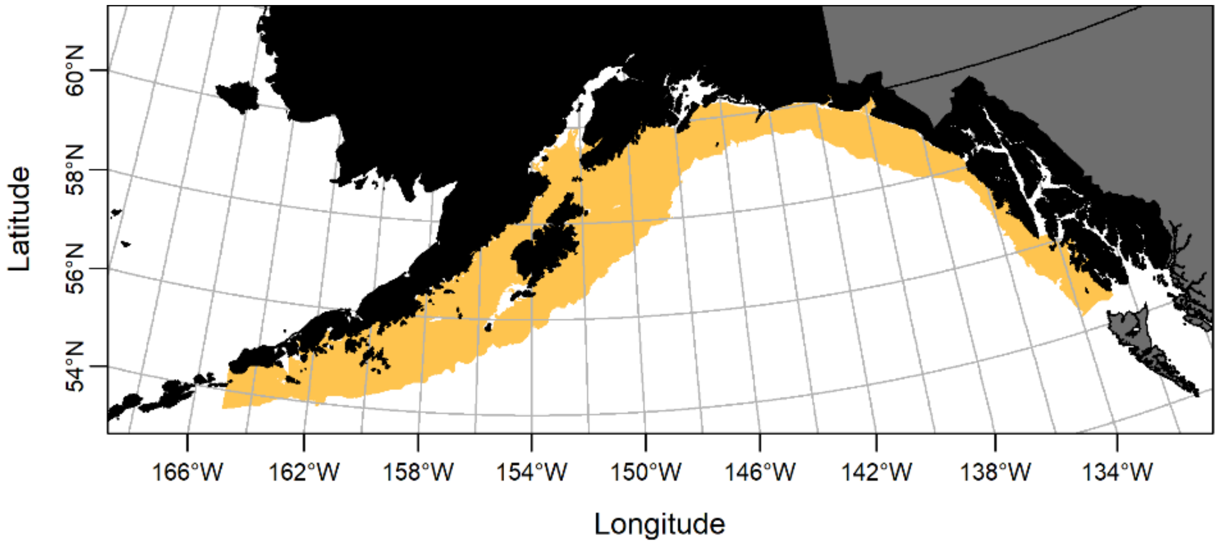

Figure 5-7 EFH area of adult arrowtooth flounder, spring

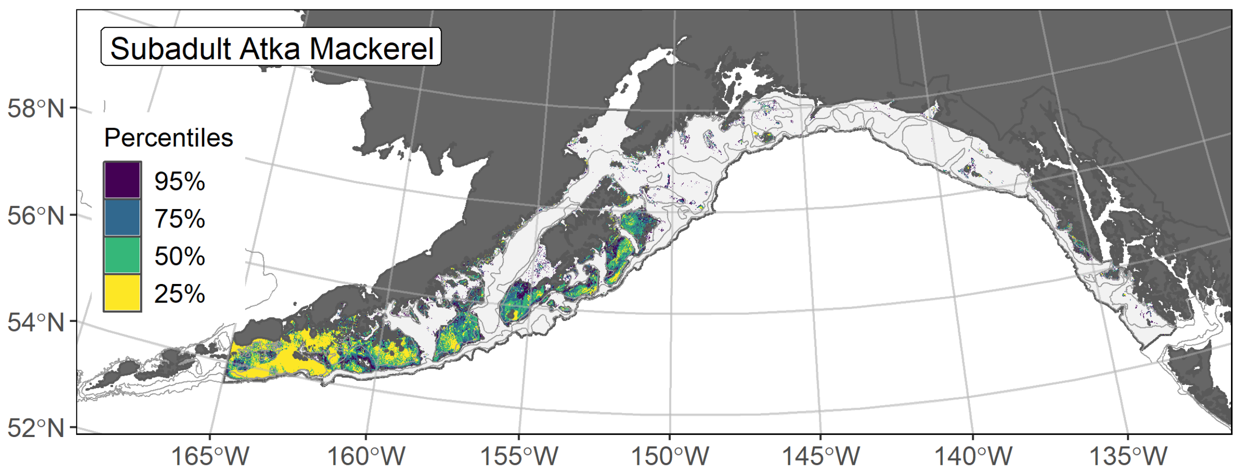

Figure 5-8 EFH area of subadult Atka mackerel, summer

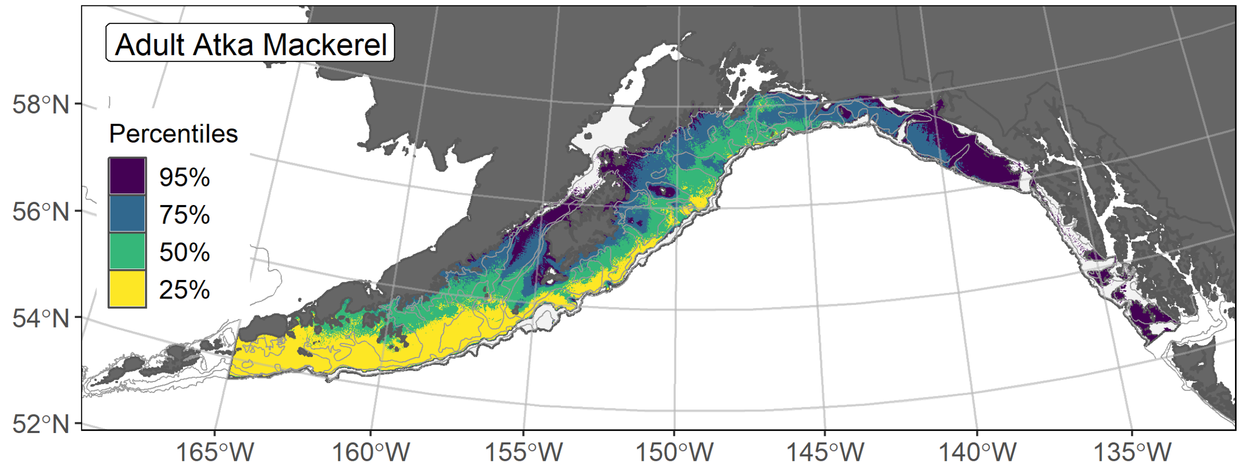

Figure 5-9 EFH area of adult Atka mackerel, summer

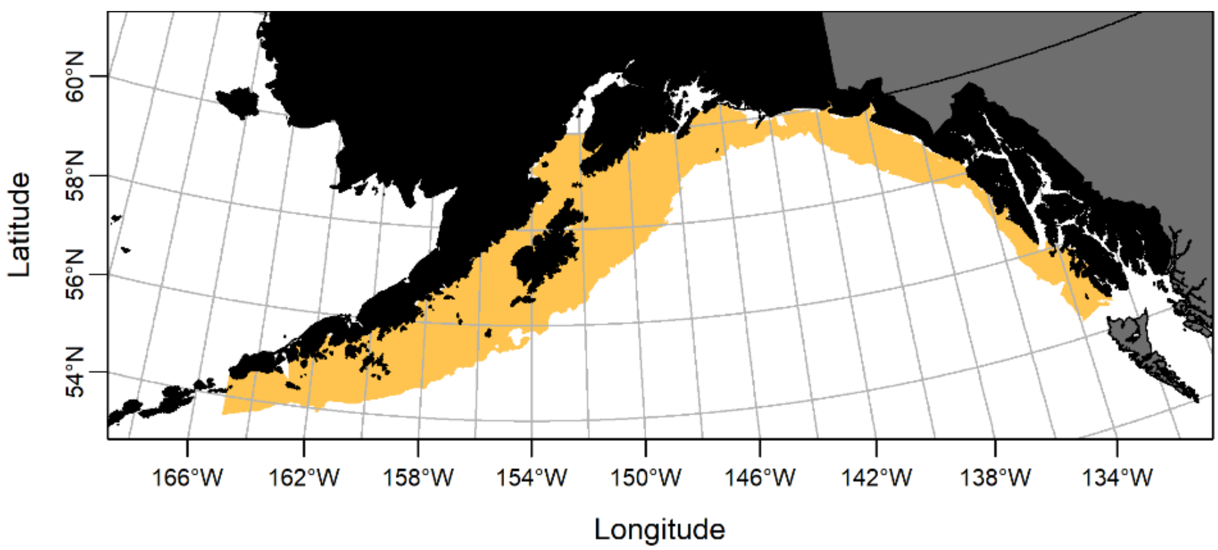

Figure 5-10 EFH area of adult Atka mackerel, fall

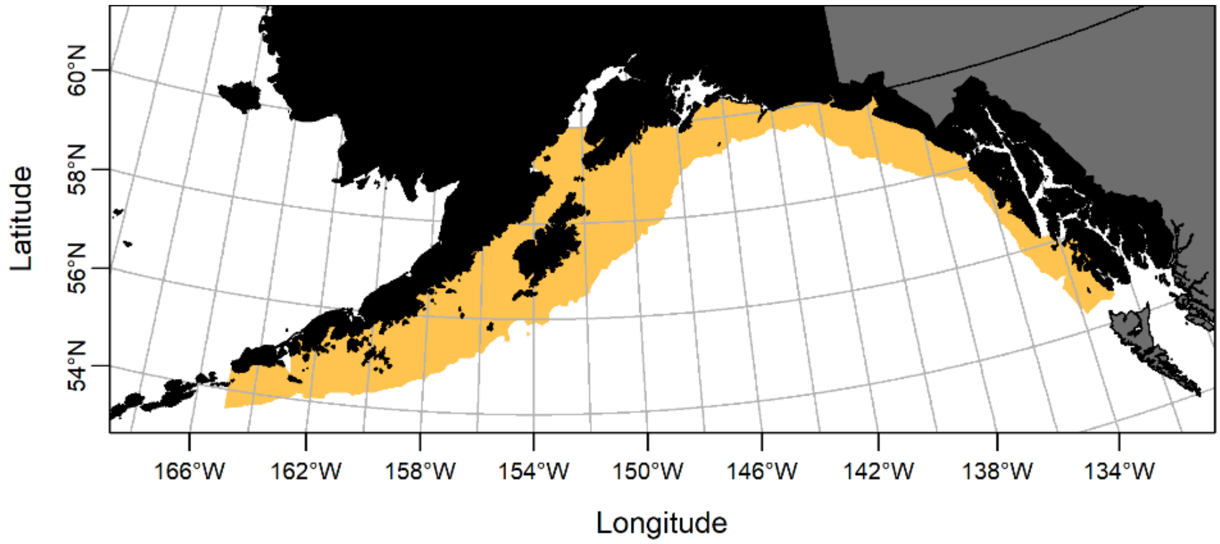

Figure 5-11 EFH area of adult Atka mackerel, winter

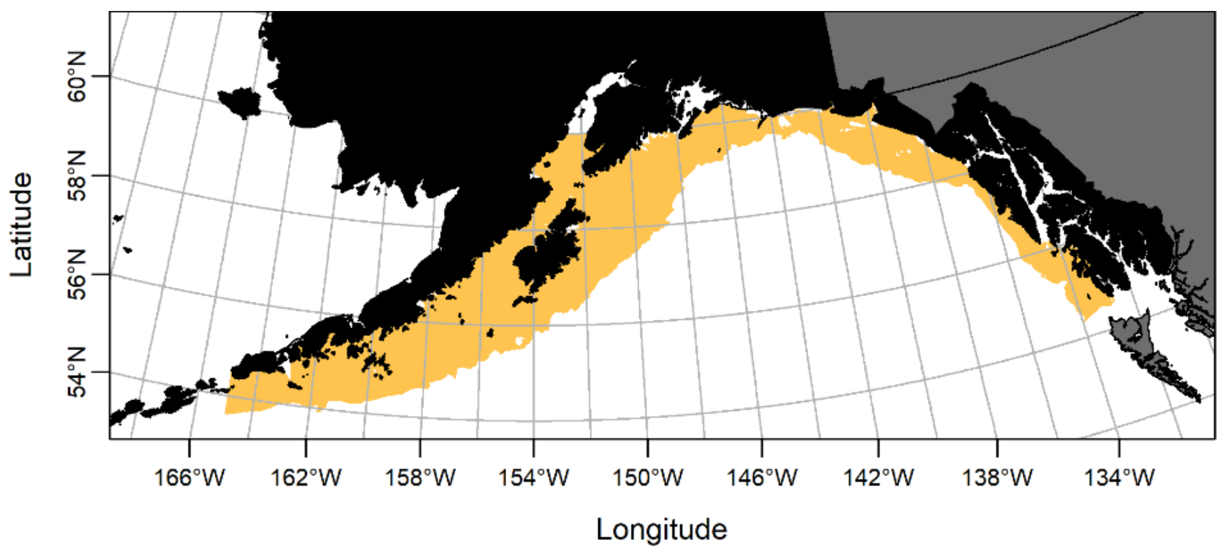

Figure 5-12 EFH area of adult Atka mackerel, spring

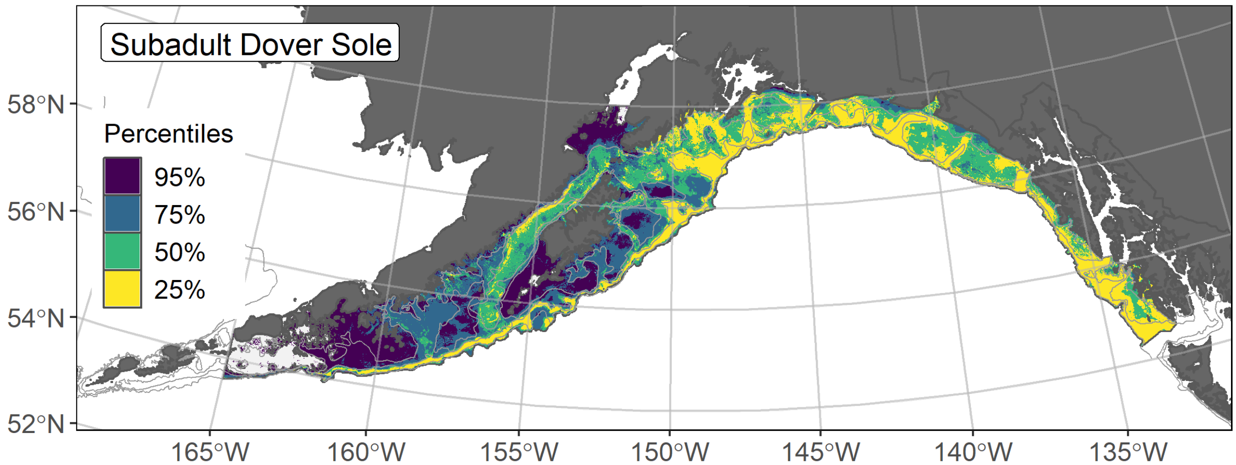

Figure 5-13 EFH area of subadult Dover sole, summer

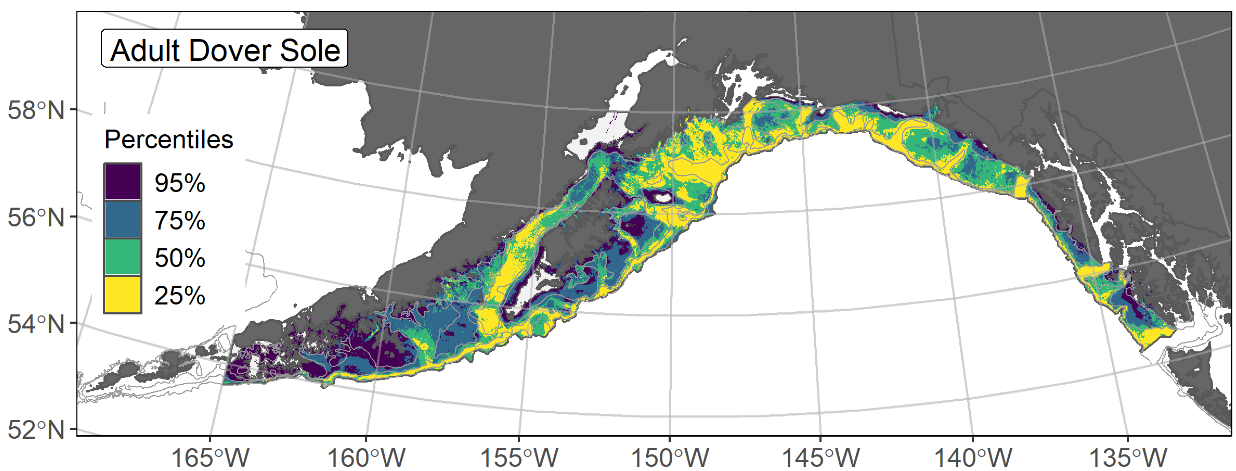

Figure 5-14 EFH area of adult Dover sole, summer

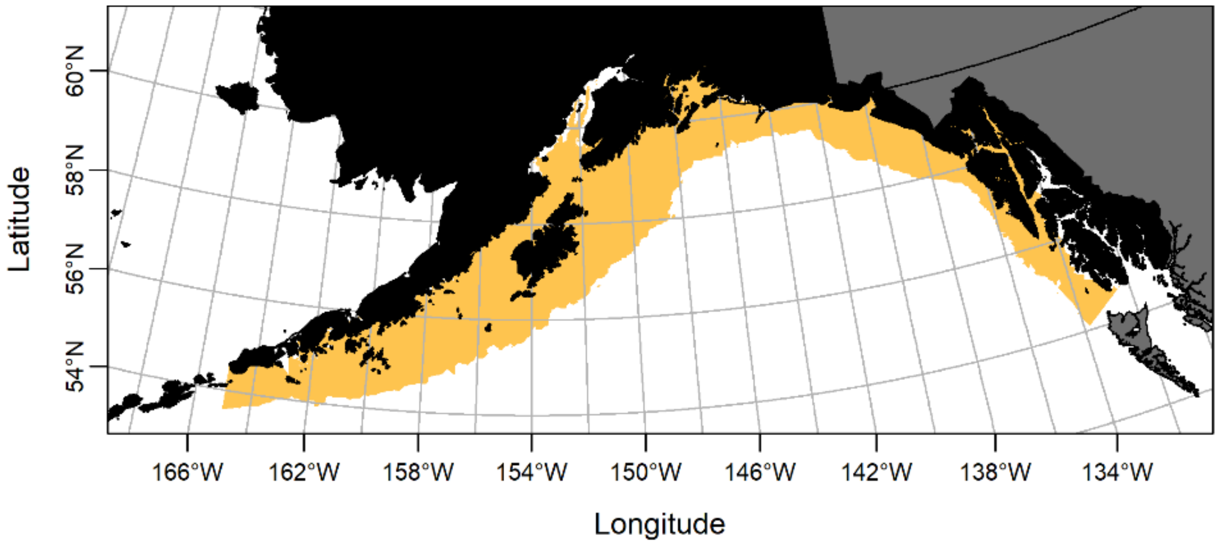

Figure 5-15 EFH area of Dover sole eggs, summer

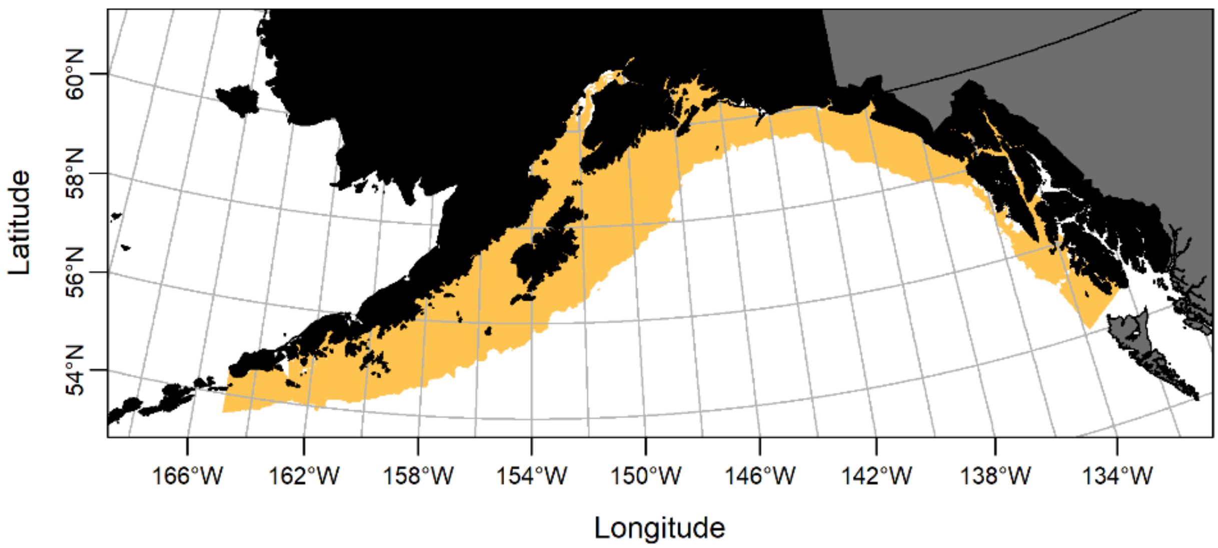

Figure 5-16 EFH area of Dover sole larvae, summer

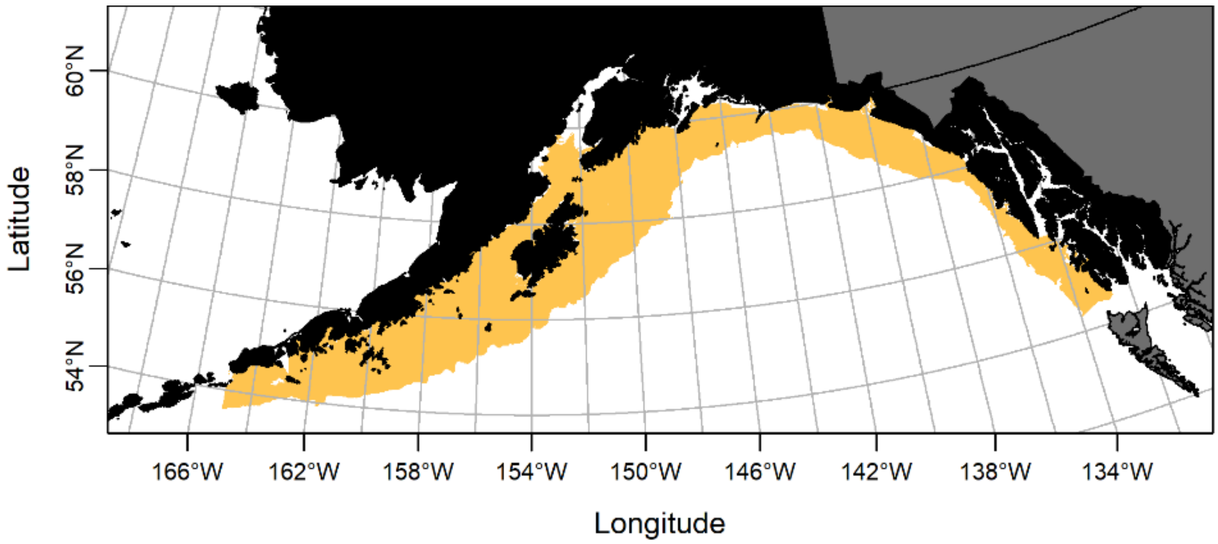

Figure 5-17 EFH area of adult Dover sole, fall

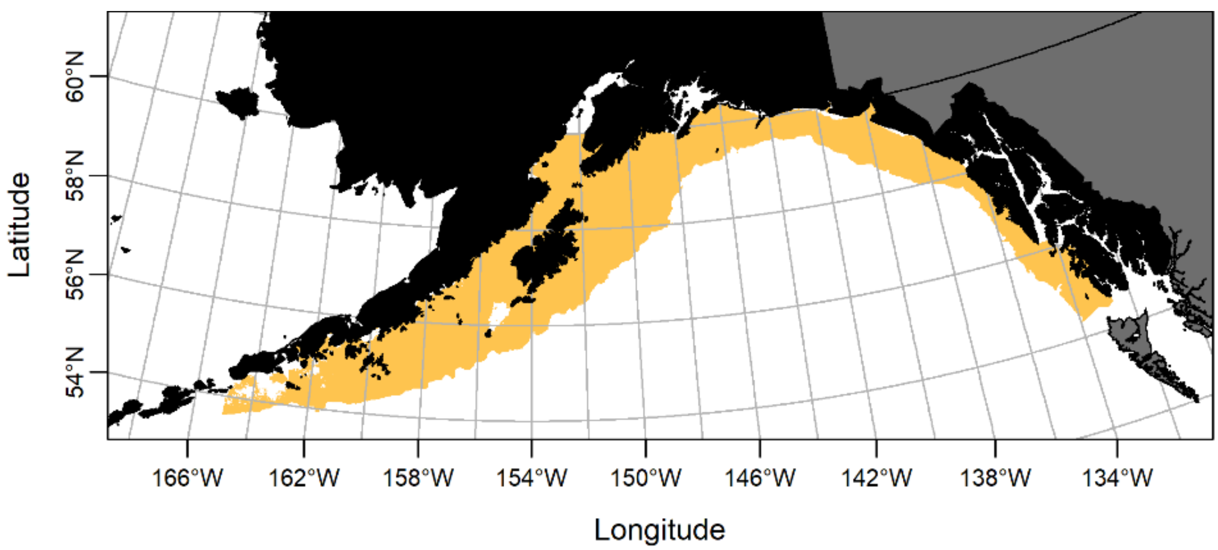

Figure 5-18 EFH area of adult Dover sole, winter

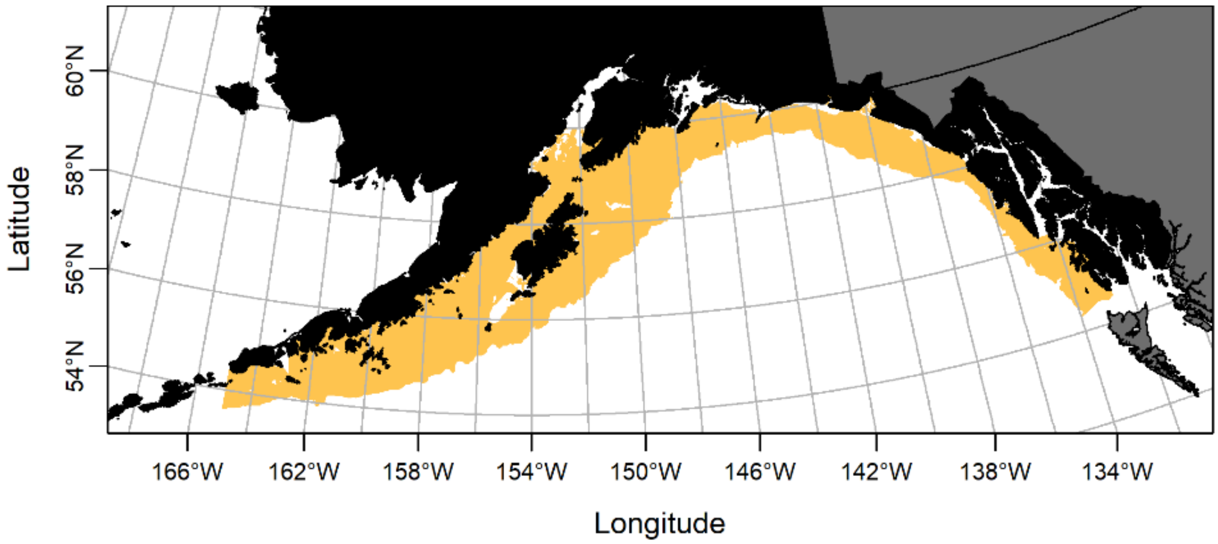

Figure 5-19 EFH area of adult Dover sole, spring

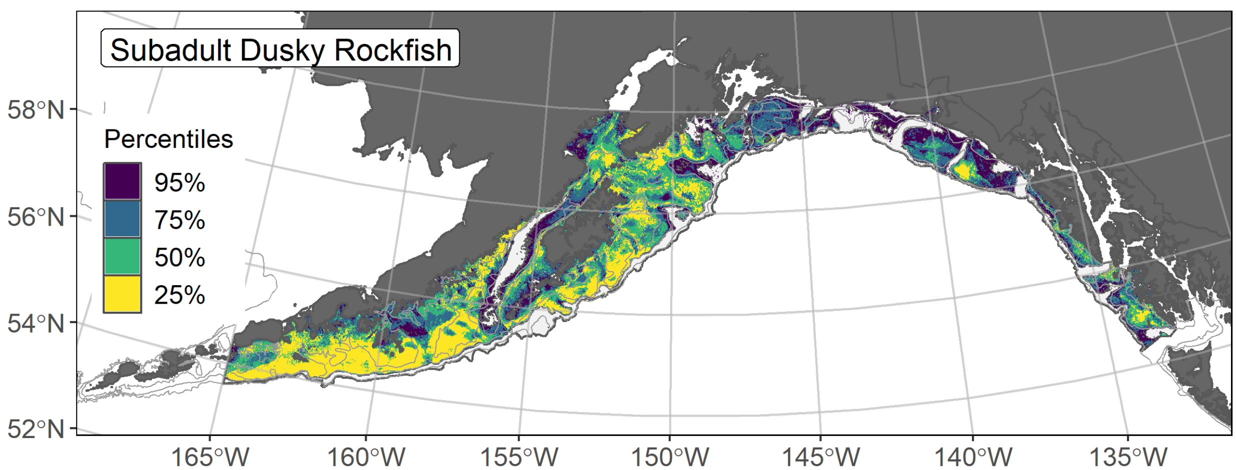

Figure 5-20 EFH area of subadult Dusky rockfish, summer

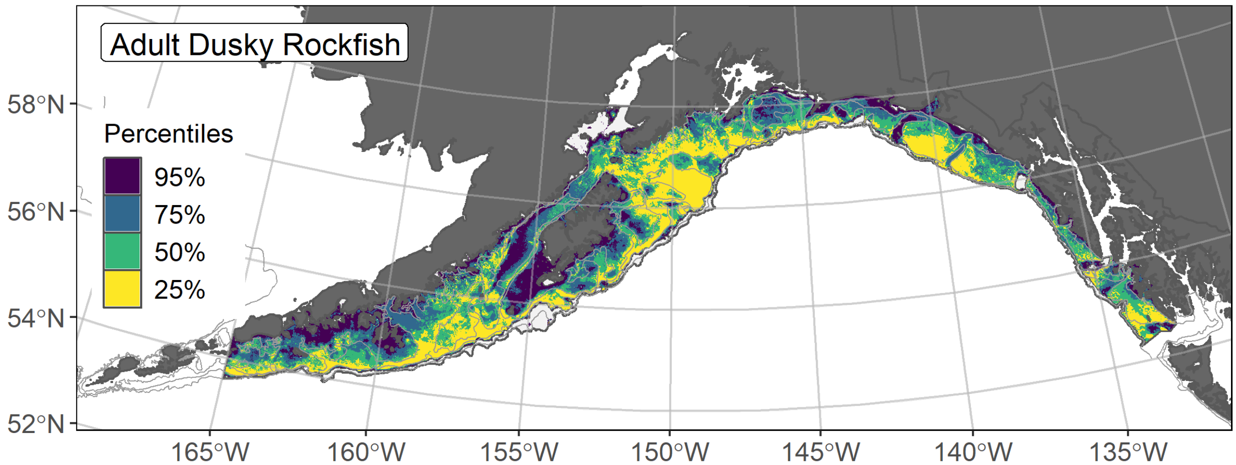

Figure 5-21 EFH area of adult Dusky rockfish, summer

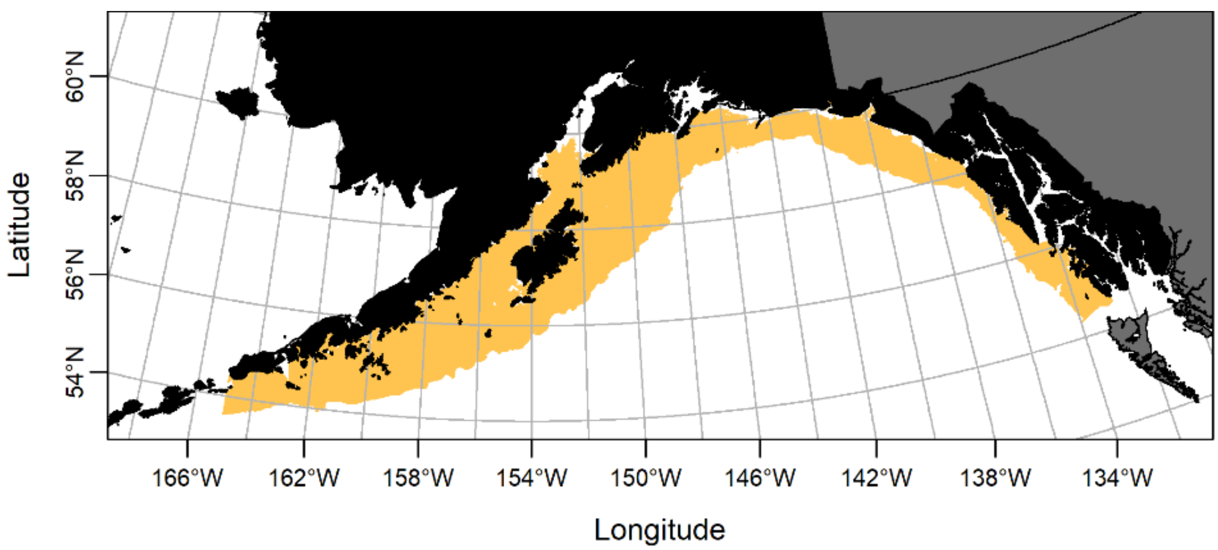

Figure 5-22 EFH area of adult Dusky rockfish, fall

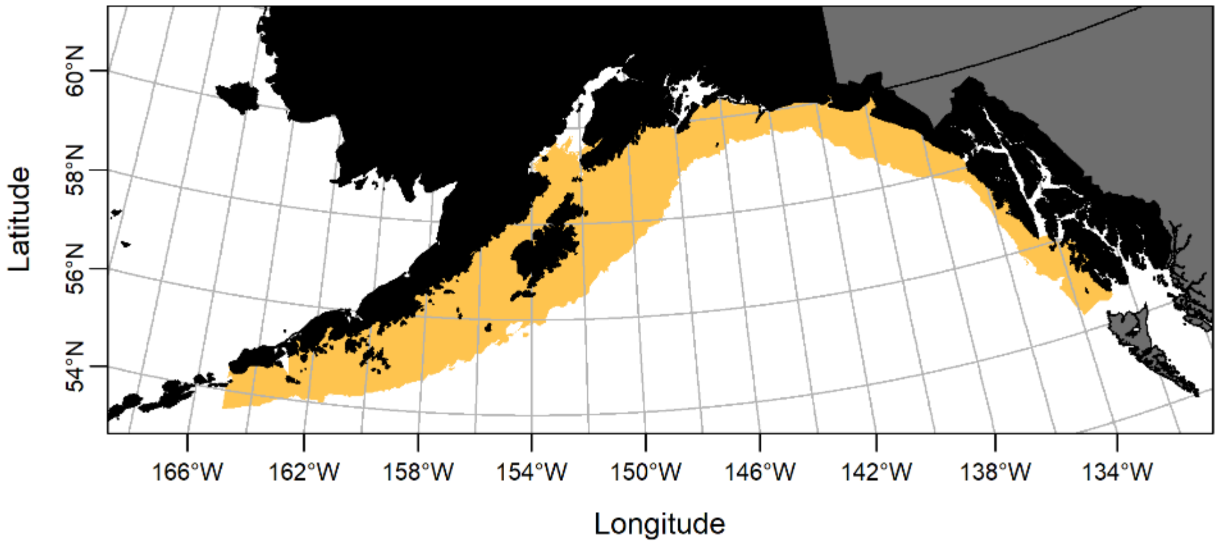

Figure 5-23 EFH area of adult Dusky rockfish, winter

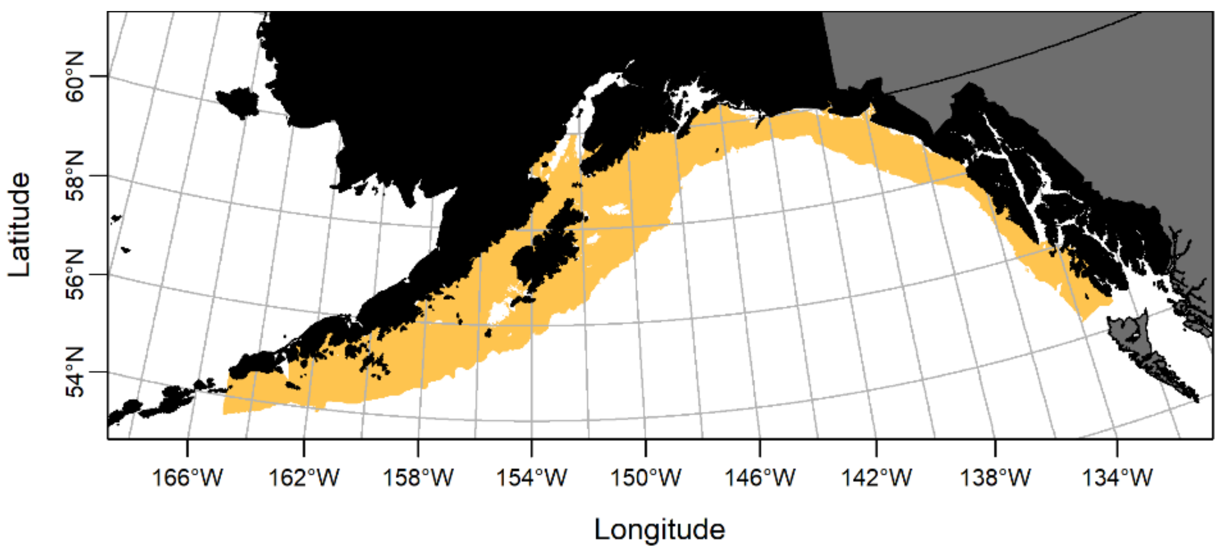

Figure 5-24 EFH area of adult Dusky rockfish, spring

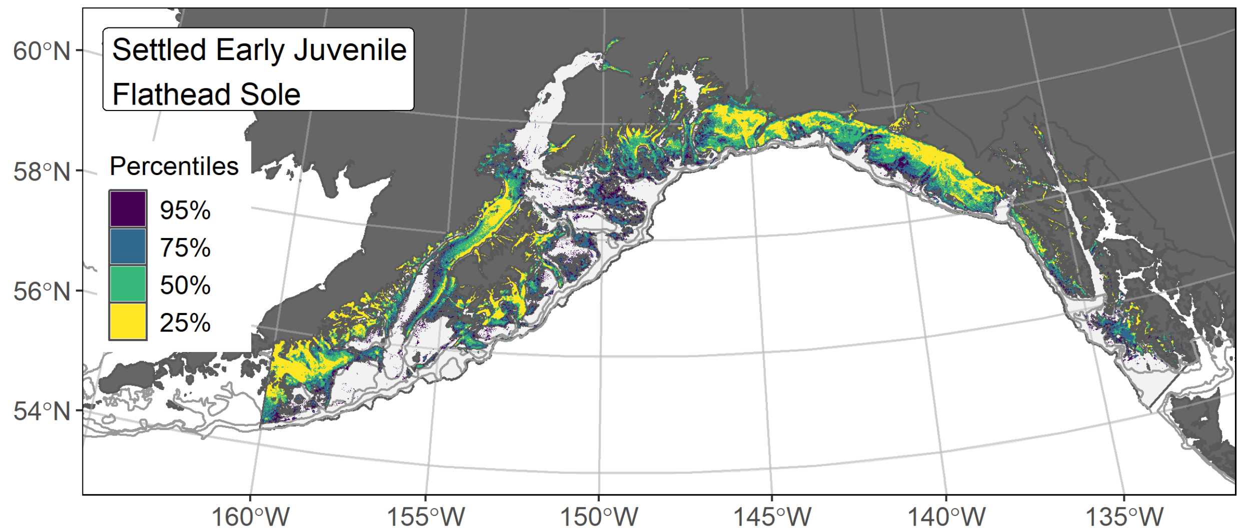

Figure 5-25 EFH area of settled early juvenile flathead sole, summer

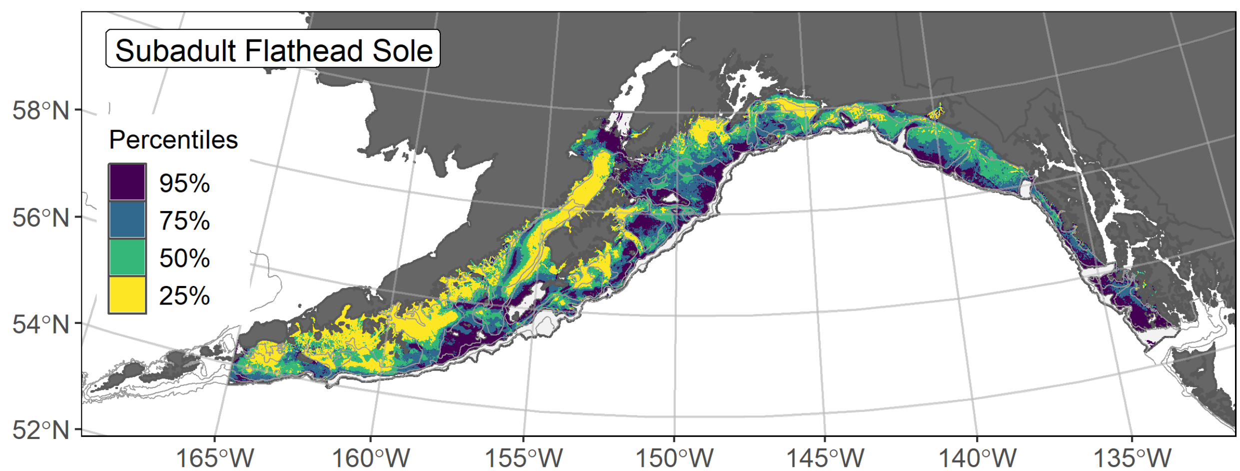

Figure 5-26 EFH area of subadult flathead sole, summer

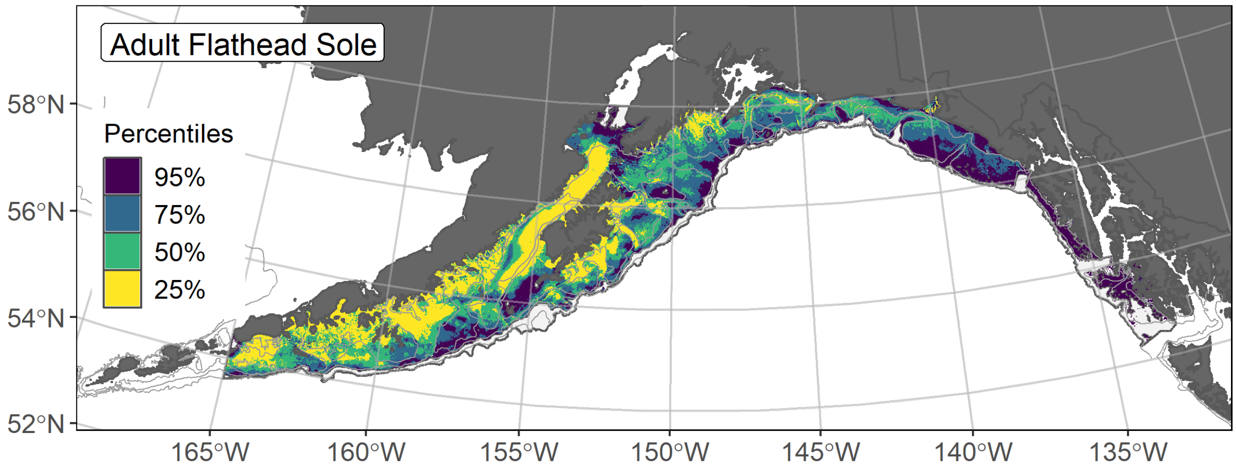

Figure 5-27 EFH area of adult flathead sole, summer

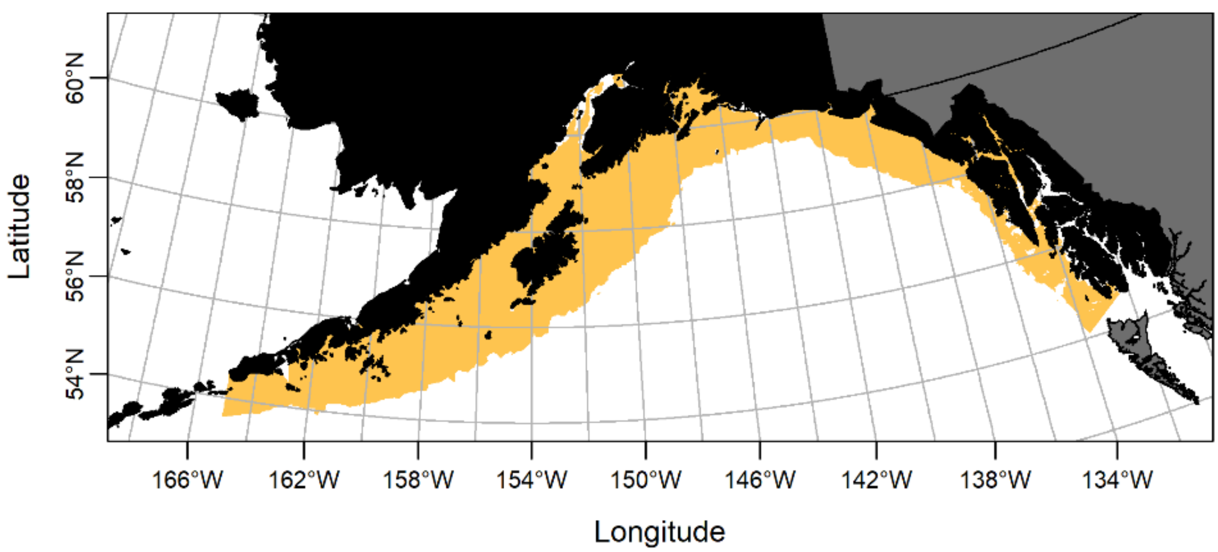

Figure 5-28 EFH area of flathead sole eggs, summer

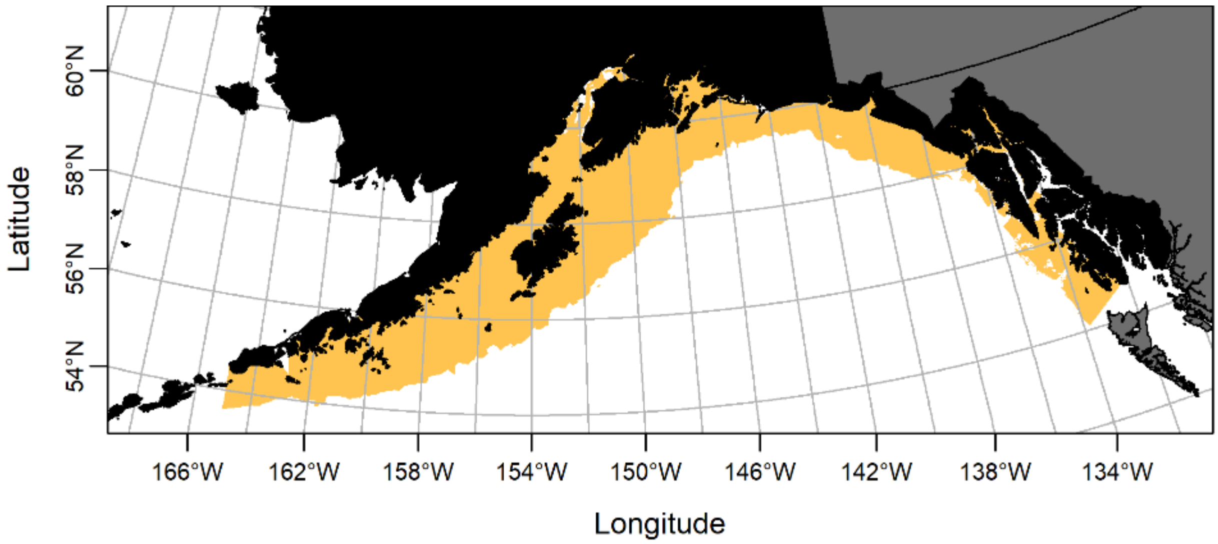

Figure 5-29 EFH area of flathead sole larvae, summer

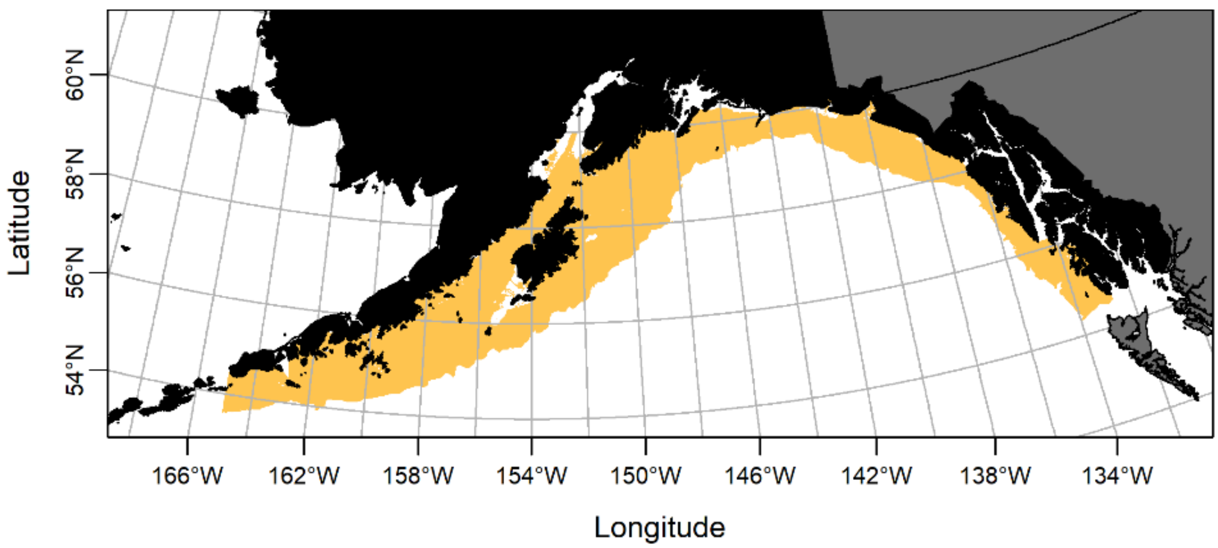

Figure 5-30 EFH area of adult flathead sole, fall

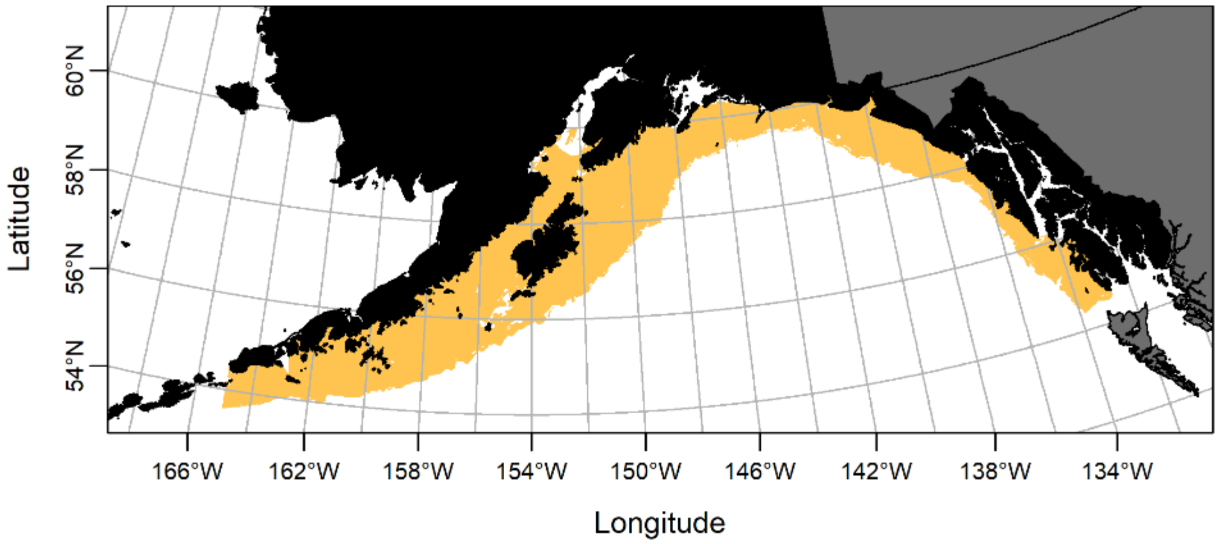

Figure 5-31 EFH area of adult flathead sole, winter

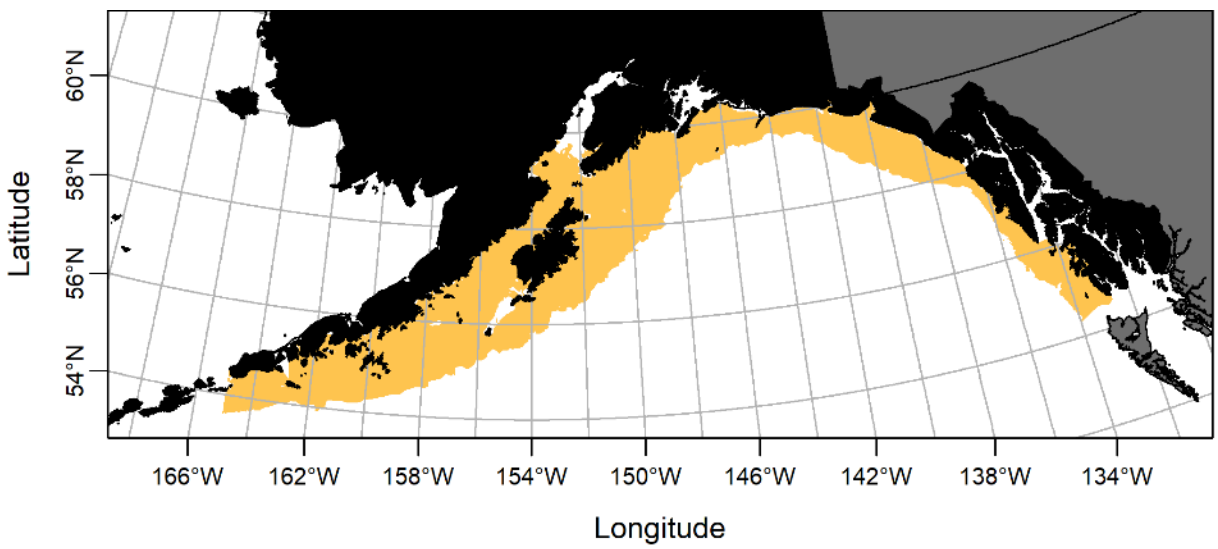

Figure 5-32 EFH area of adult flathead sole, spring

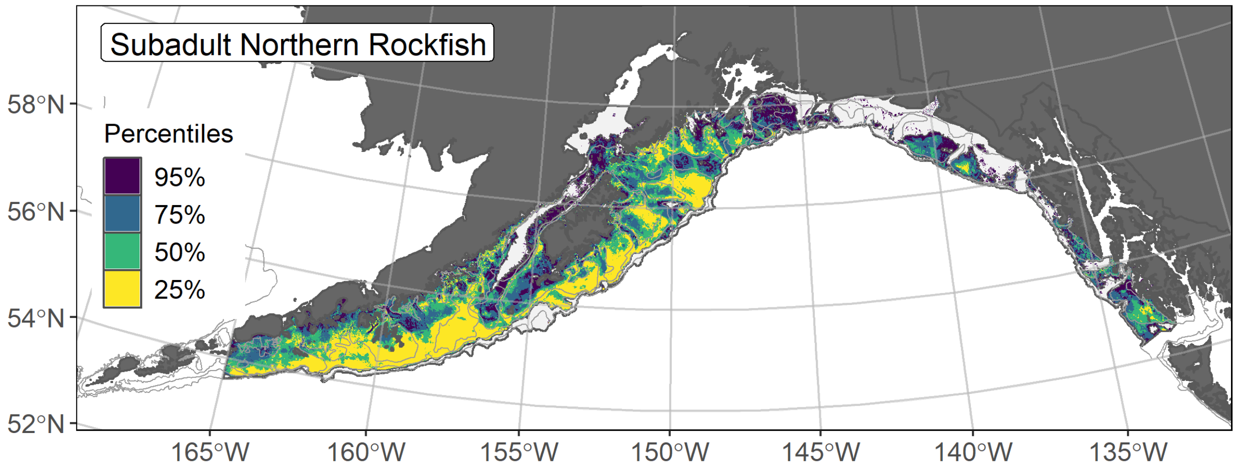

Figure 5-33 EFH area of subadult northern rockfish, summer

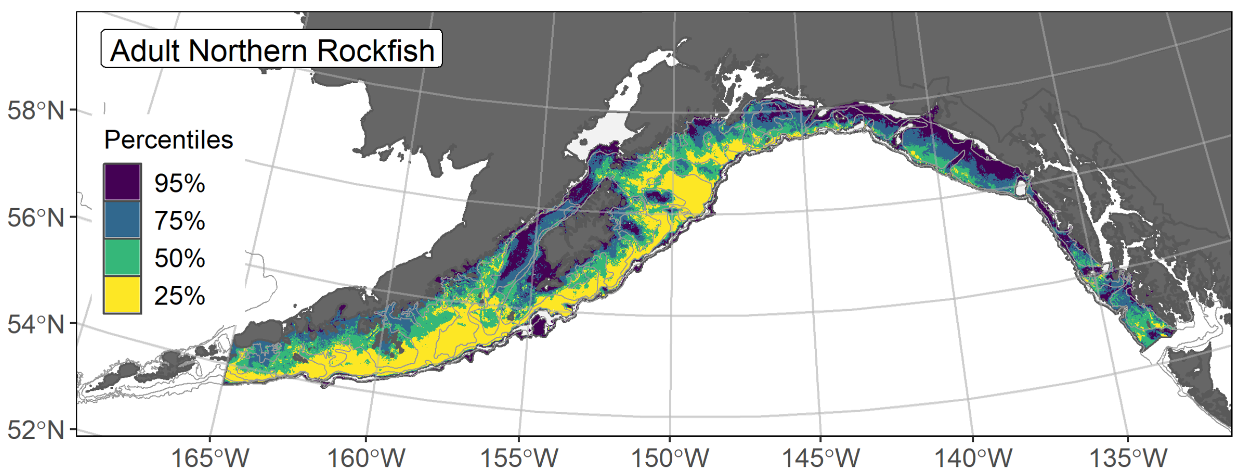

Figure 5-34 EFH area of adult northern rockfish, summer

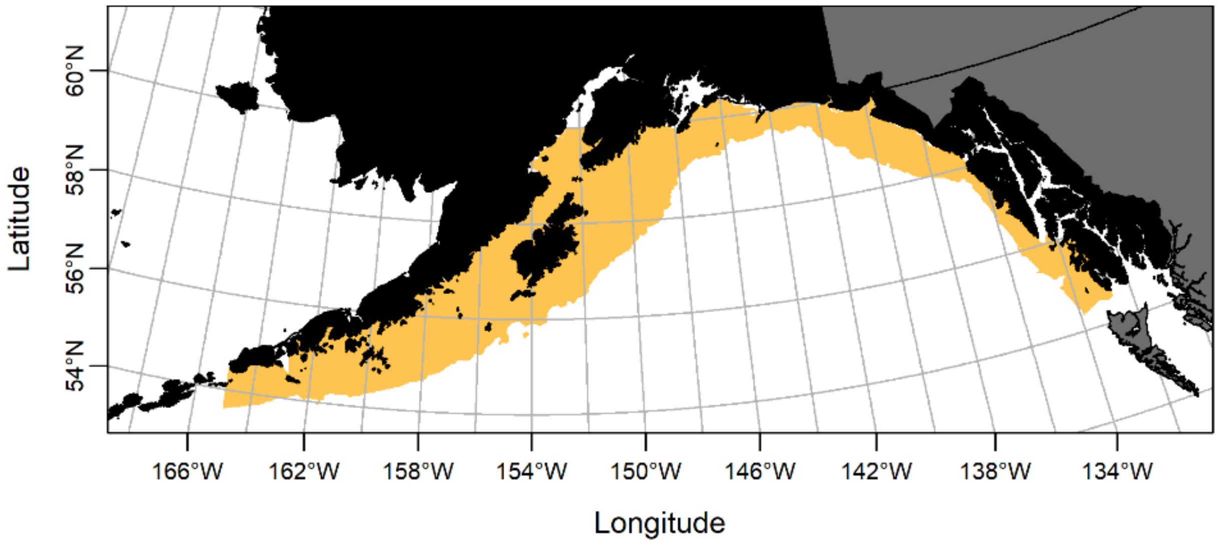

Figure 5-35 EFH area of adult northern rockfish, fall

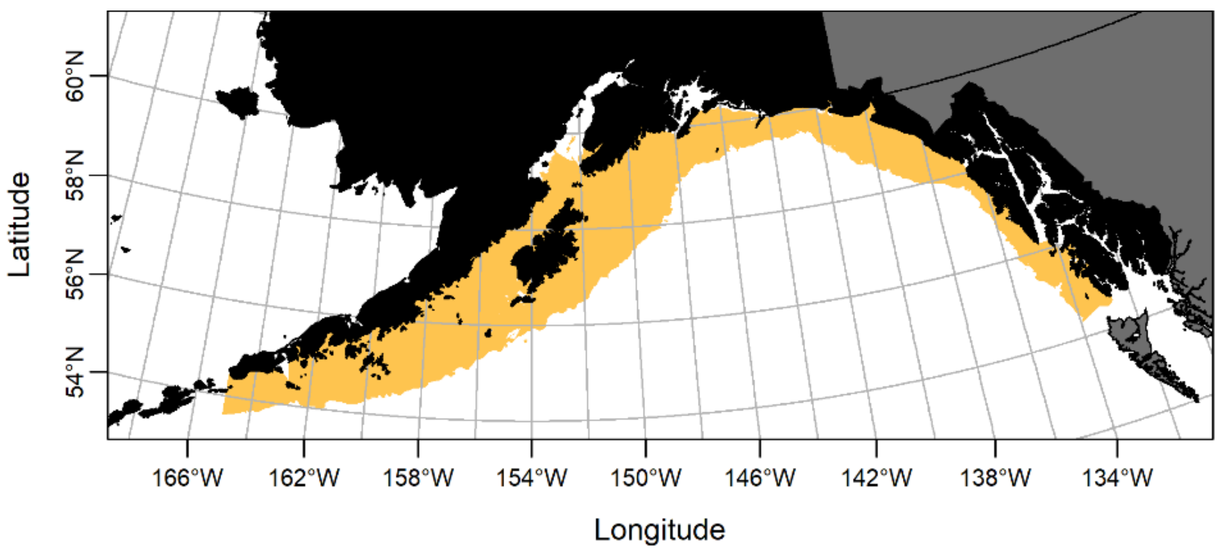

Figure 5-36 EFH area of adult northern rockfish, winter

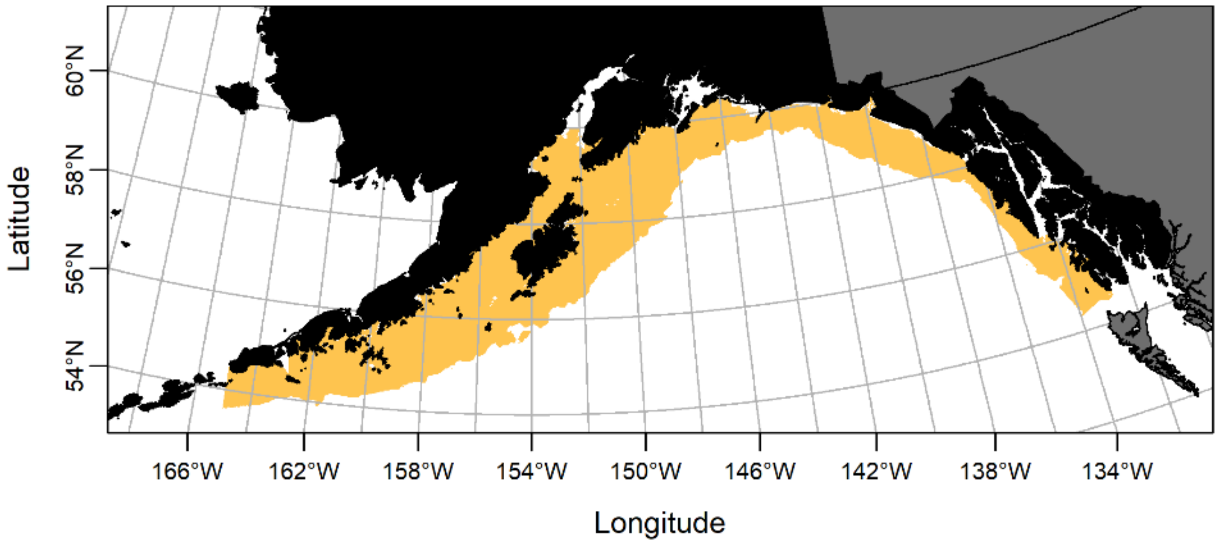

Figure 5-37 EFH area of adult northern rockfish, spring

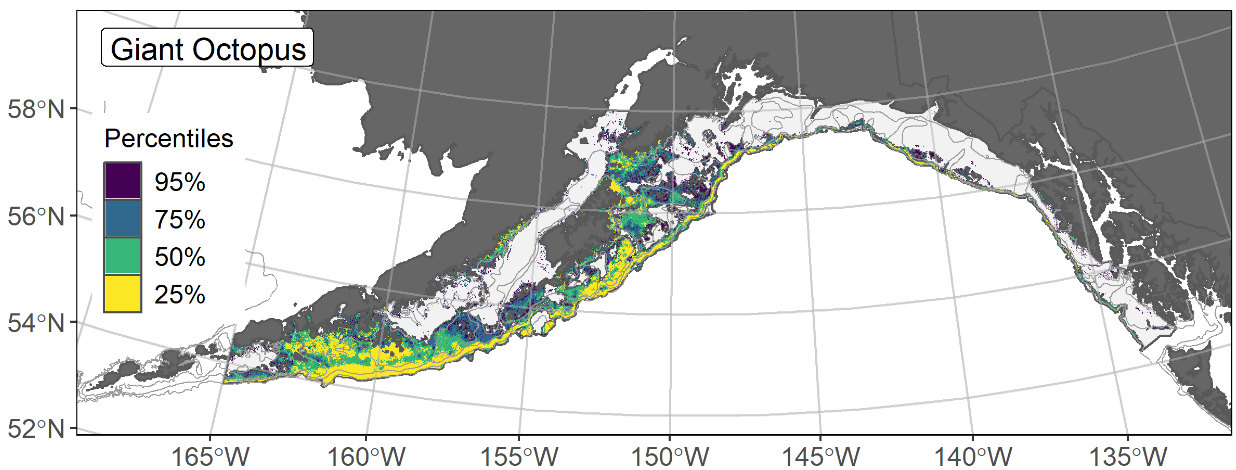

Figure 5-38 EFH area of subadult/adult giant octopus, summer

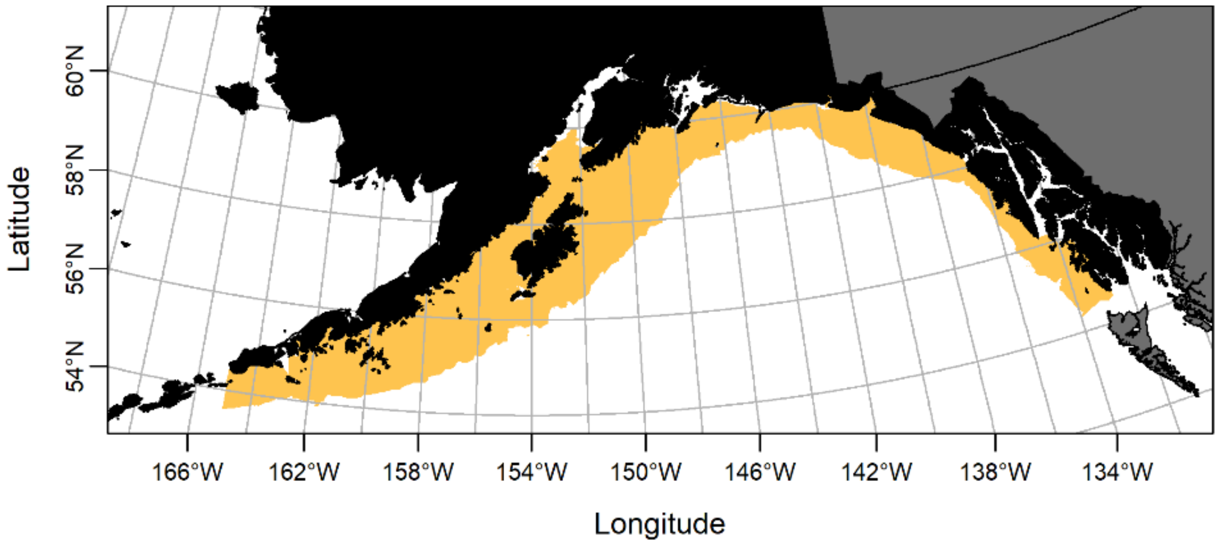

Figure 5-39 EFH area of adult octopus, fall

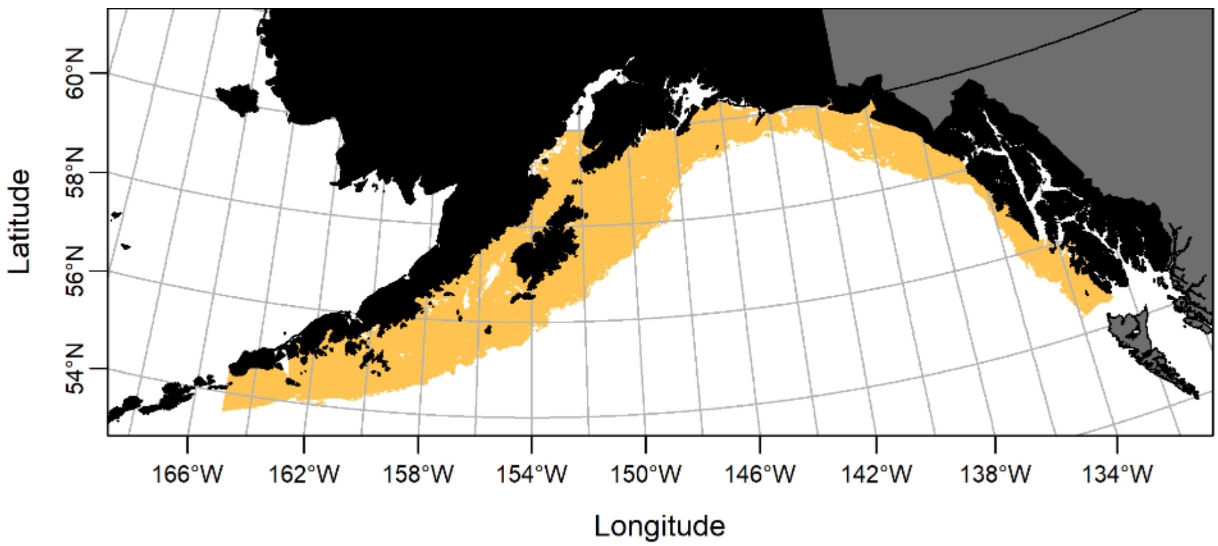

Figure 5-40 EFH area of adult octopus, winter

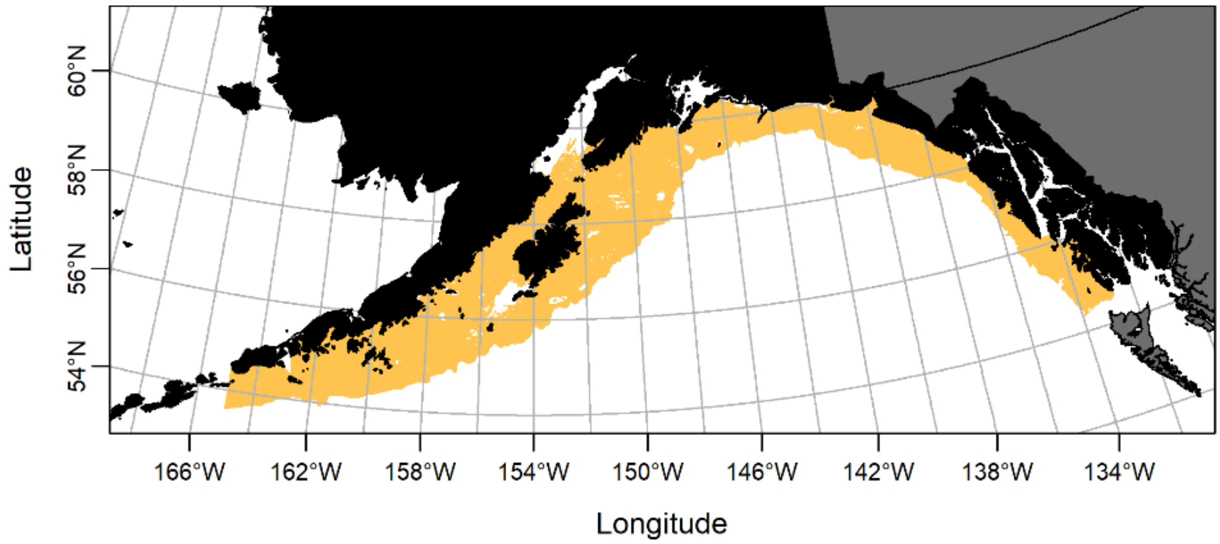

Figure 5-41 EFH area of adult octopus, spring

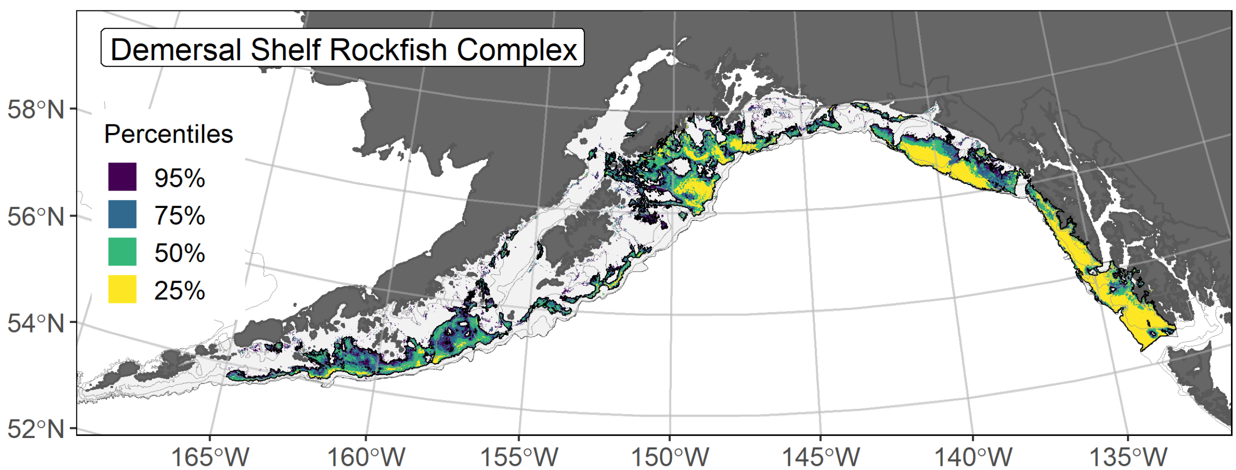

Figure 5-42 EFH area of subadult/adult other rockfish complex, demersal subgroup, summer

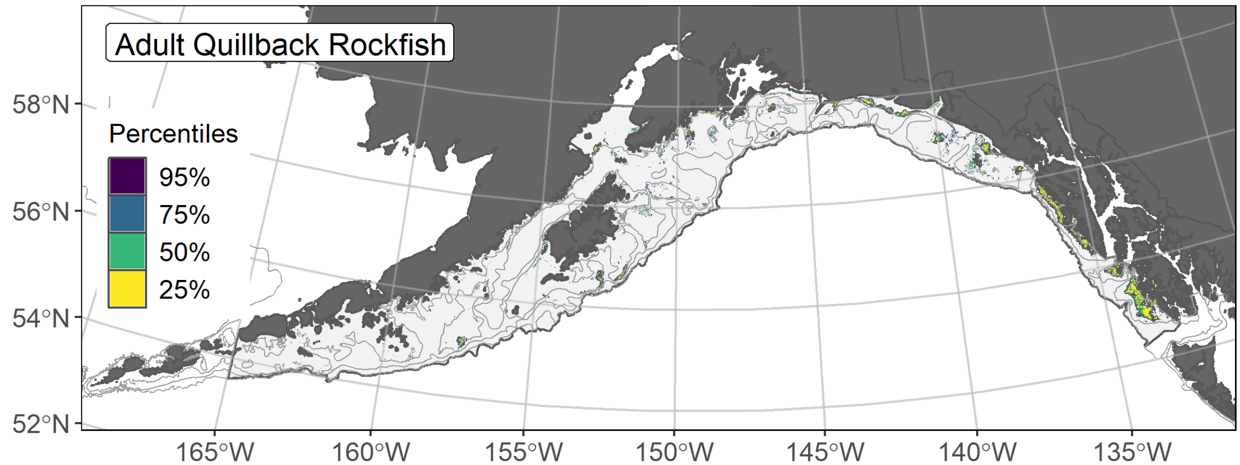

Figure 5-43 EFH area of adult quillback rockfish, summer

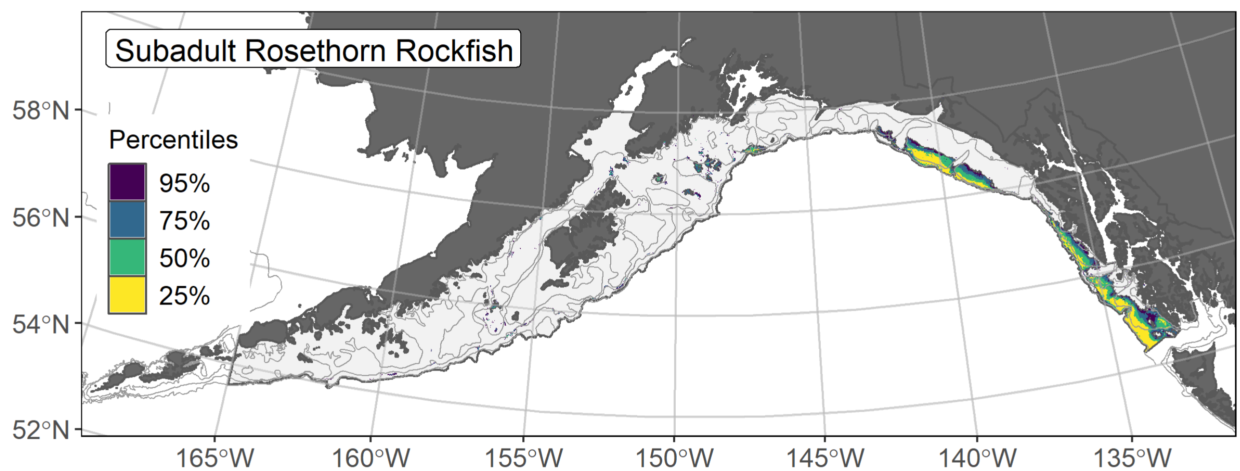

Figure 5-44 EFH area of subadult rosethorn rockfish, summer

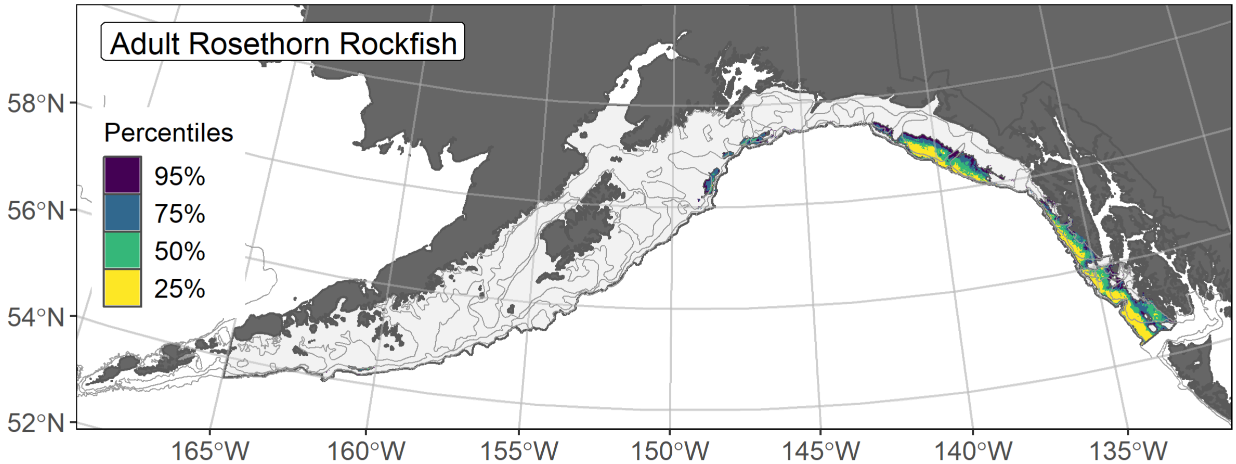

Figure 5-45 EFH area of adult rosethorn rockfish, summer

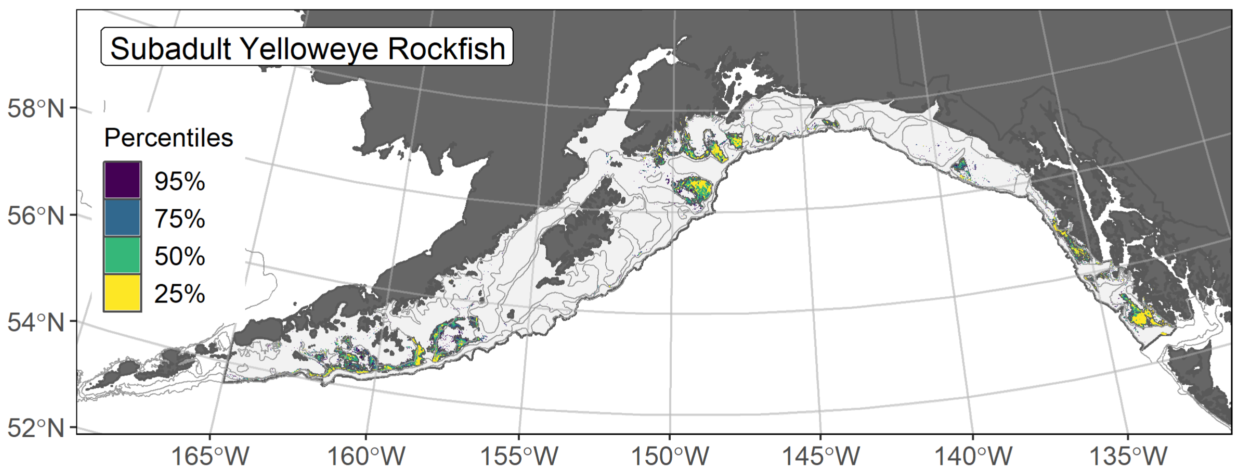

Figure 5-46 EFH area of subadult yelloweye rockfish, summer

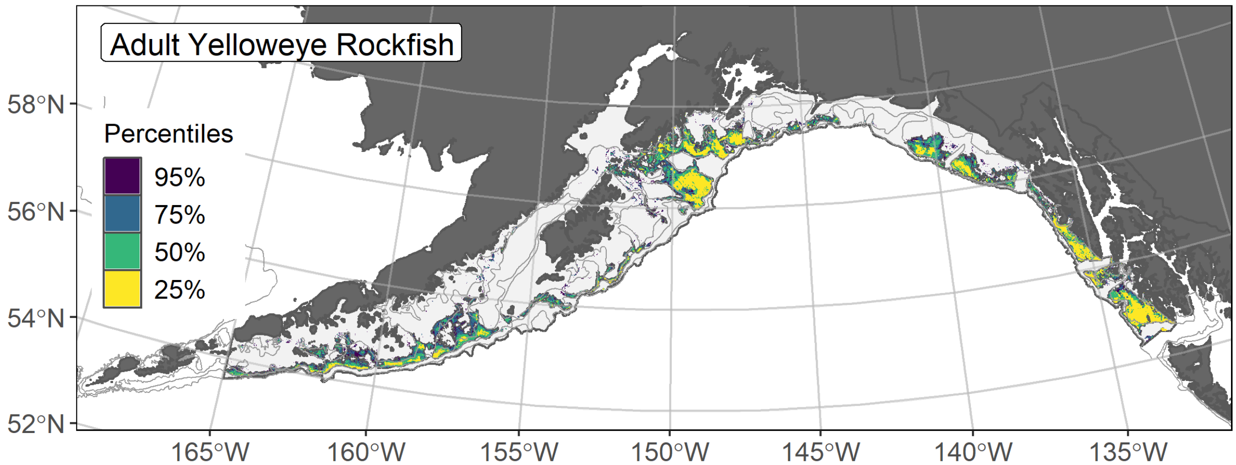

Figure 5-47 EFH area of adult yelloweye rockfish, summer

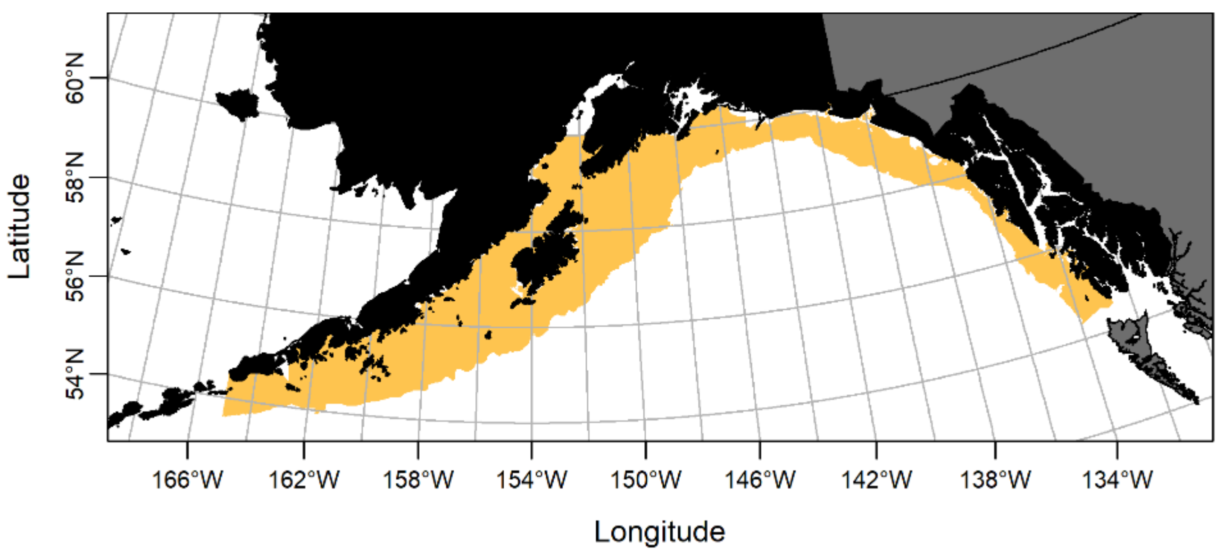

Figure 5-48 EFH area of adult yelloweye rockfish, fall

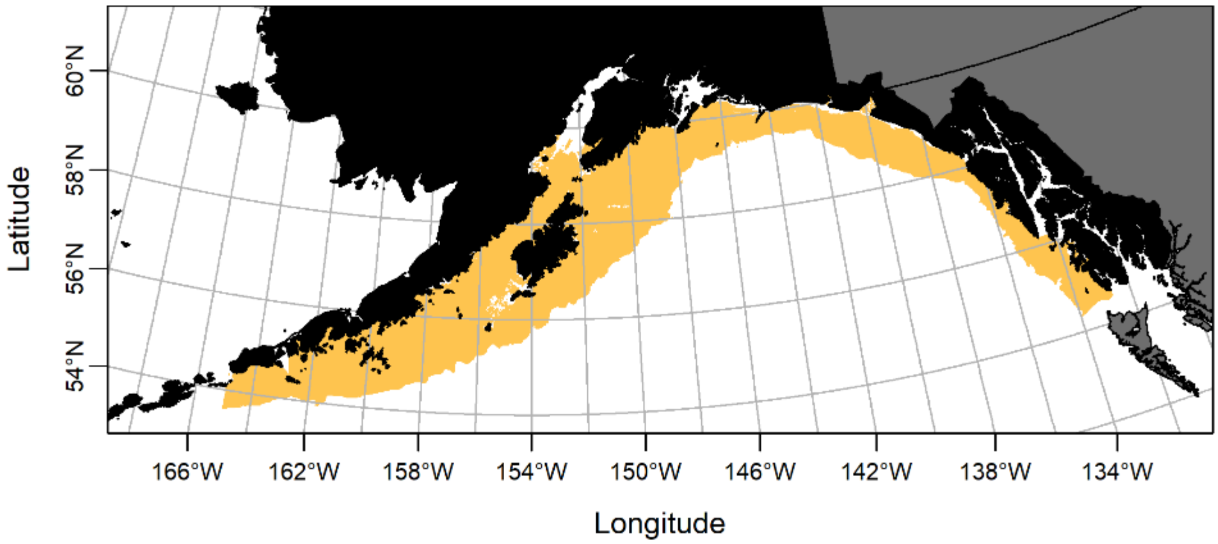

Figure 5-49 EFH area of adult yelloweye rockfish, spring

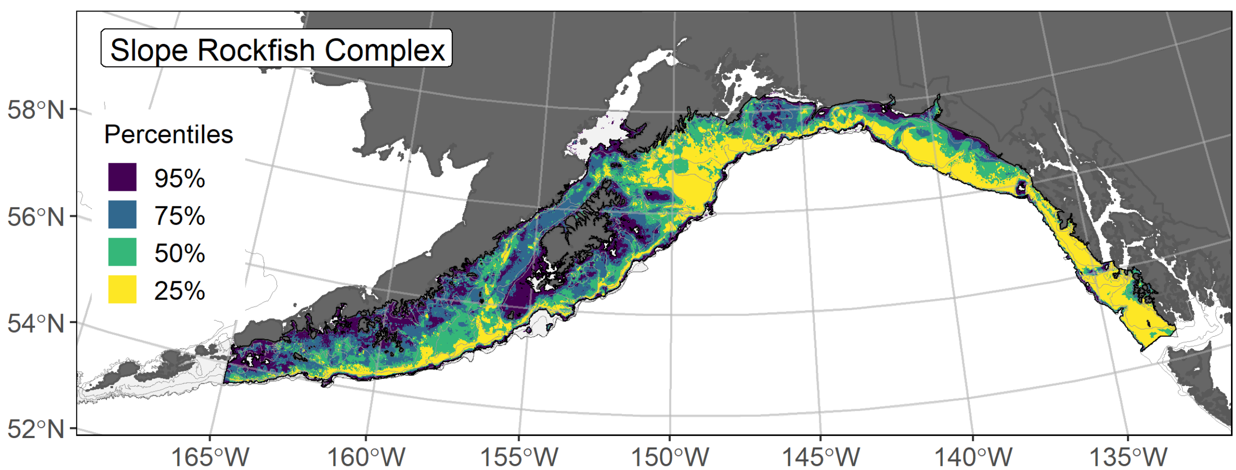

Figure 5-50 EFH area of subadult/adult other rockfish complex, slope subgroup, summer

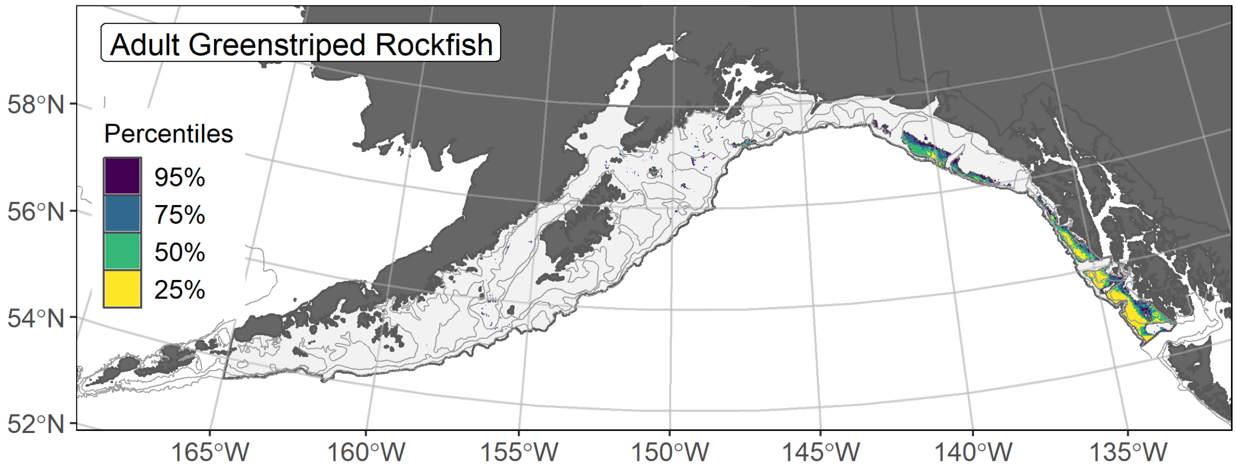

Figure 5-51 EFH area of adult greenstriped rockfish, summer

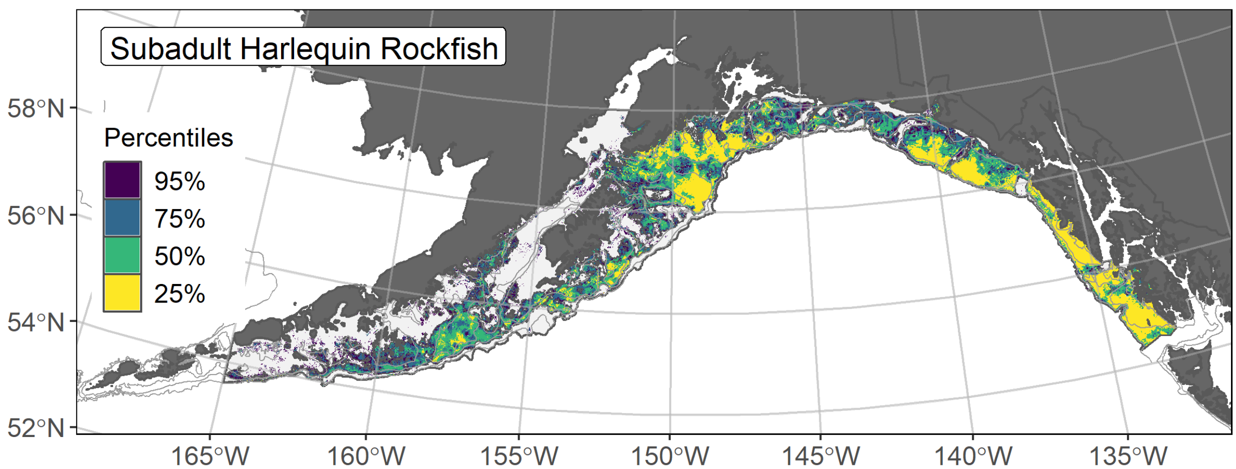

Figure 5-52 EFH area of subadult harlequin rockfish, summer

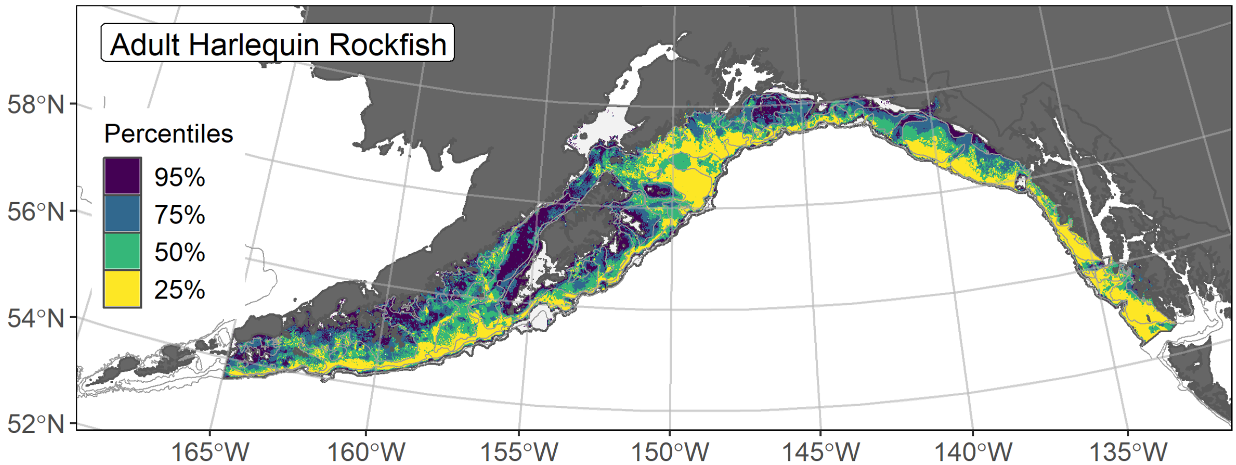

Figure 5-53 EFH area of adult harlequin rockfish, summer

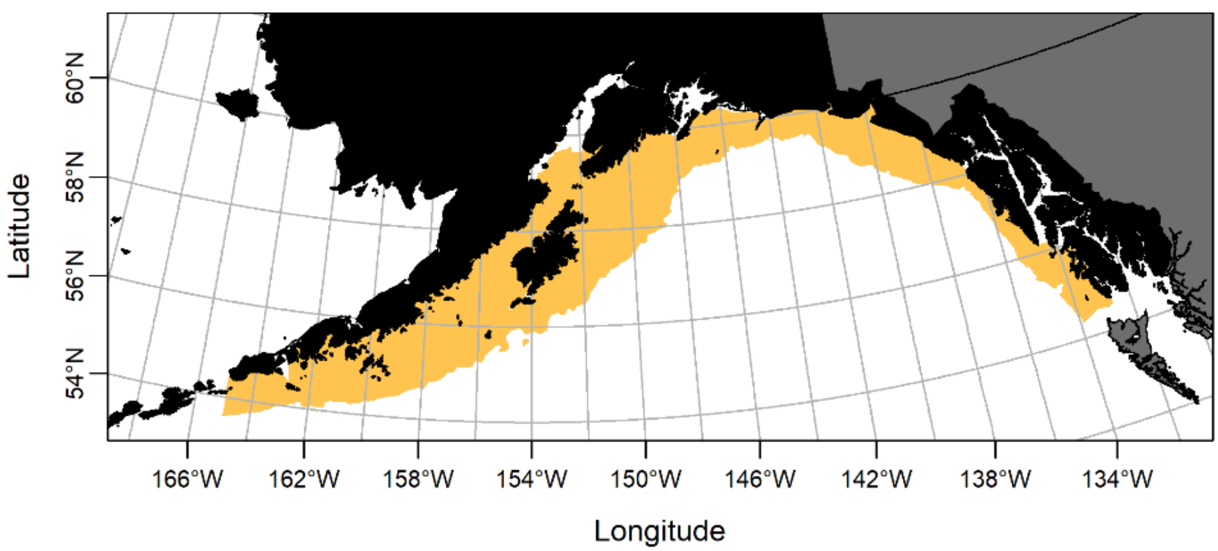

Figure 5-54 EFH area of adult harlequin rockfish, spring

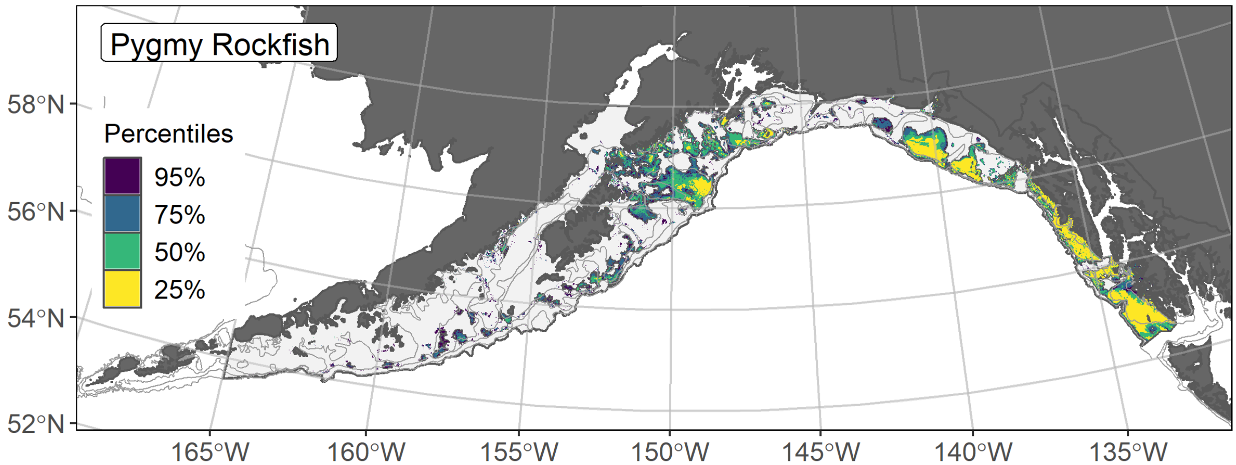

Figure 5-55 EFH area of subadult/adult pygmy rockfish, summer

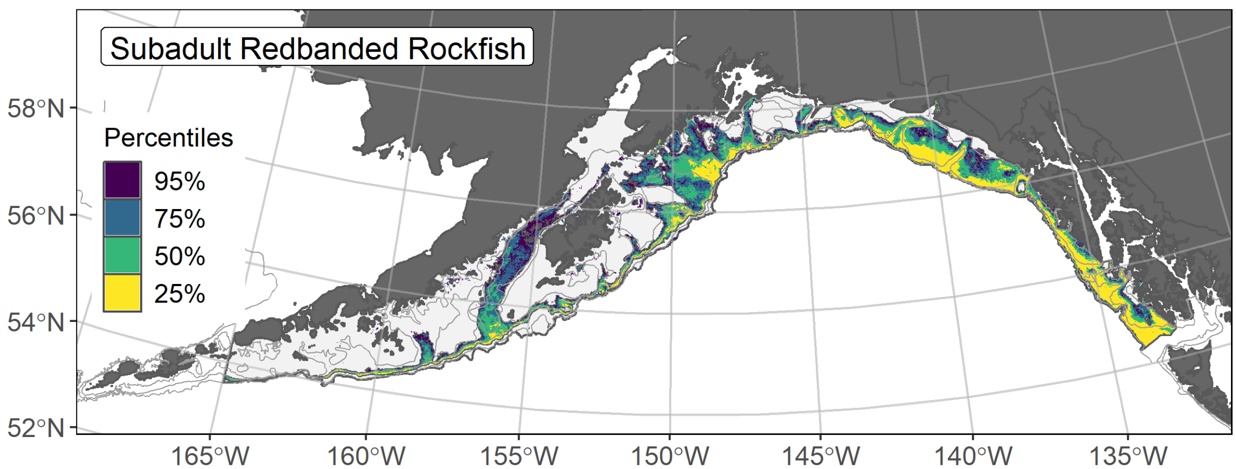

Figure 5-56 EFH area of subadult redbanded rockfish, summer

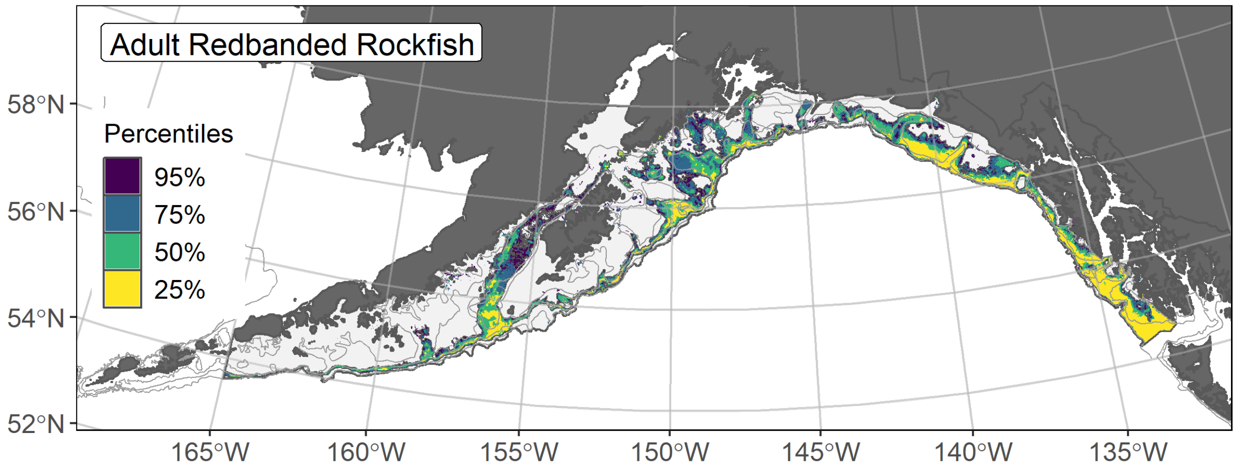

Figure 5-57 EFH area of adult redbanded rockfish, summer

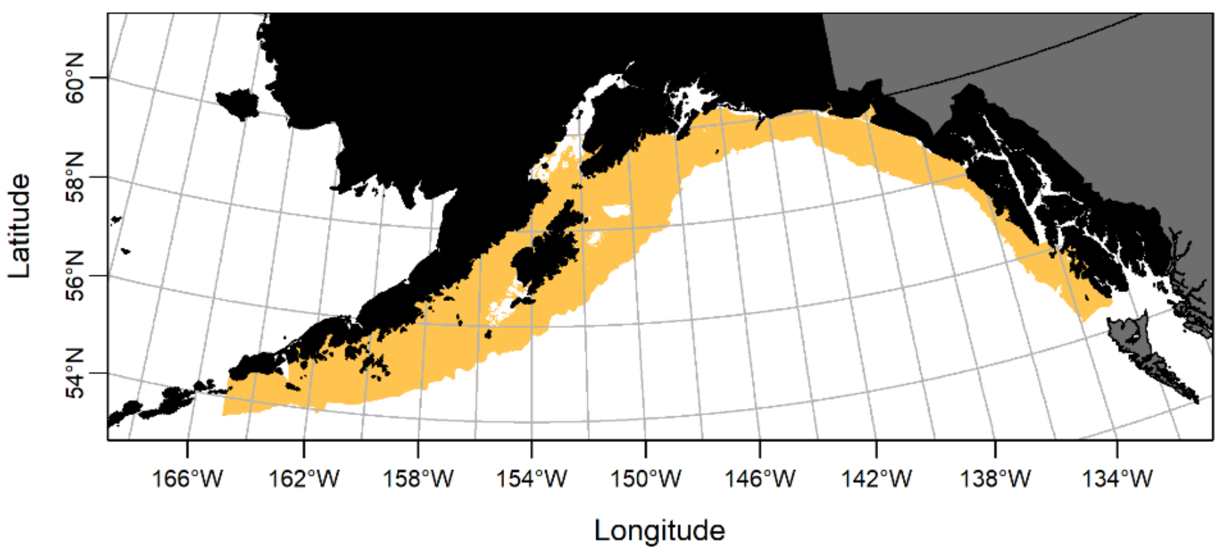

Figure 5-58 EFH area of adult redbanded rockfish, spring

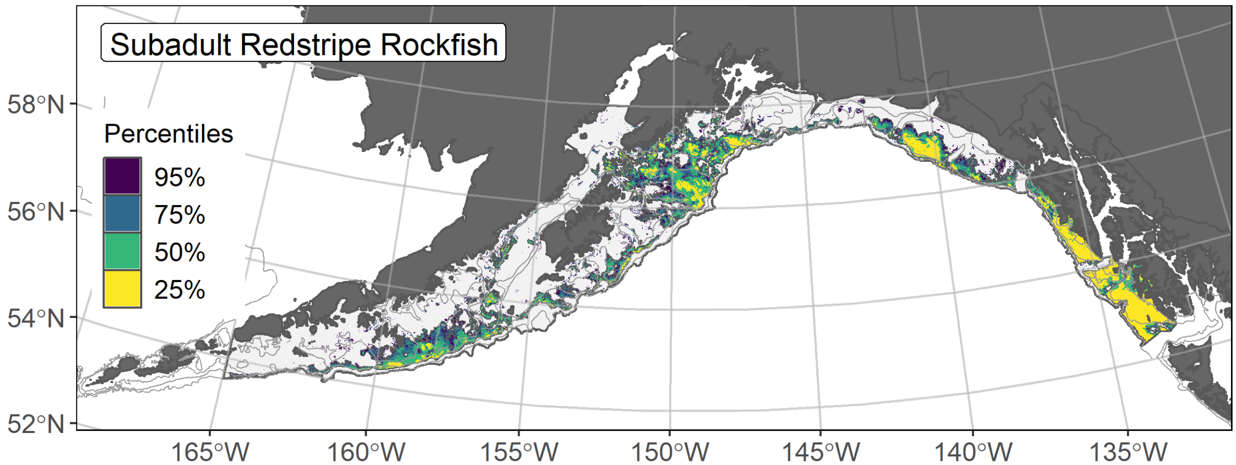

Figure 5-59 EFH area of subadult redtripe rockfish, summer

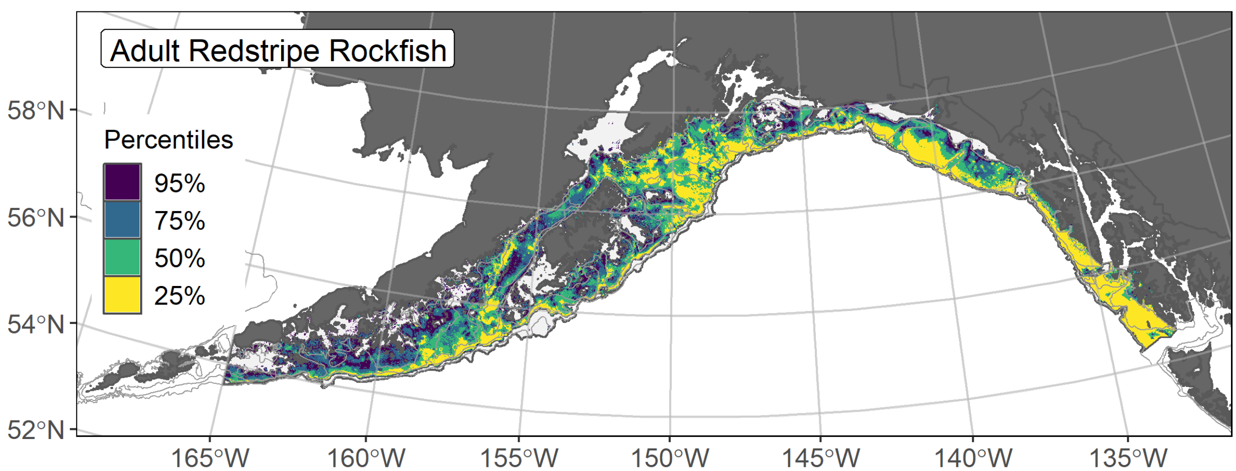

Figure 5-60 EFH area of adult redtripe rockfish, summer

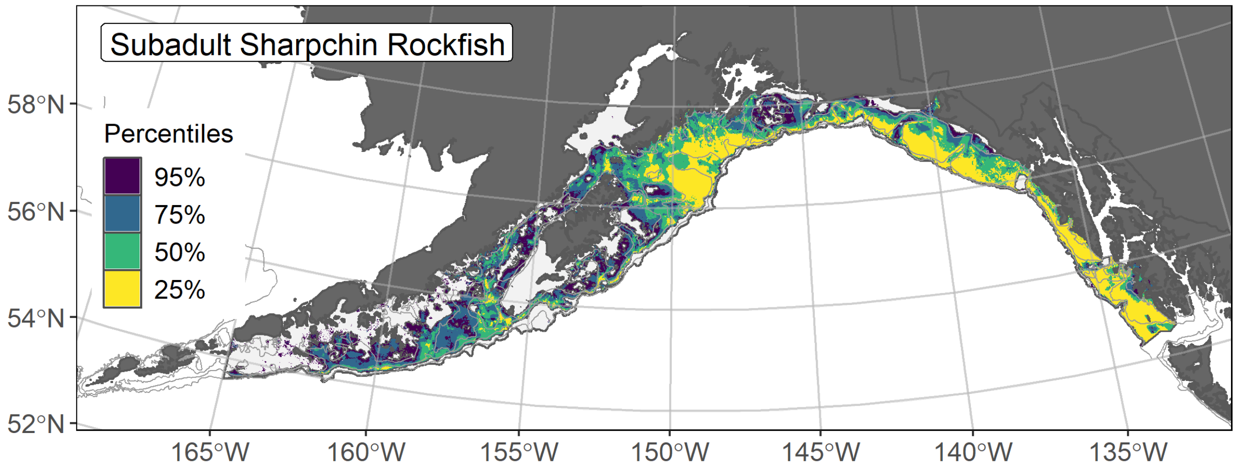

Figure 5-61 EFH area of subadult sharpchin rockfish, summer

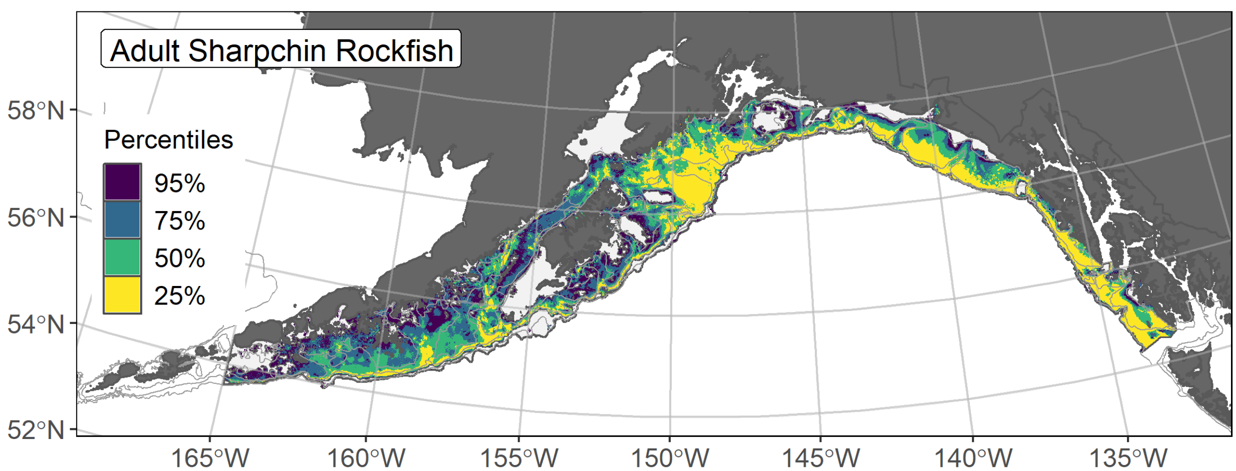

Figure 5-62 EFH area of adult sharpchin rockfish, summer

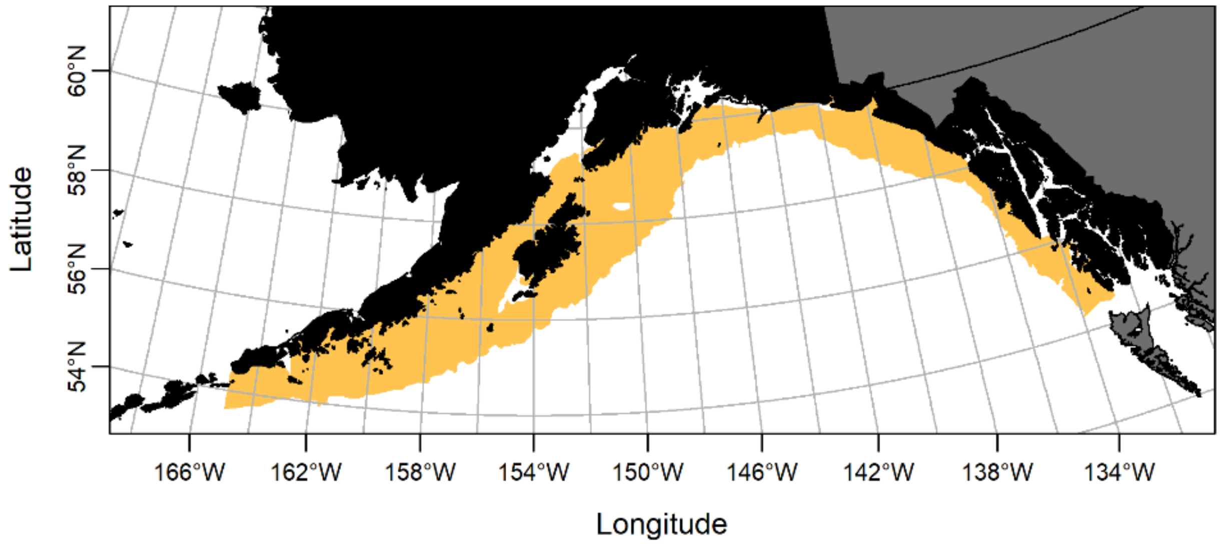

Figure 5-63 EFH area of adult sharpchin rockfish, spring

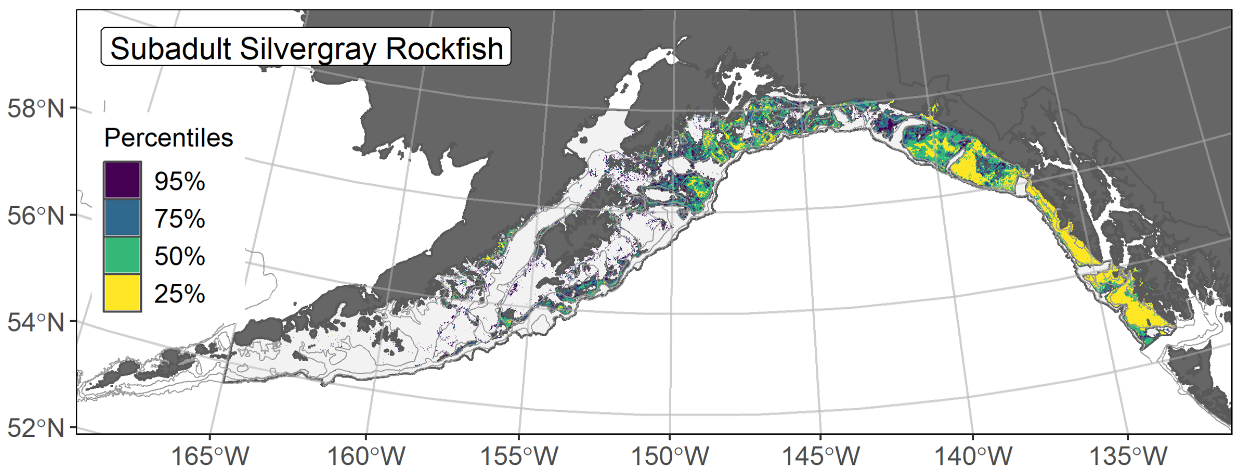

Figure 5-64 EFH area of subadult silvergray rockfish, summer

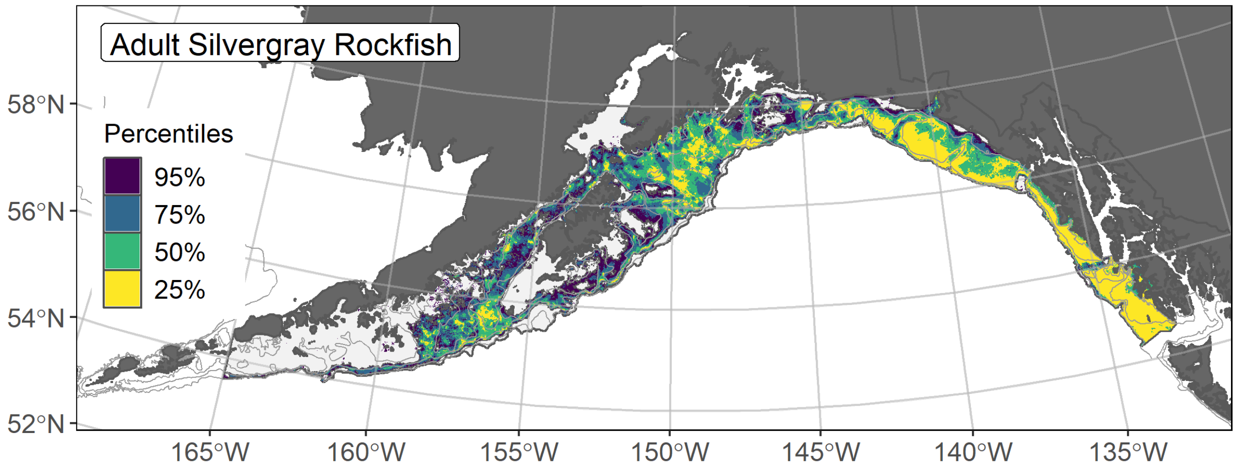

Figure 5-65 EFH area of adult silvergray rockfish, summer

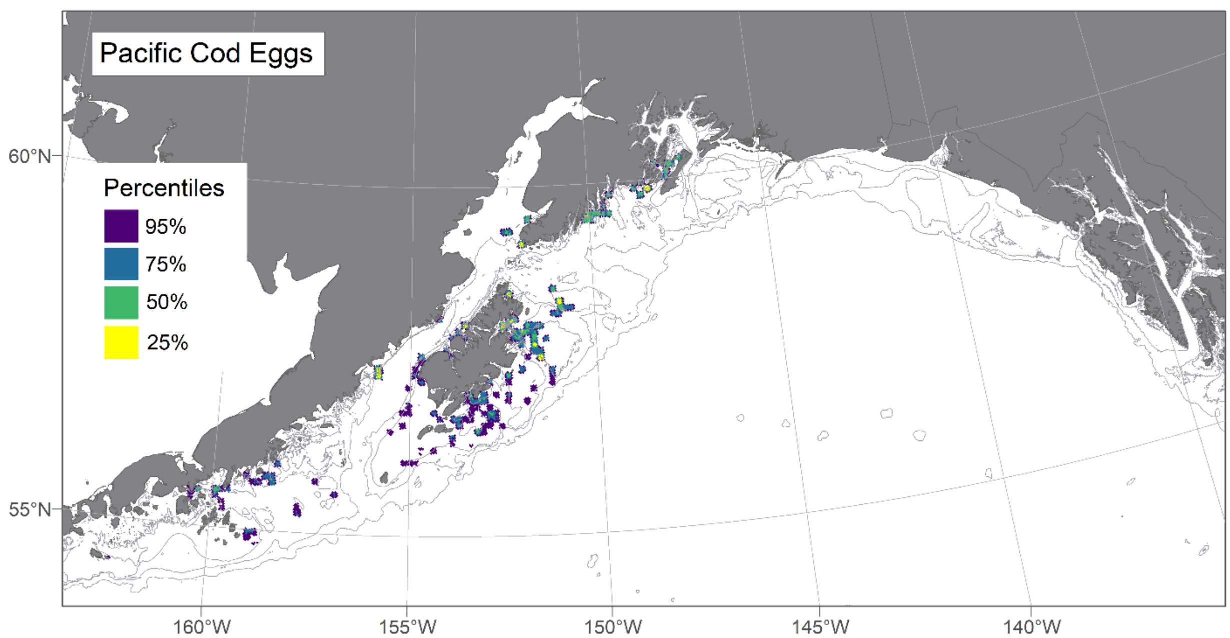

Figure 5-66 EFH area of Pacific cod eggs, summer

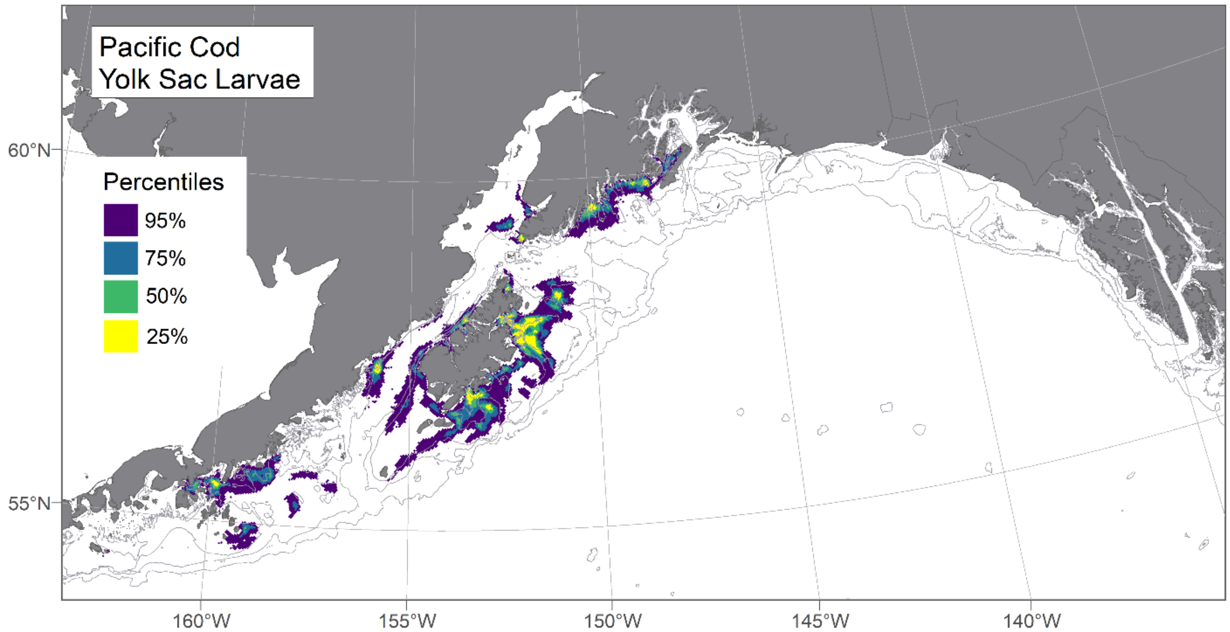

Figure 5-67 EFH area of Pacific cod yolk sac larvae, summer

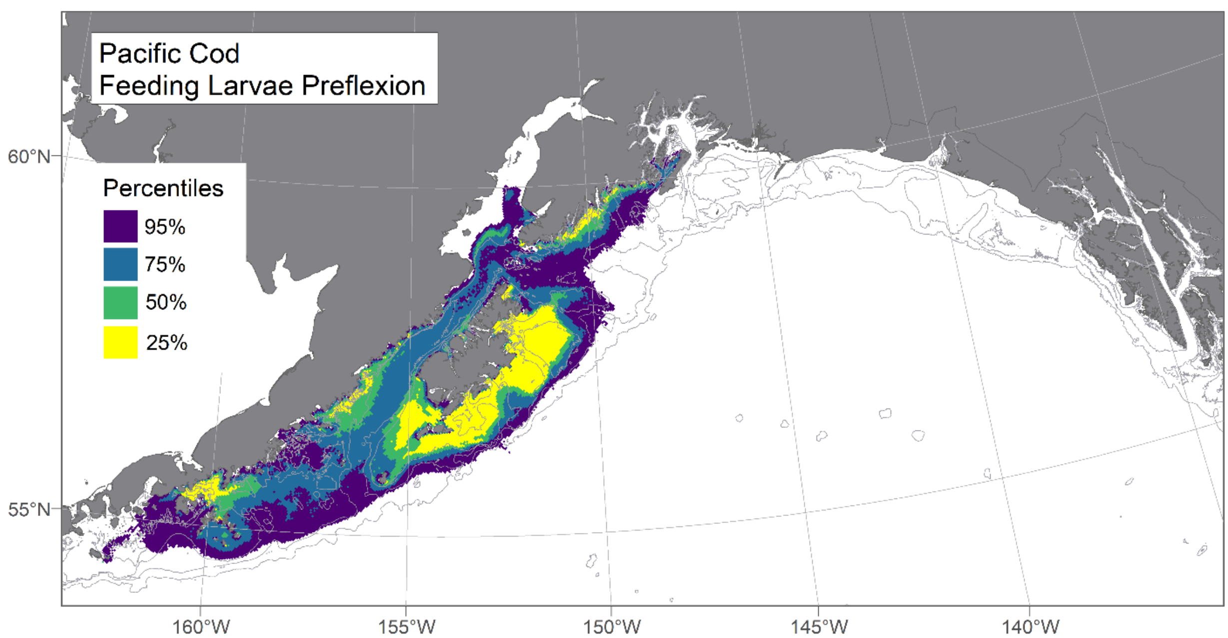

Figure 5-68 EFH area of Pacific cod feeding larvae preflexion, summer

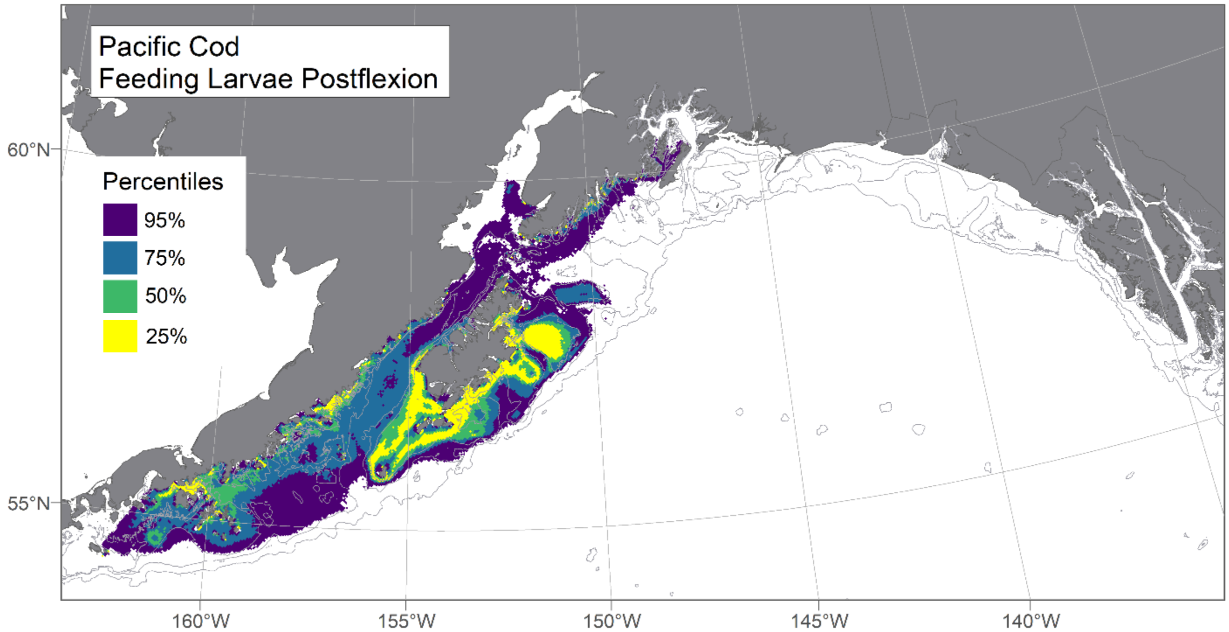

Figure 5-69 EFH area of Pacific cod feeding larvae postflexion, summer

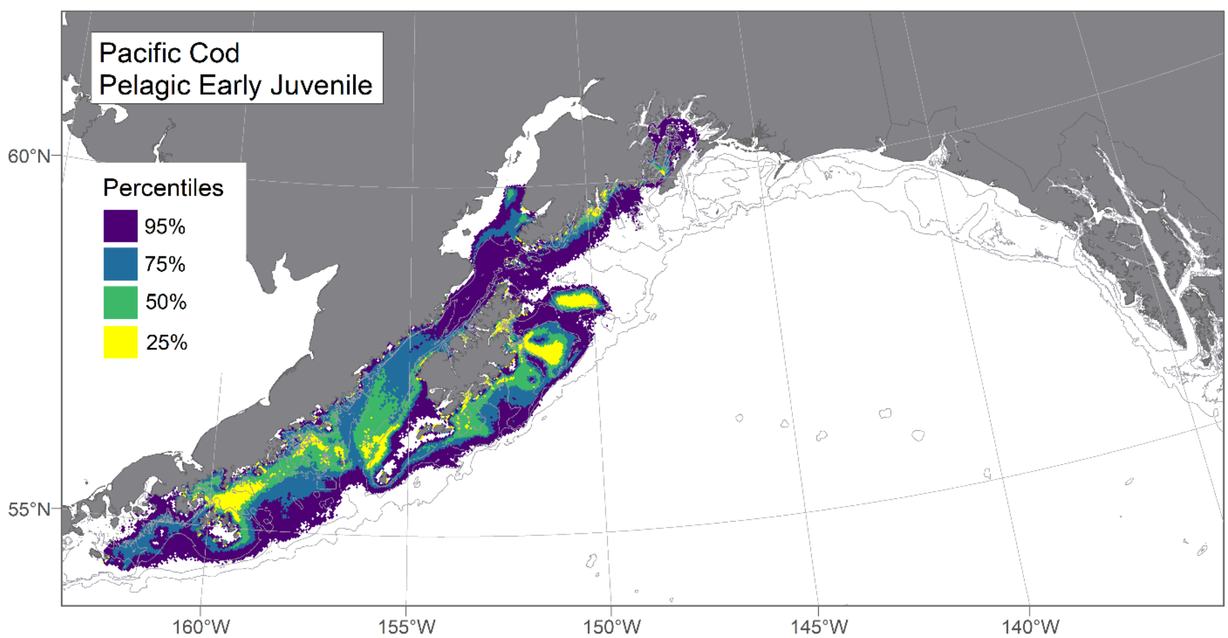

Figure 5-70 EFH area of pelagic early juvenile Pacific cod, summer

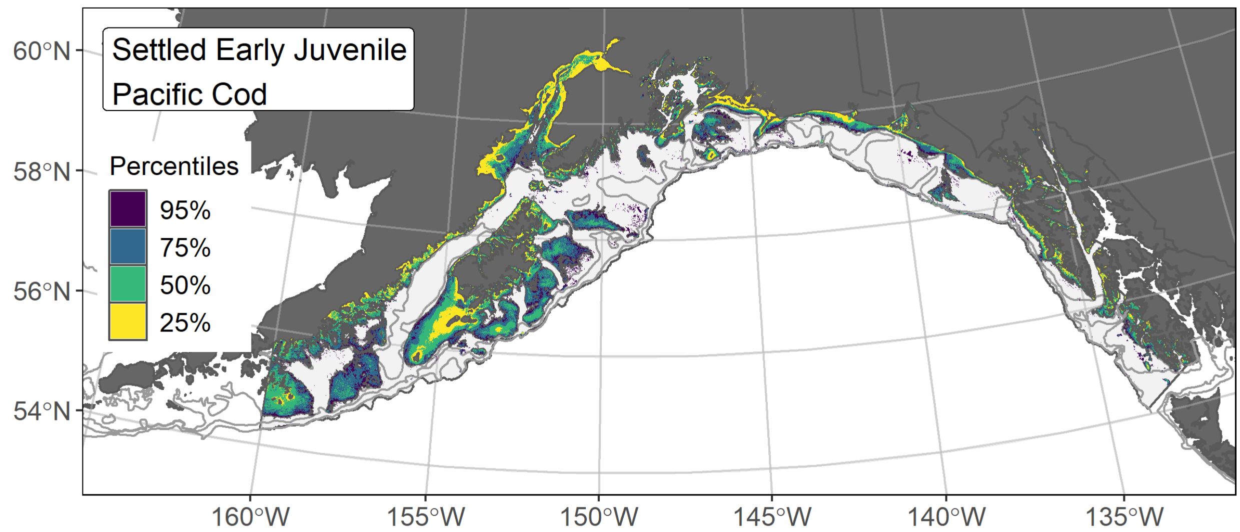

Figure 5-71 EFH area of settled early juvenile Pacific cod, summer

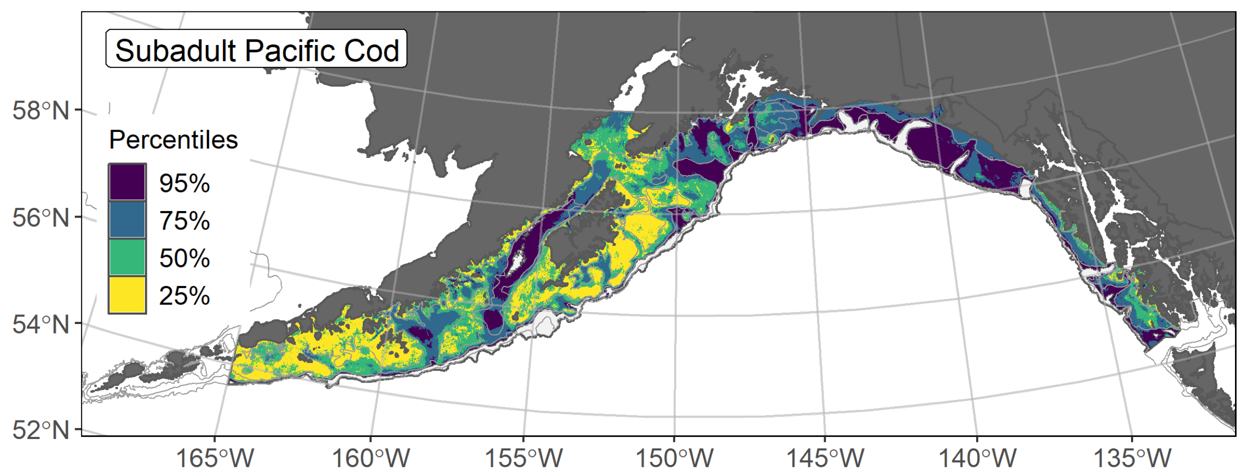

Figure 5-72 EFH area of subadult Pacific cod, summer

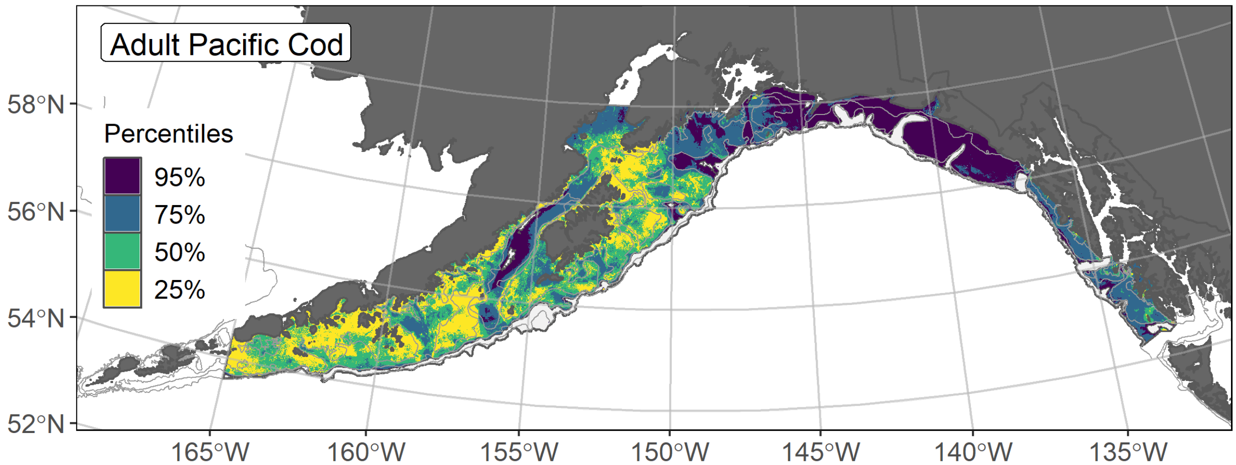

Figure 5-73 EFH area of adult Pacific cod, summer

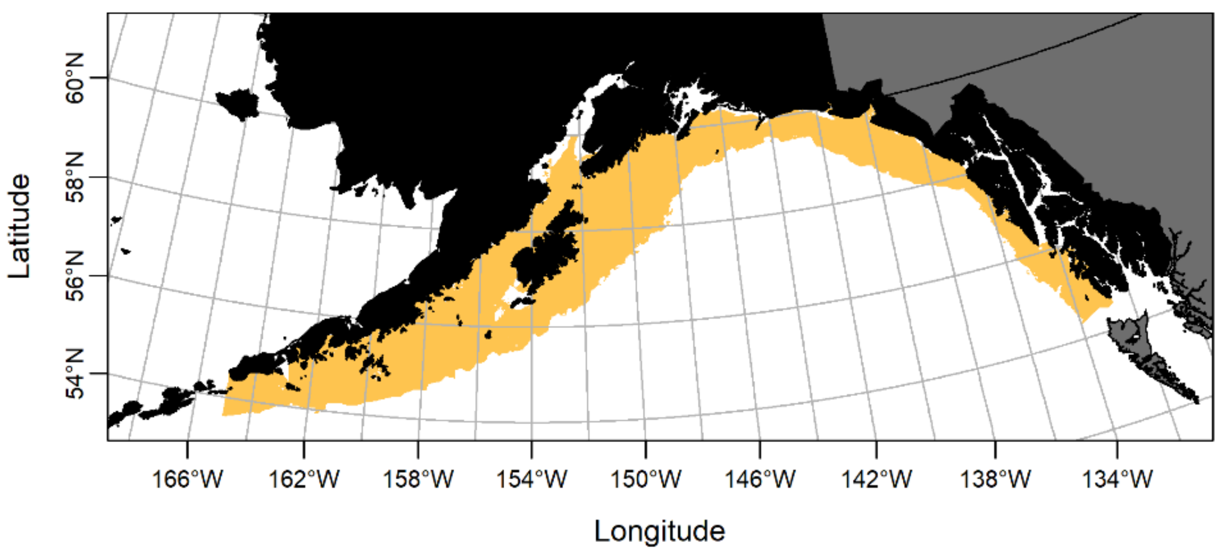

Figure 5-74 EFH area of adult Pacific cod, fall

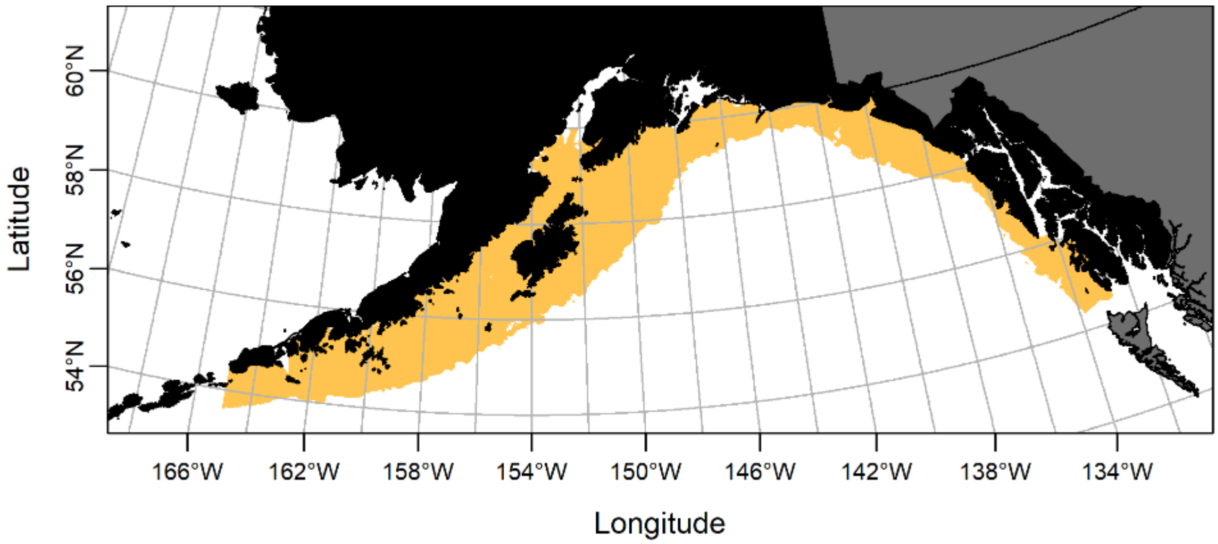

Figure 5-75 EFH area of adult Pacific cod, winter

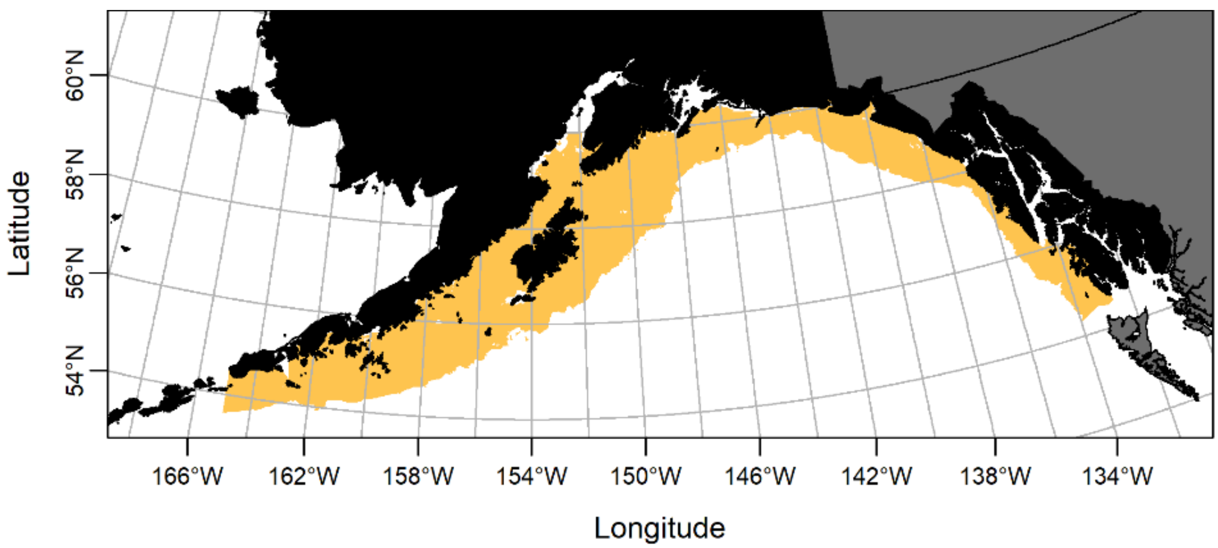

Figure 5-76 EFH area of adult Pacific cod, spring

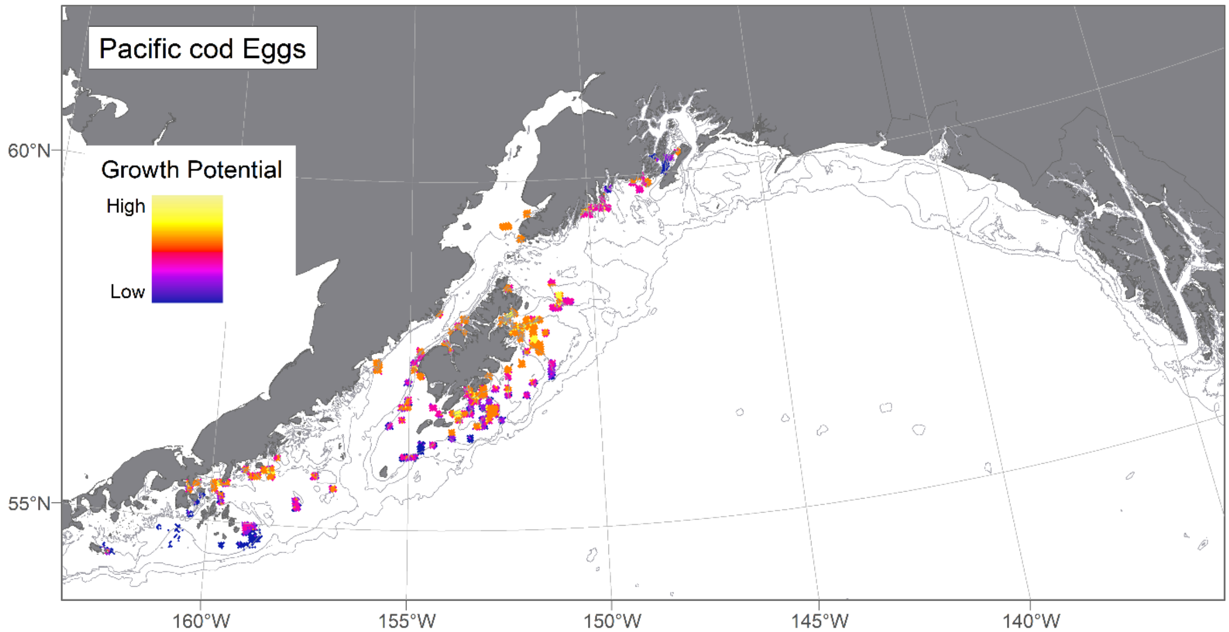

Figure 5-77 EFH area of Pacific cod eggs, habitat-related growth potential, summer

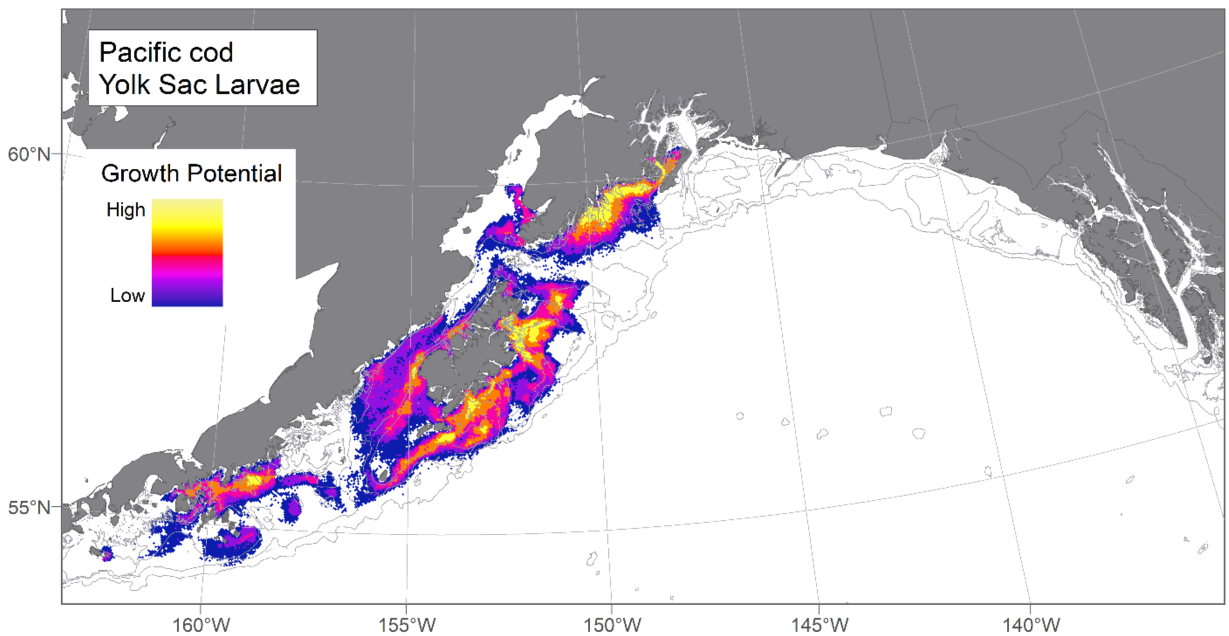

Figure 5-78 EFH area of Pacific cod yolk sac larvae, habitat-related growth potential, summer

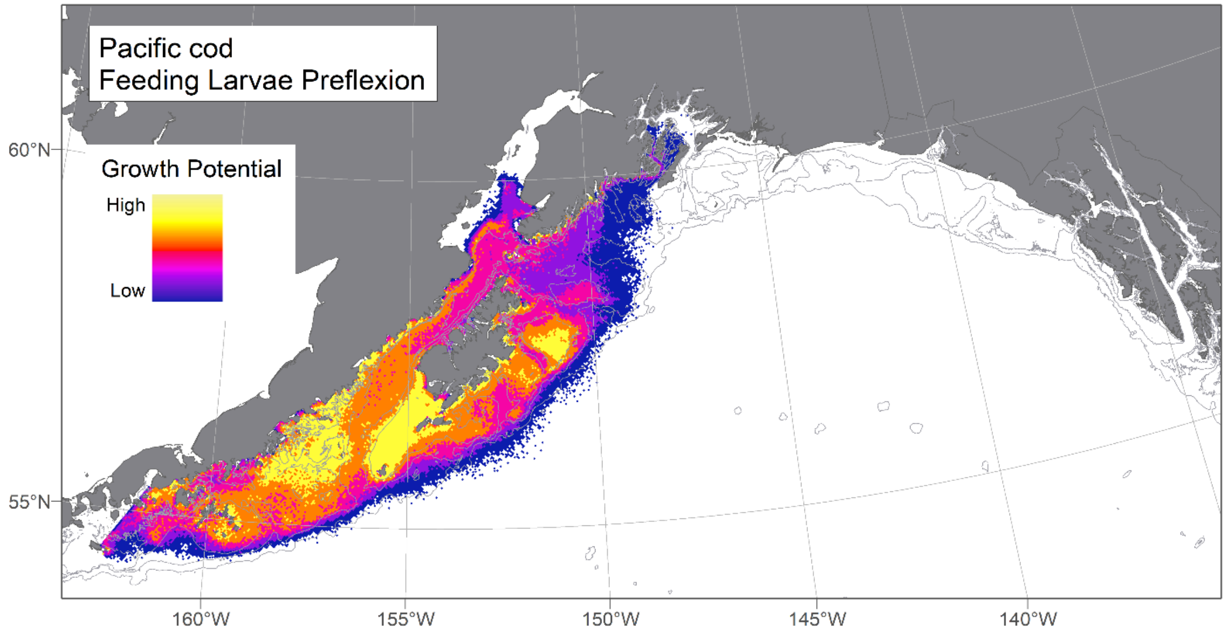

Figure 5-79 EFH area of Pacific cod feeding larvae preflexion, habitat-related growth potential, summer

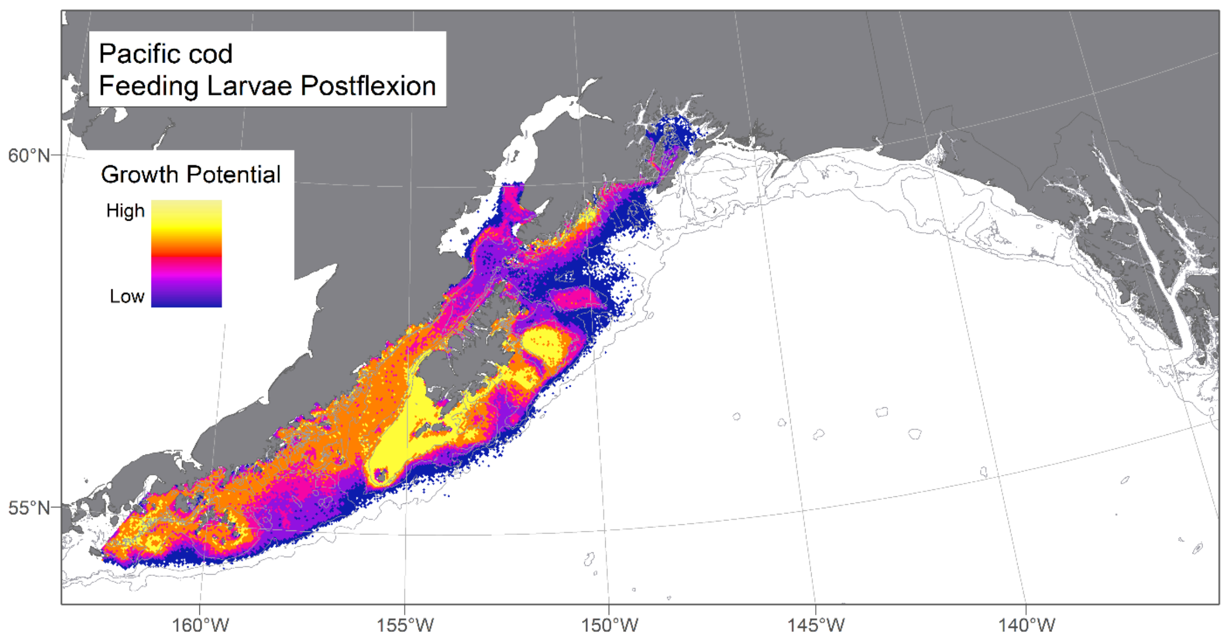

Figure 5-80 EFH area of Pacific cod feeding larvae postflexion, habitat-related growth potential, summer

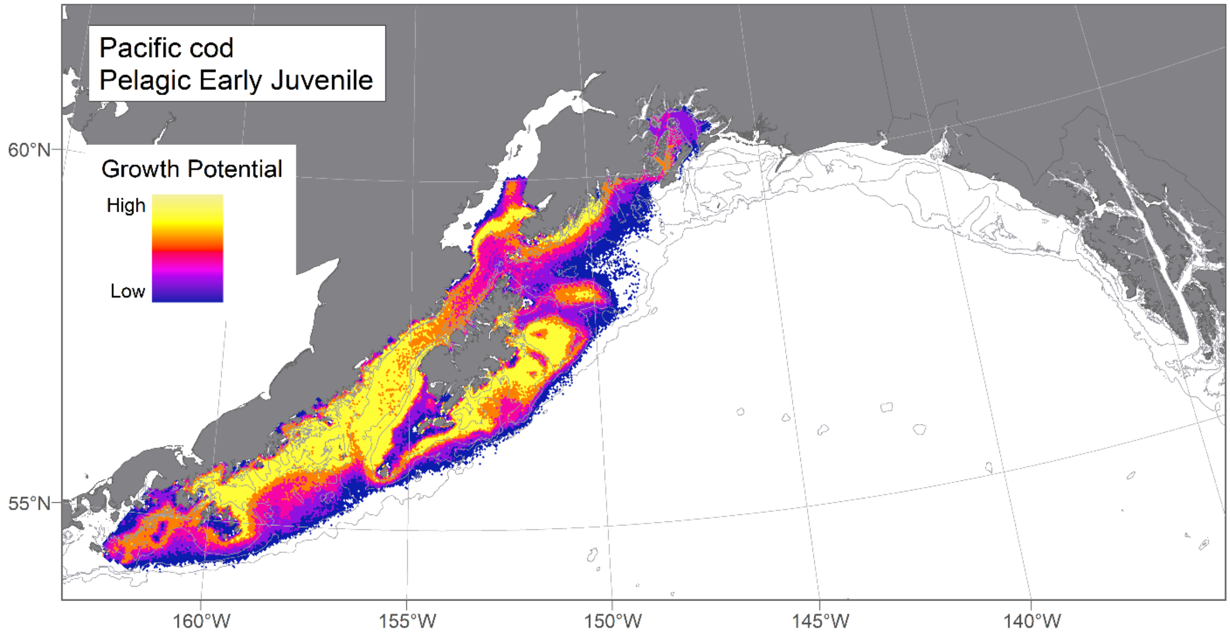

Figure 5-81 EFH area of pelagic early juvenile Pacific cod, habitat-related growth potential, summer

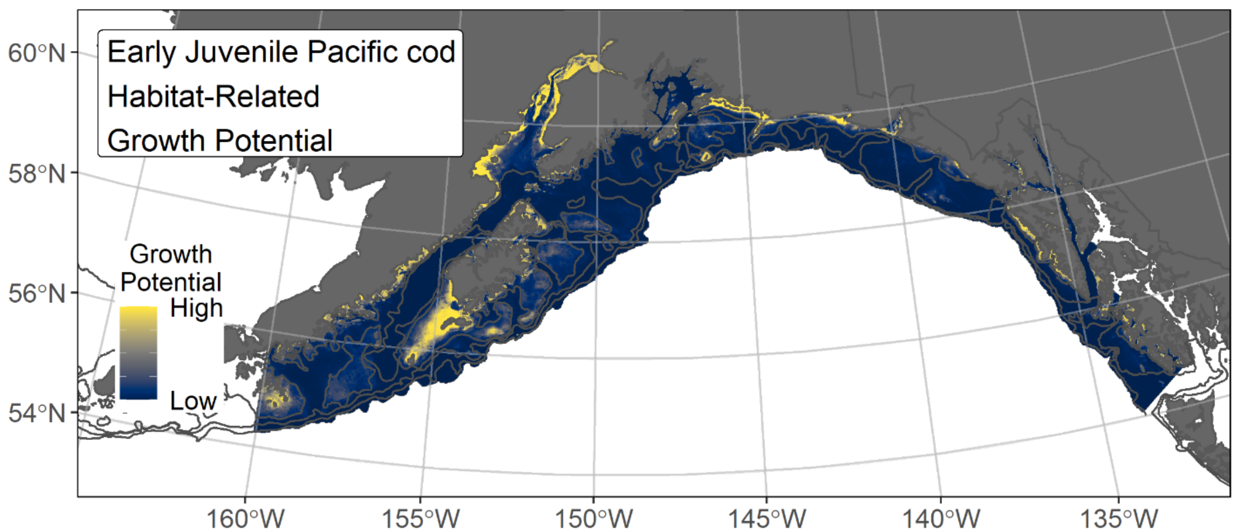

Figure 5-82 EFH area of settled early juvenile Pacific cod, habitat-related growth potential, summer

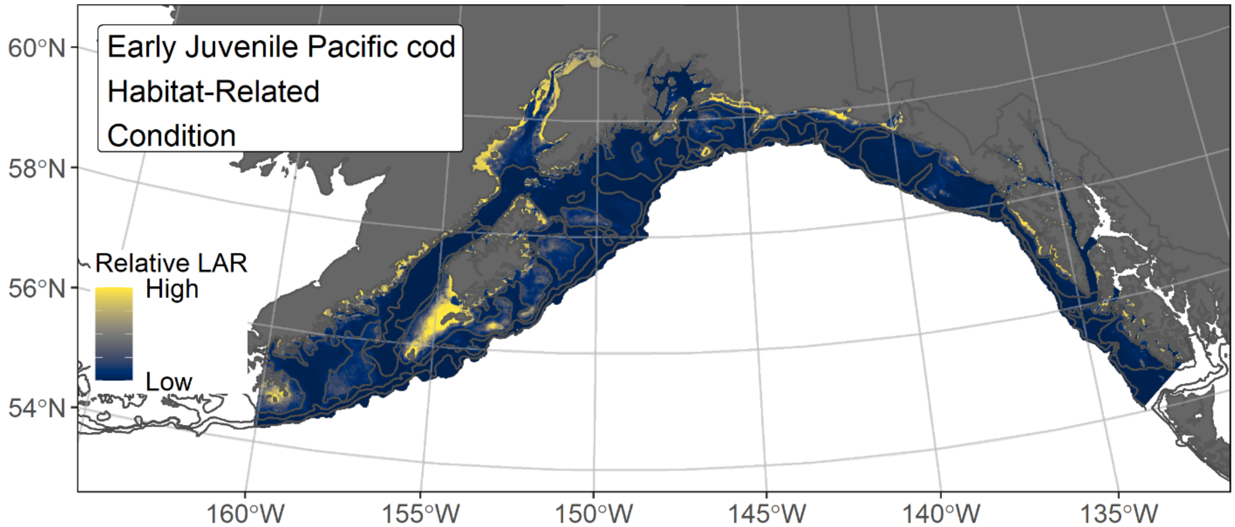

Figure 5-83 EFH area of settled early juvenile Pacific cod, habitat-related condition, summer

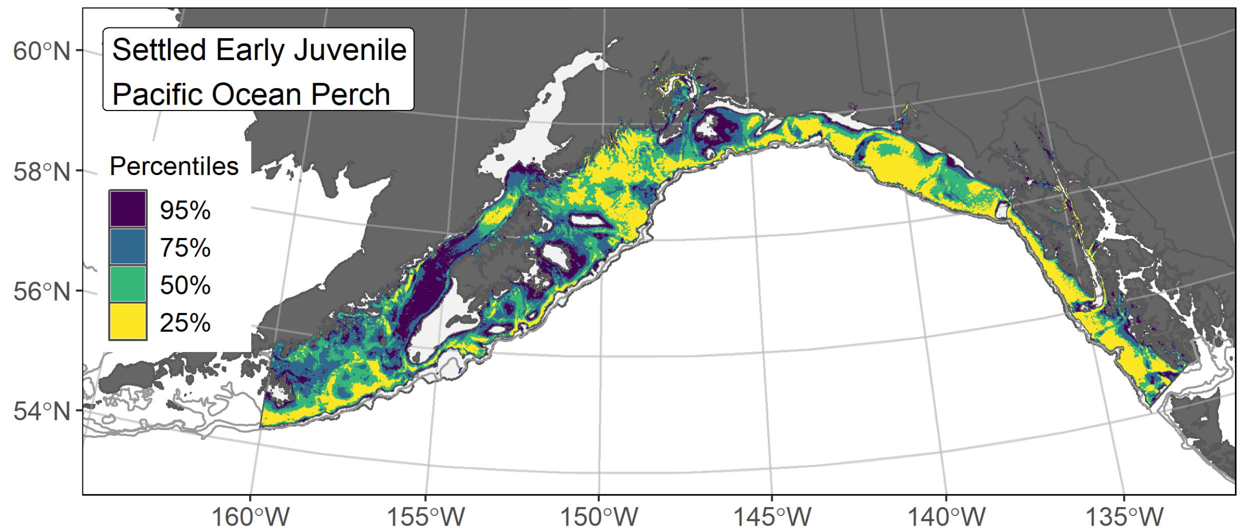

Figure 5-84 EFH area of settled early juvenile Pacific ocean perch, summer

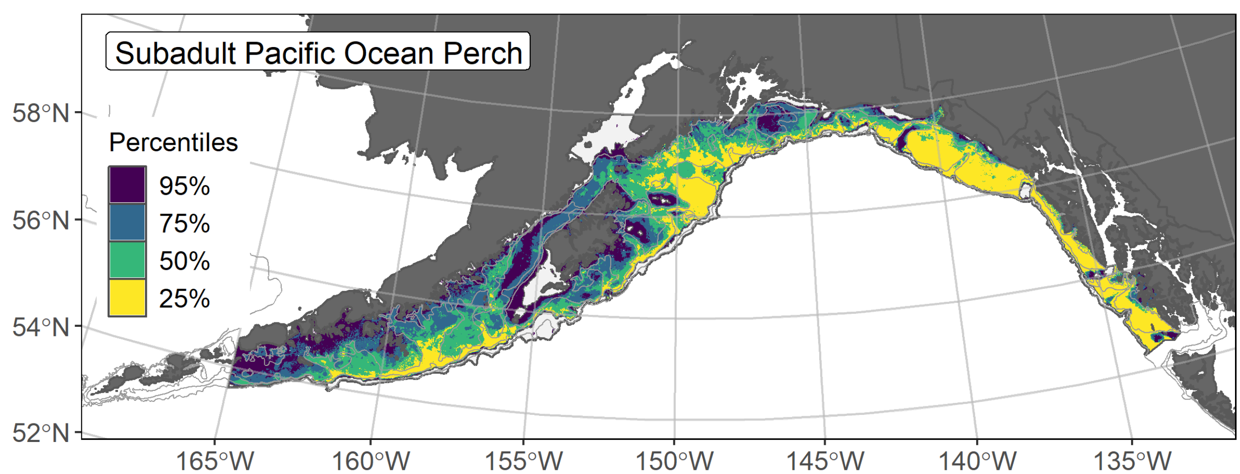

Figure 5-85 EFH area of subadult Pacific ocean perch, summer

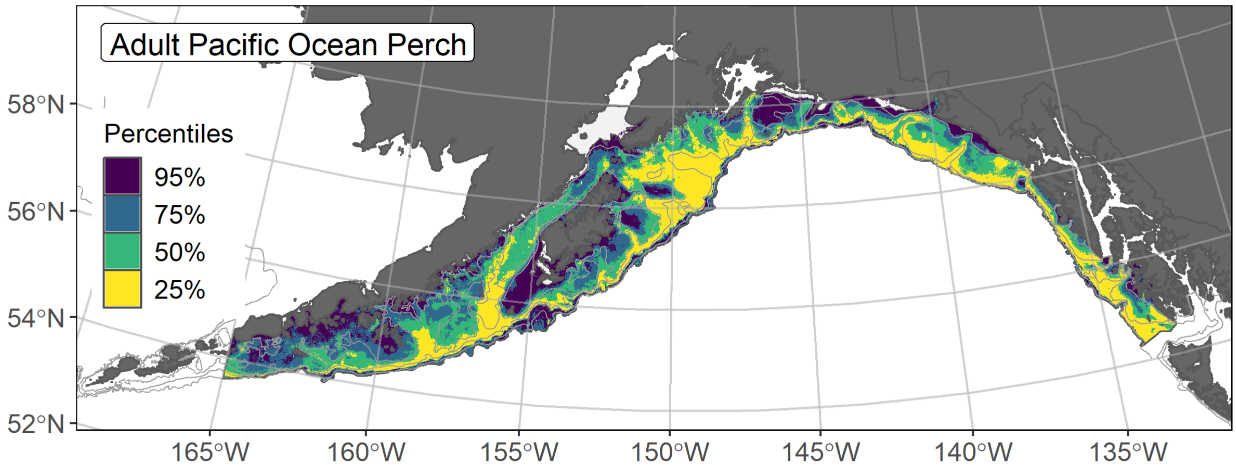

Figure 5-86 EFH area of adult Pacific ocean perch, summer

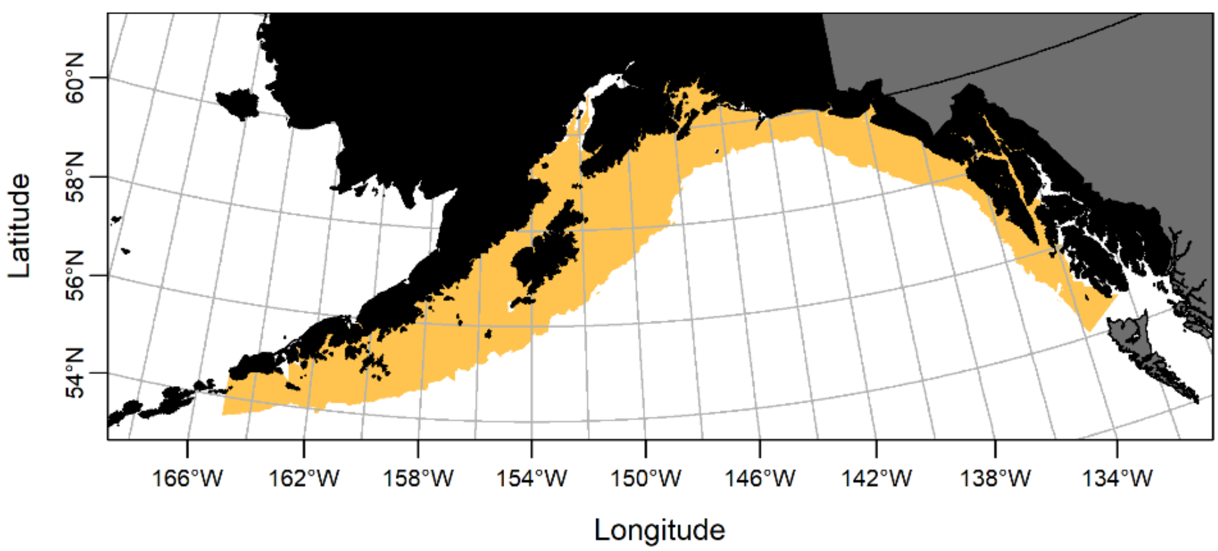

Figure 5-87 EFH area of Pacific ocean perch larvae, summer

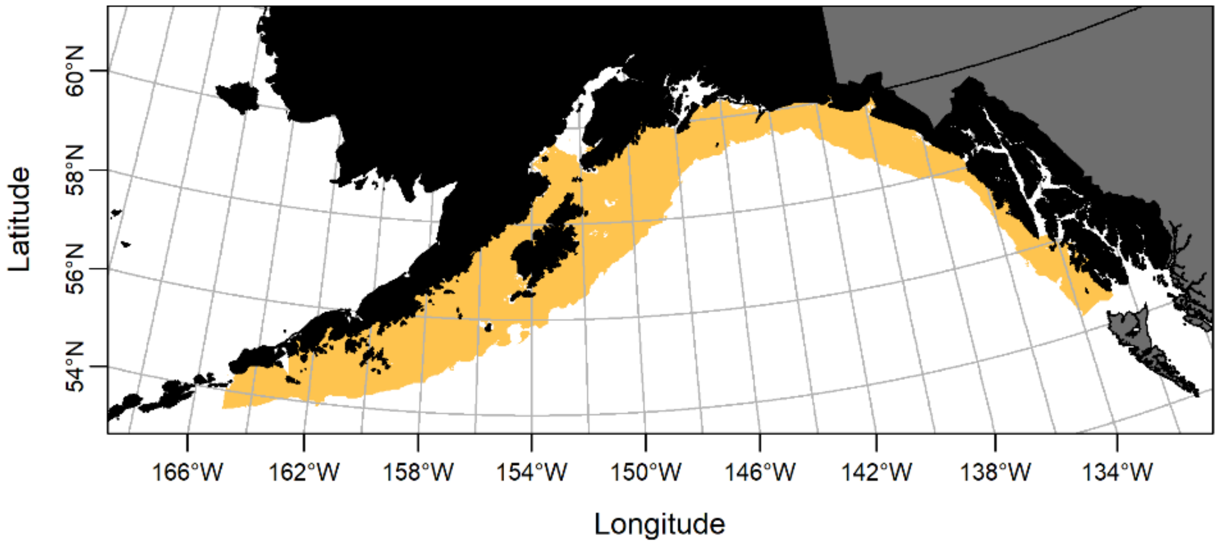

Figure 5-88 EFH area of adult Pacific ocean perch, fall

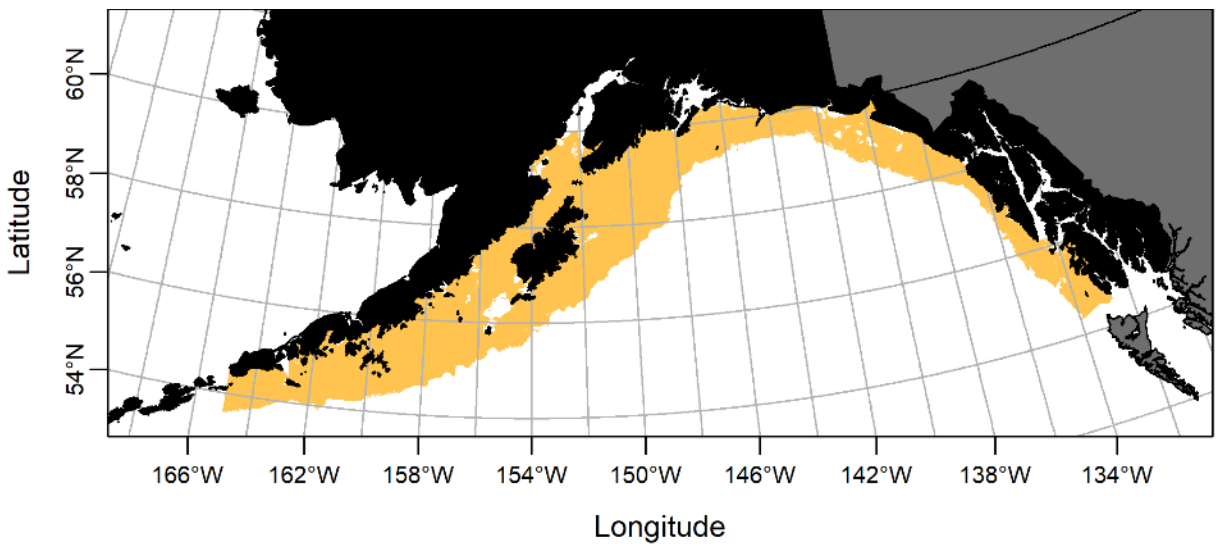

Figure 5-89 EFH area of adult Pacific ocean perch, winter

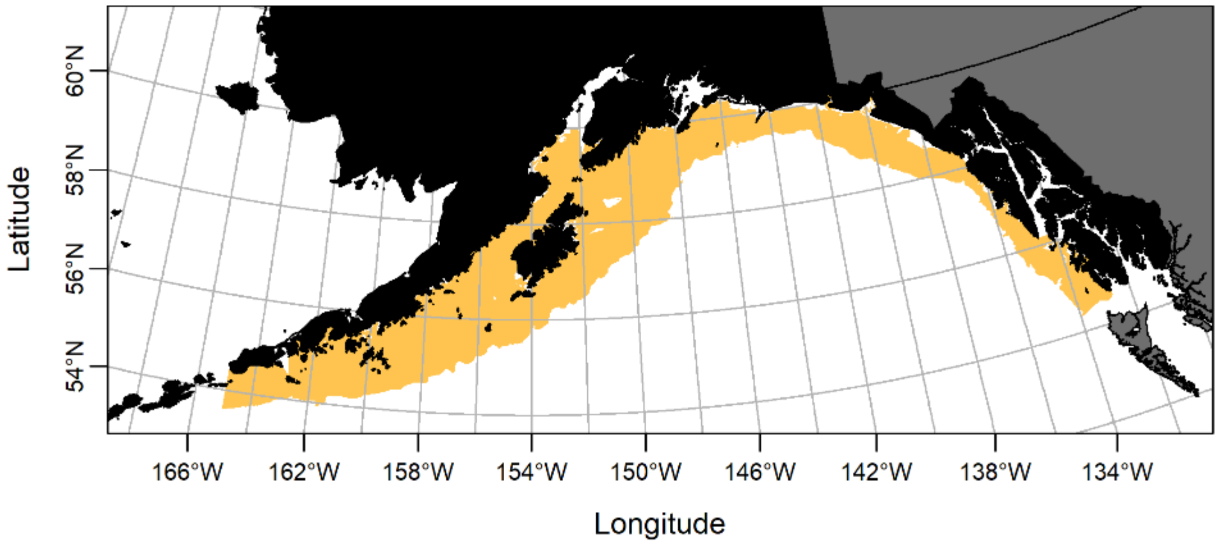

Figure 5-90 EFH area of adult Pacific ocean perch, spring

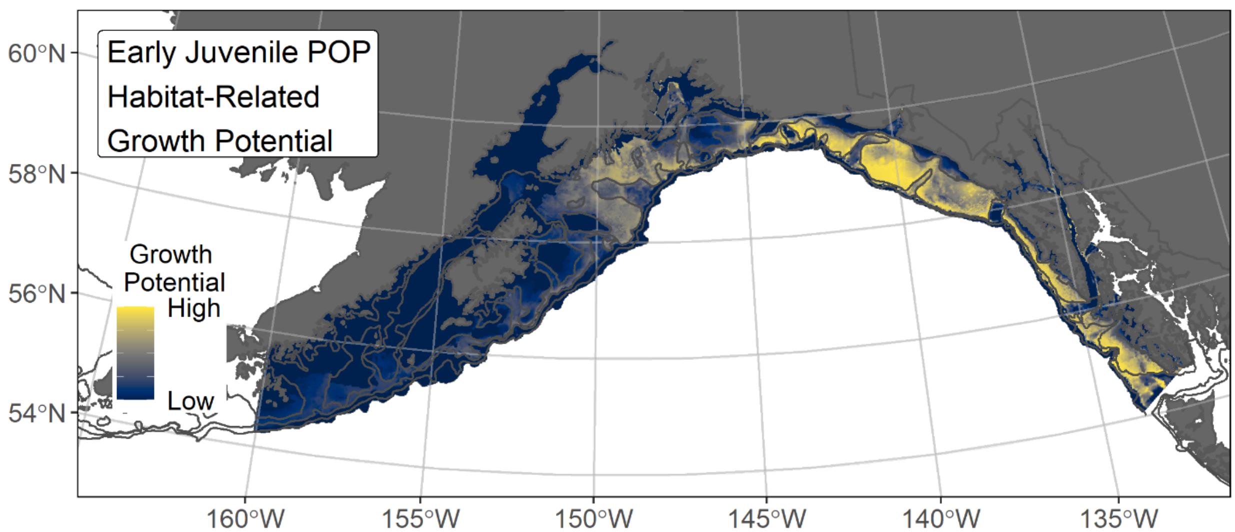

Figure 5-91 EFH area of settled early juvenile Pacific ocean perch, habitat-related growth potential, summer

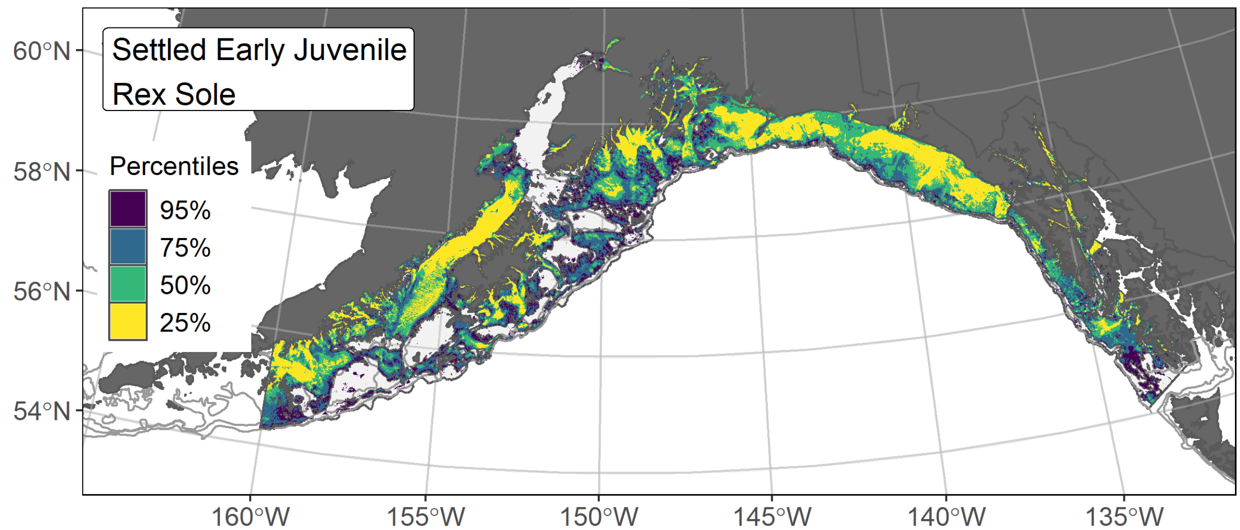

Figure 5-92 EFH area of settled early juvenile rex sole, summer

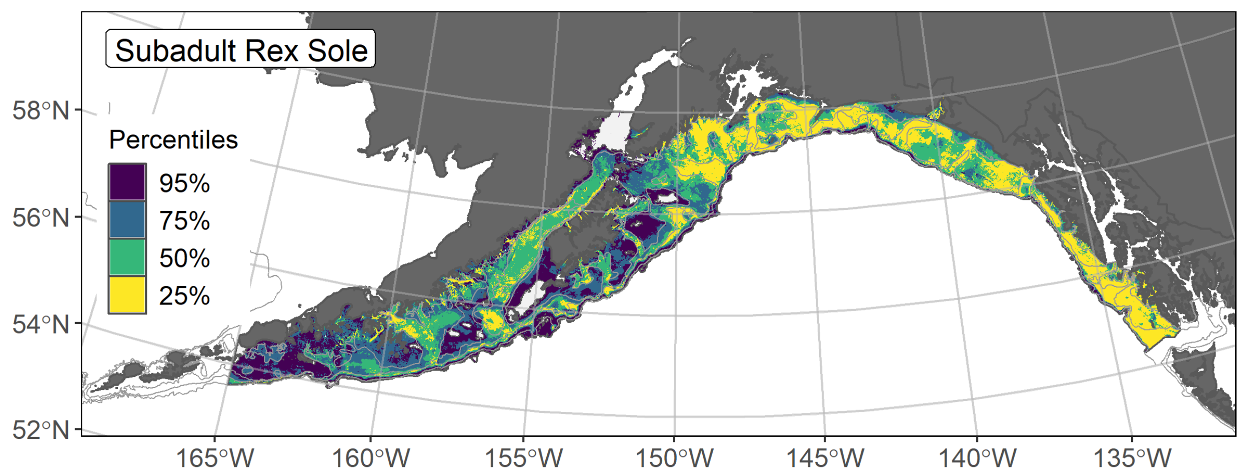

Figure 5-93 EFH area of subadult rex sole, summer

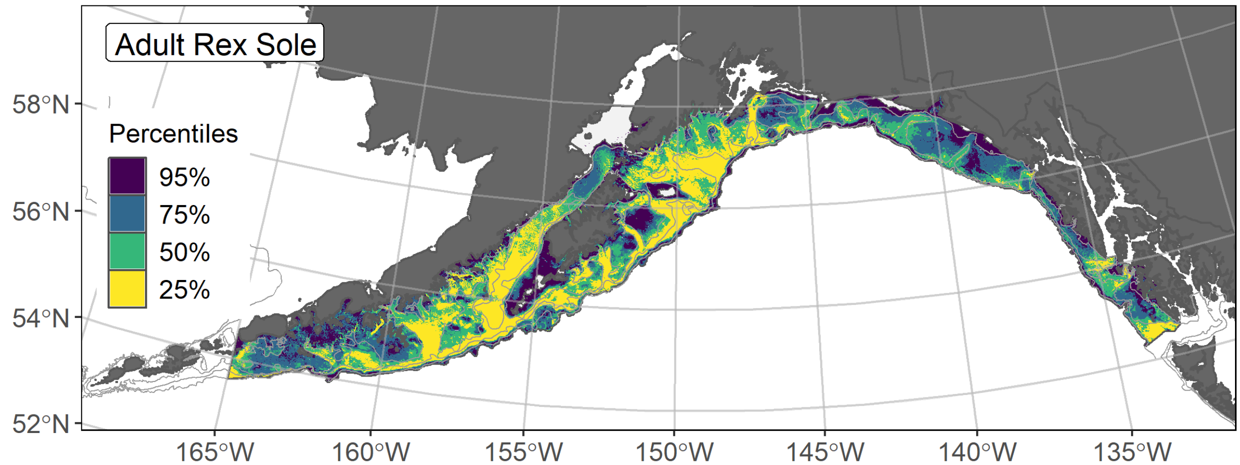

Figure 5-94 EFH area of adult rex sole, summer

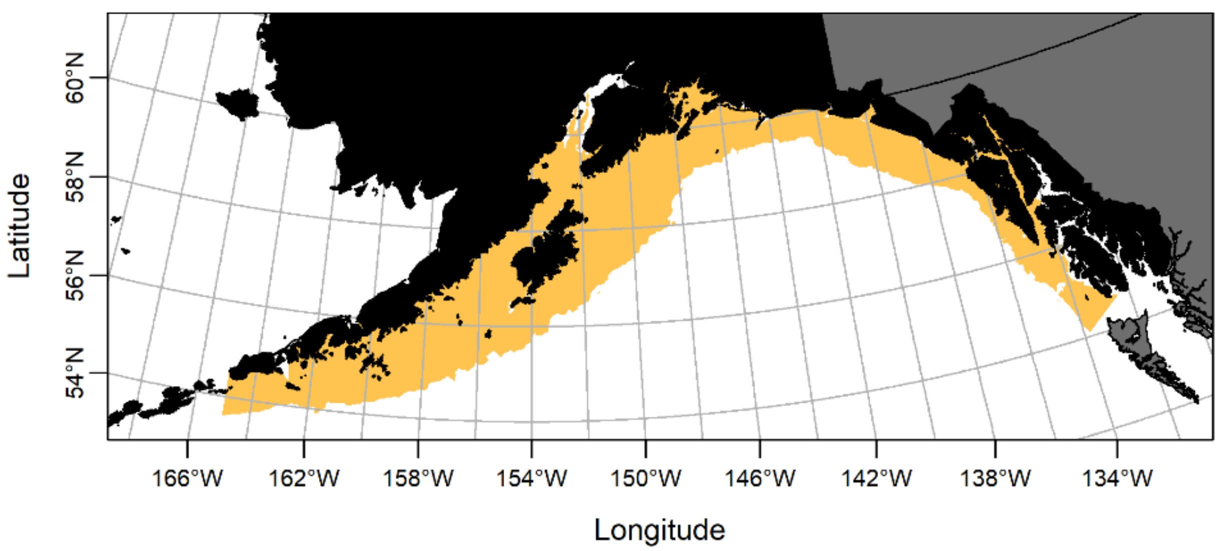

Figure 5-95 EFH area of rex sole eggs, summer

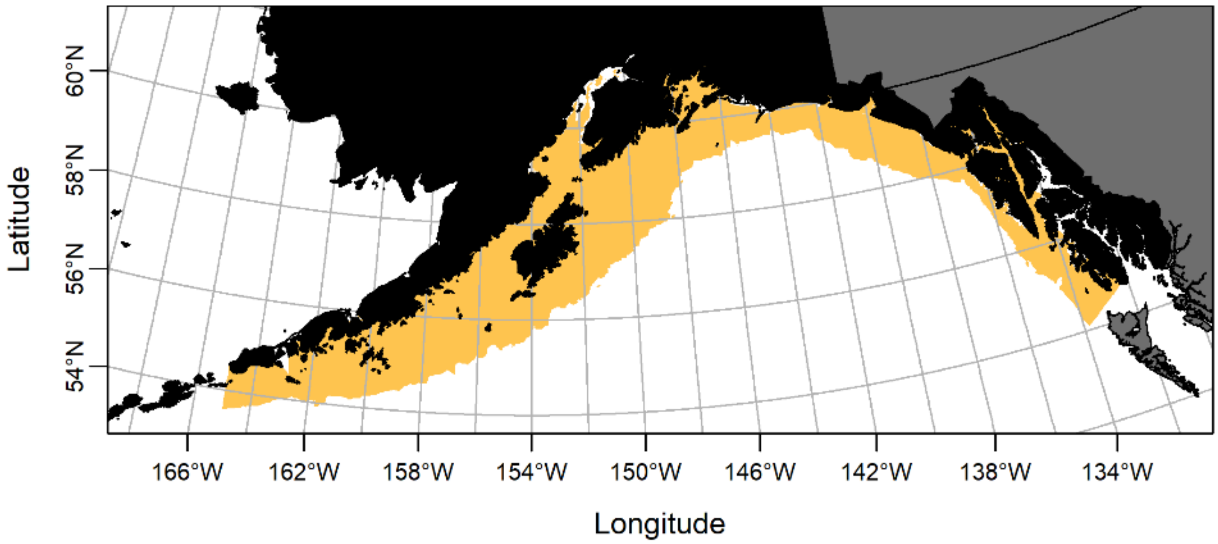

Figure 5-96 EFH area of rex sole larvae, summer

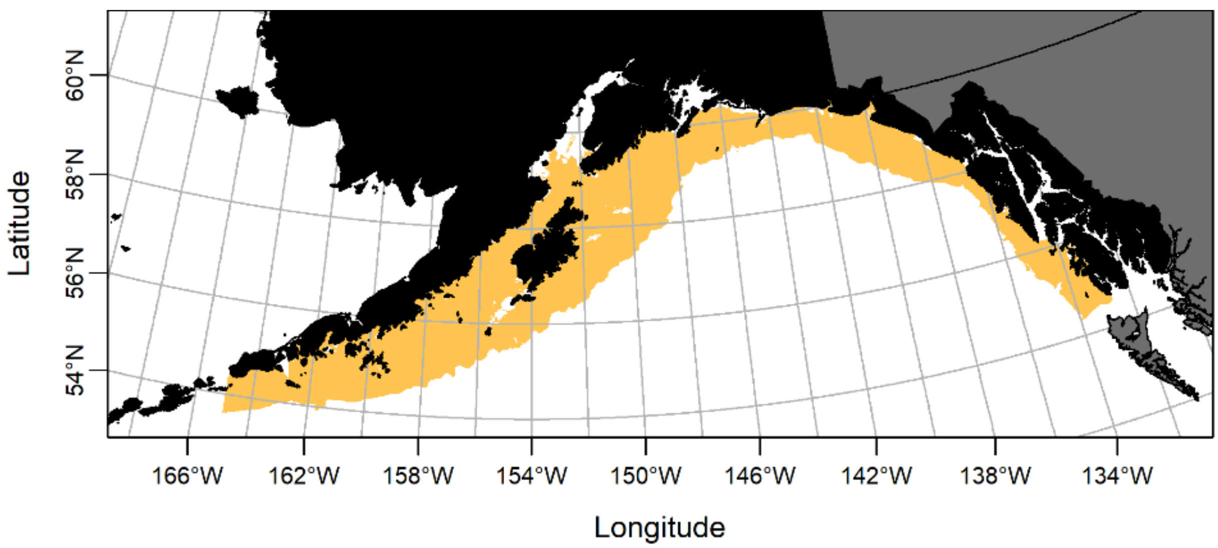

Figure 5-97 EFH area of adult rex sole, fall

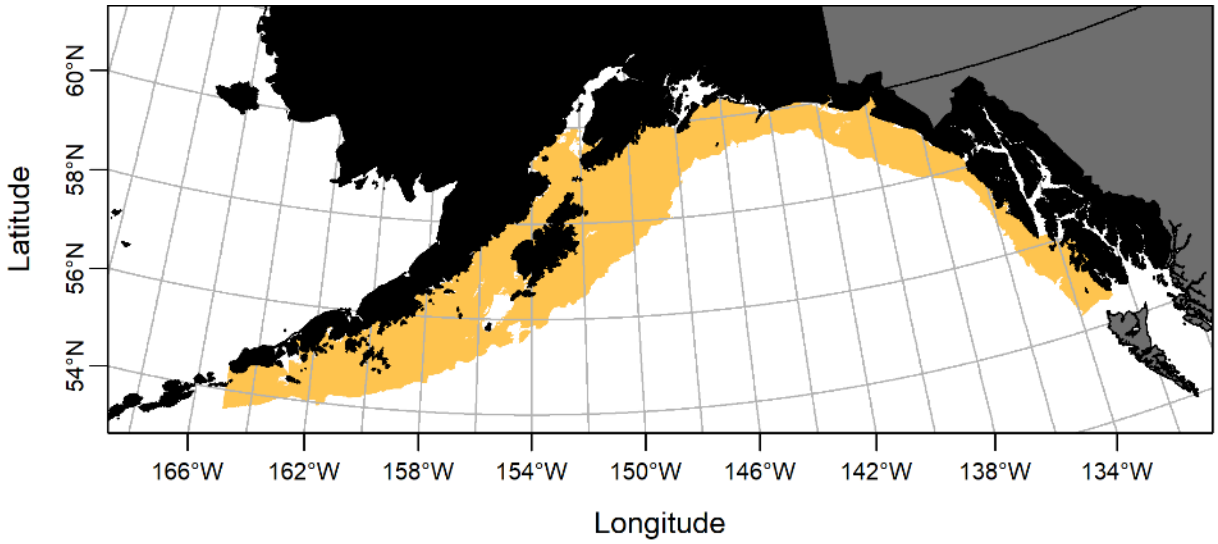

Figure 5-98 EFH area of adult rex sole, winter

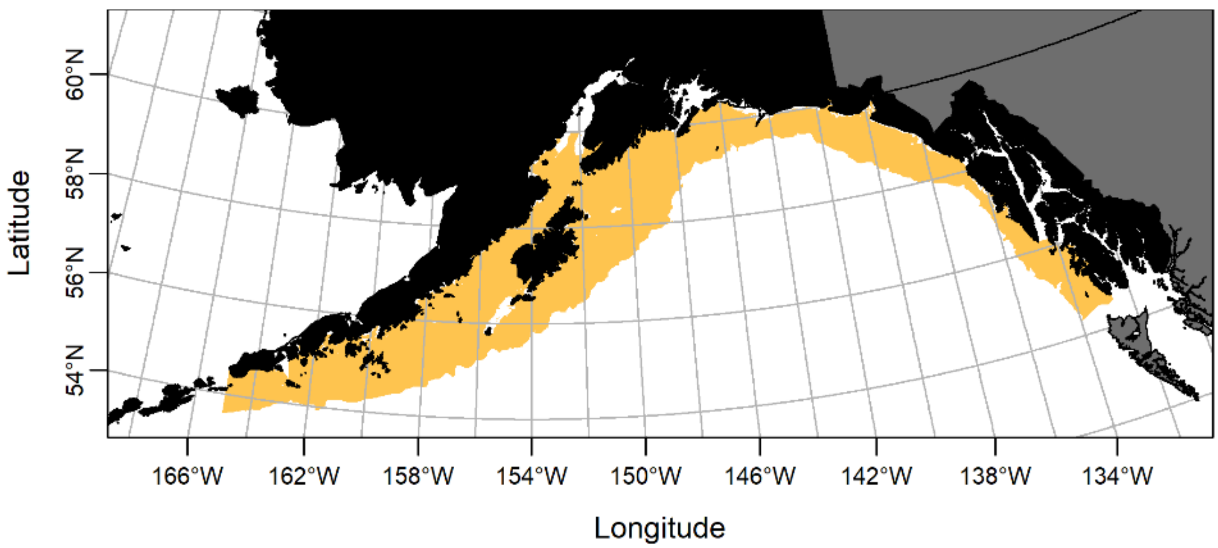

Figure 5-99 EFH area of adult rex sole, spring

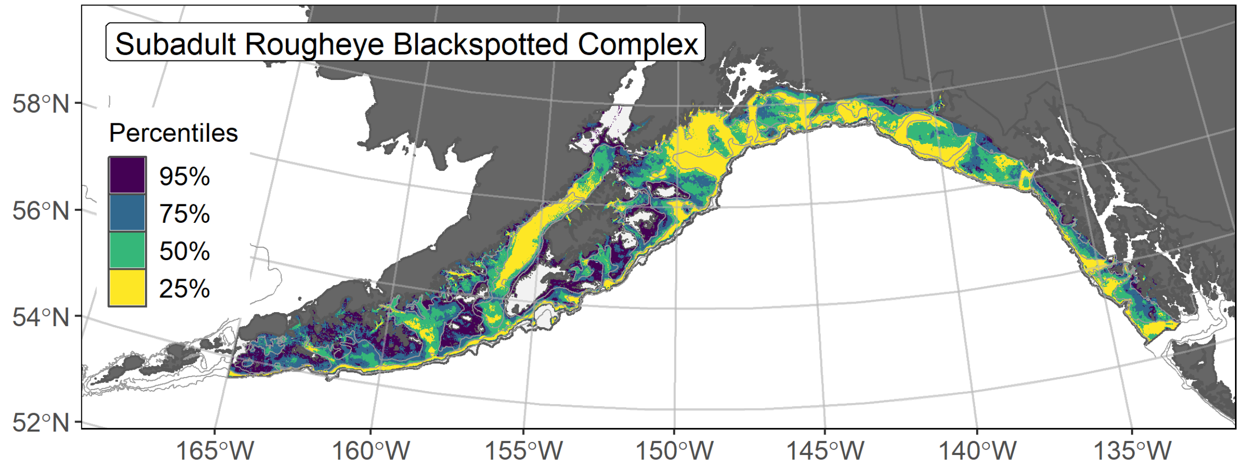

Figure 5-100 EFH area of subadult rougheye/blackspotted rockfish, summe

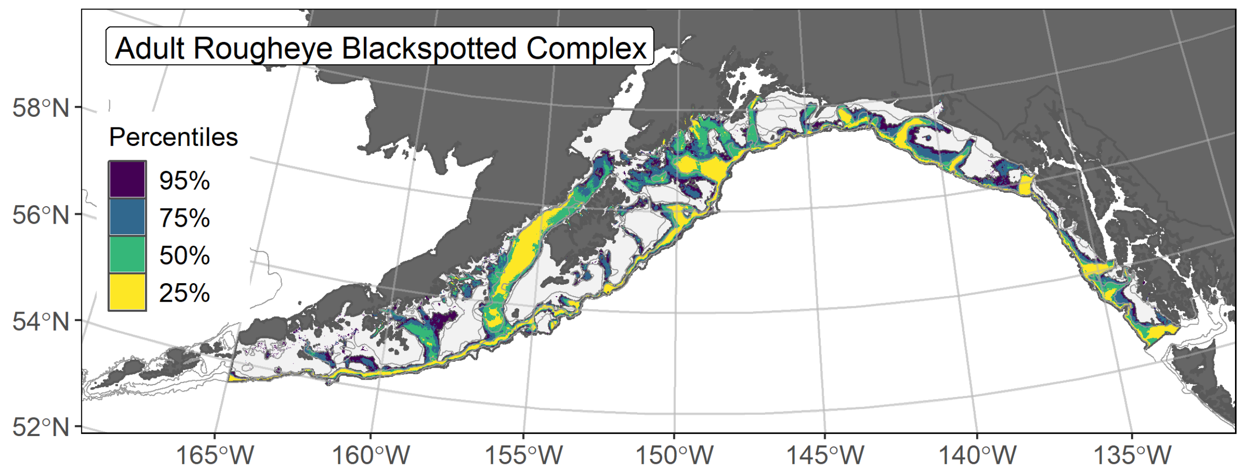

Figure 5-101 EFH area of adult rougheye/blackspotted rockfish, summer

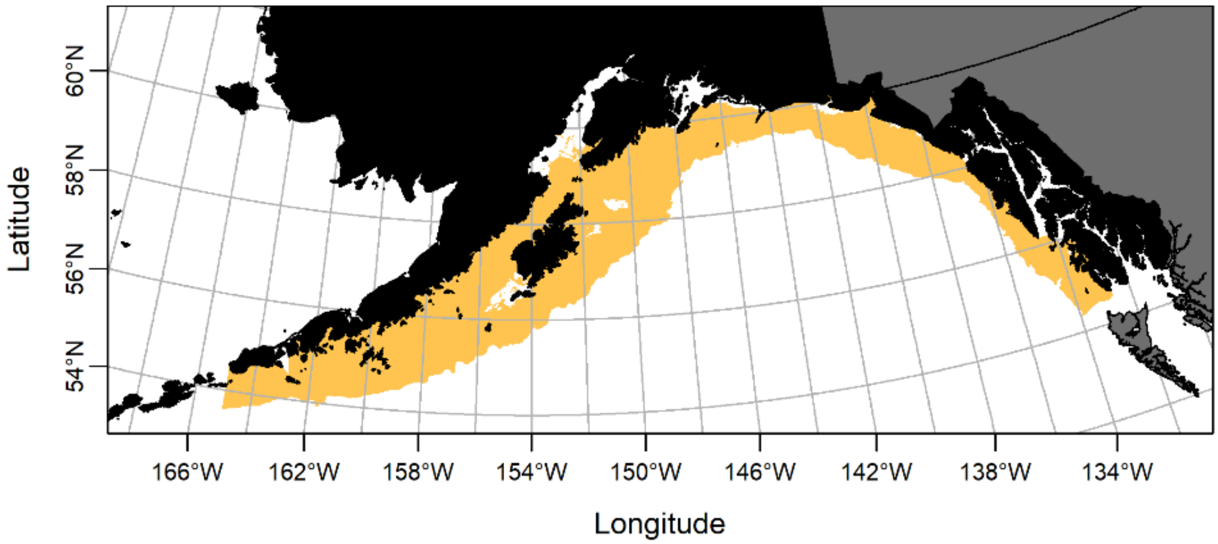

Figure 5-102 EFH area of adult rougheye rockfish, fall

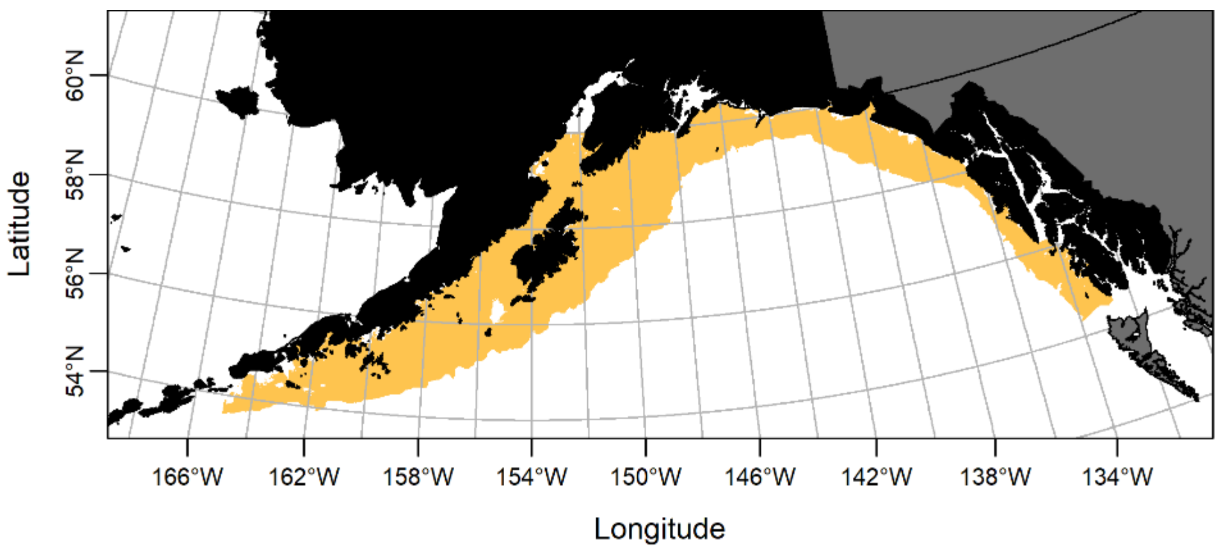

Figure 5-103 EFH area of adult rougheye rockfish, winter

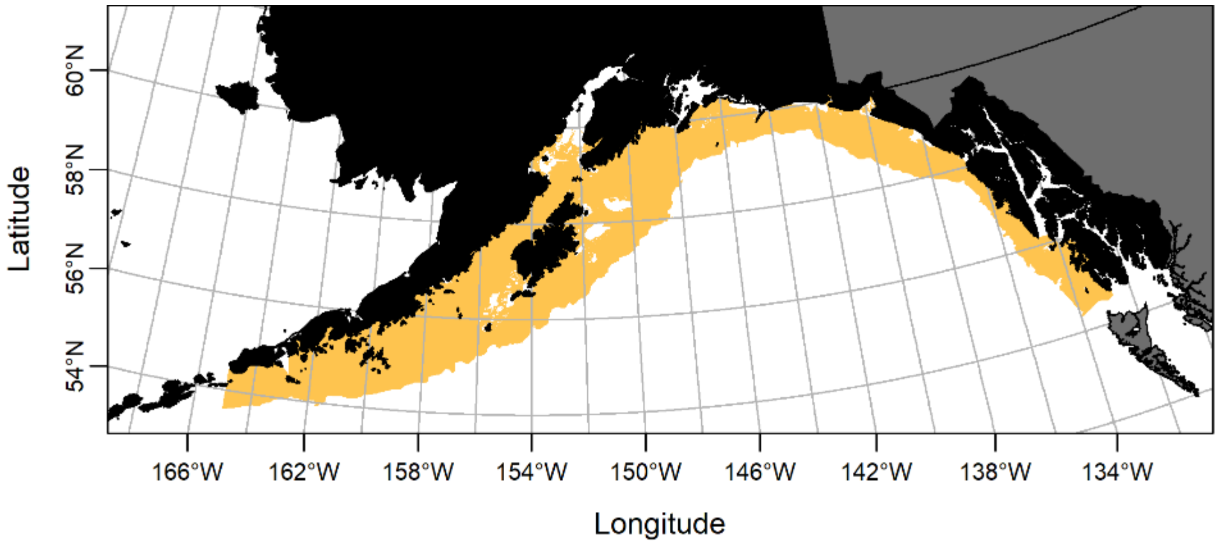

Figure 5-104 EFH area of adult rougheye rockfish, spring

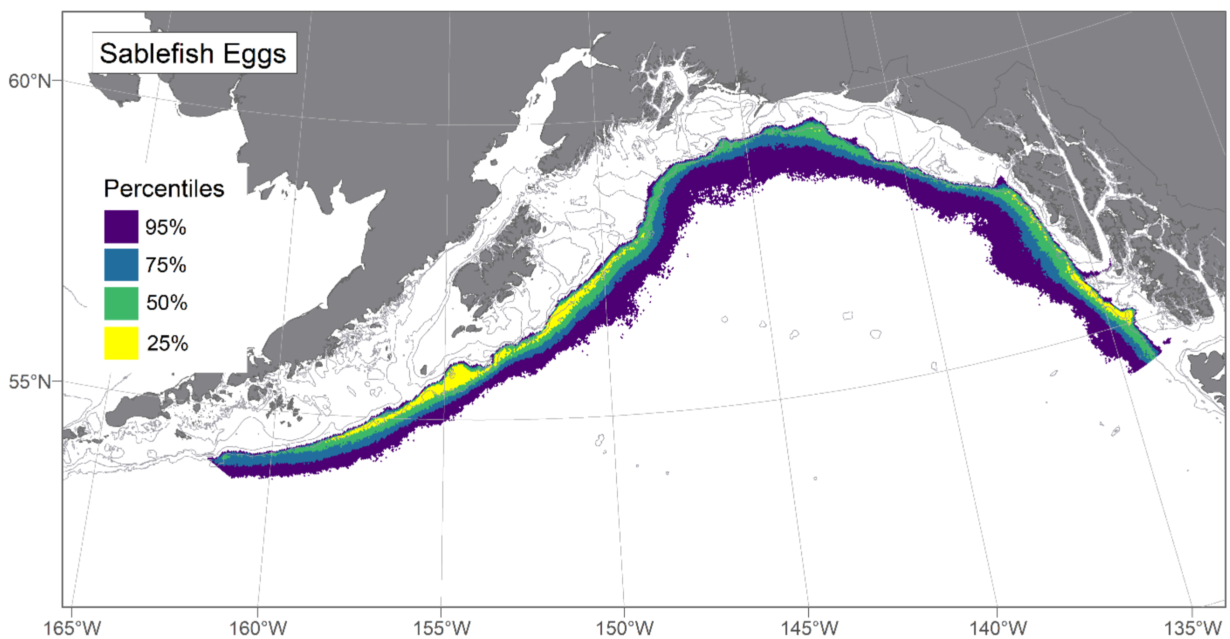

Figure 5-105 EFH area of sablefish eggs, summer

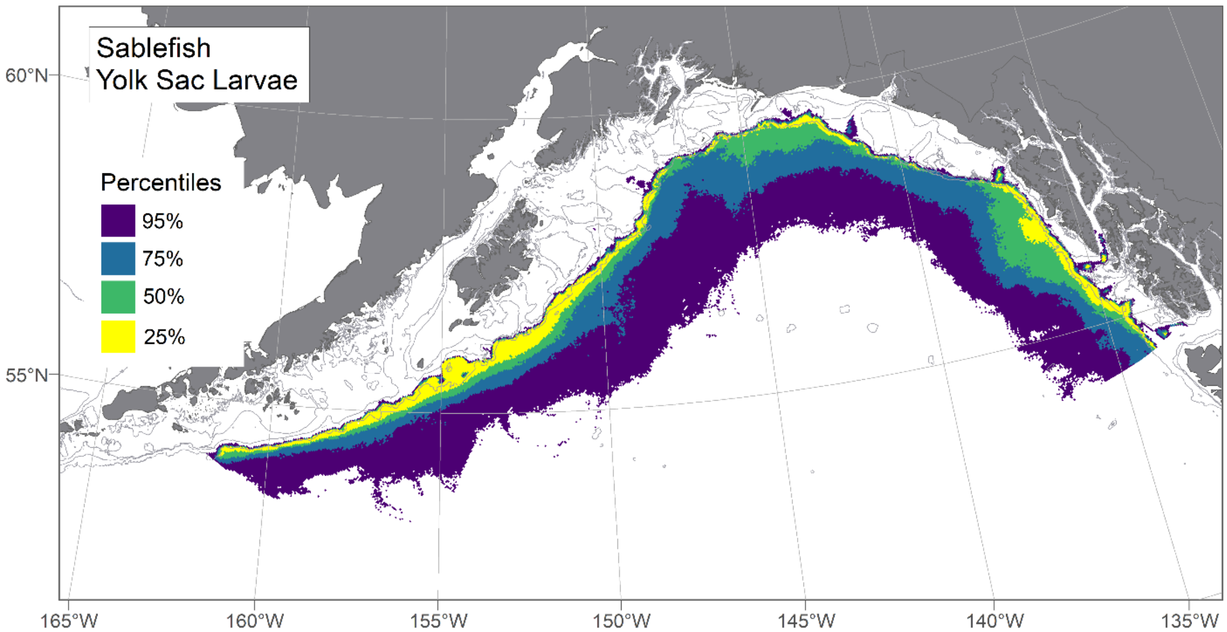

Figure 5-106 EFH area of sablefish yolk sac larvae, summer

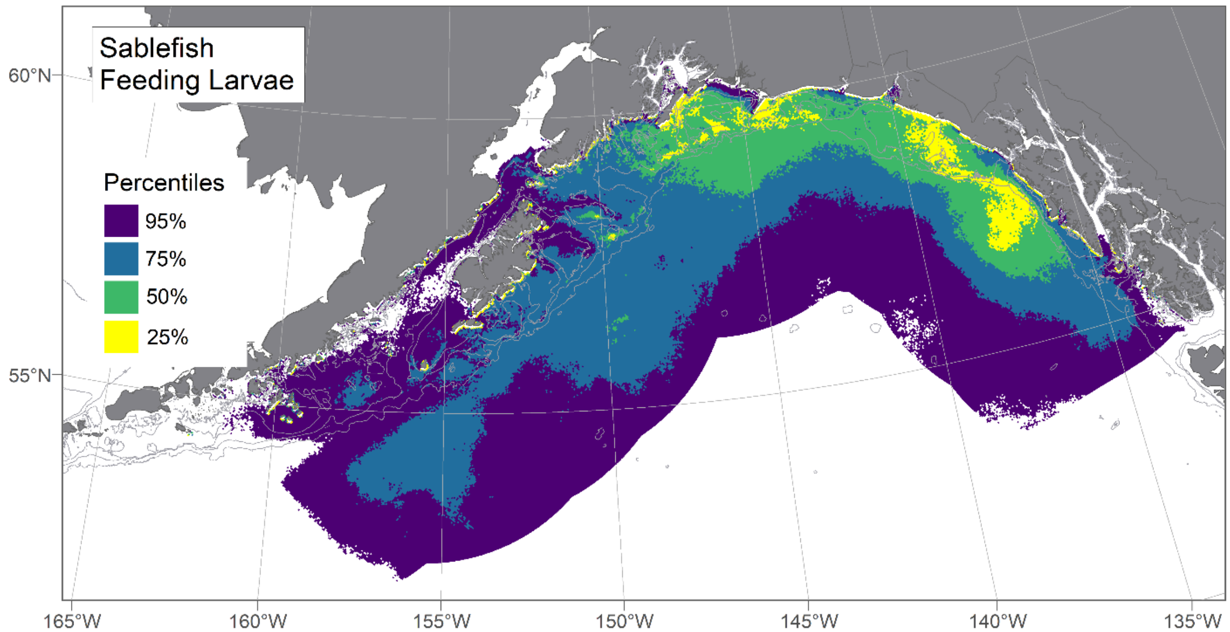

Figure 5-107 EFH area of sablefish feeding larvae, summer

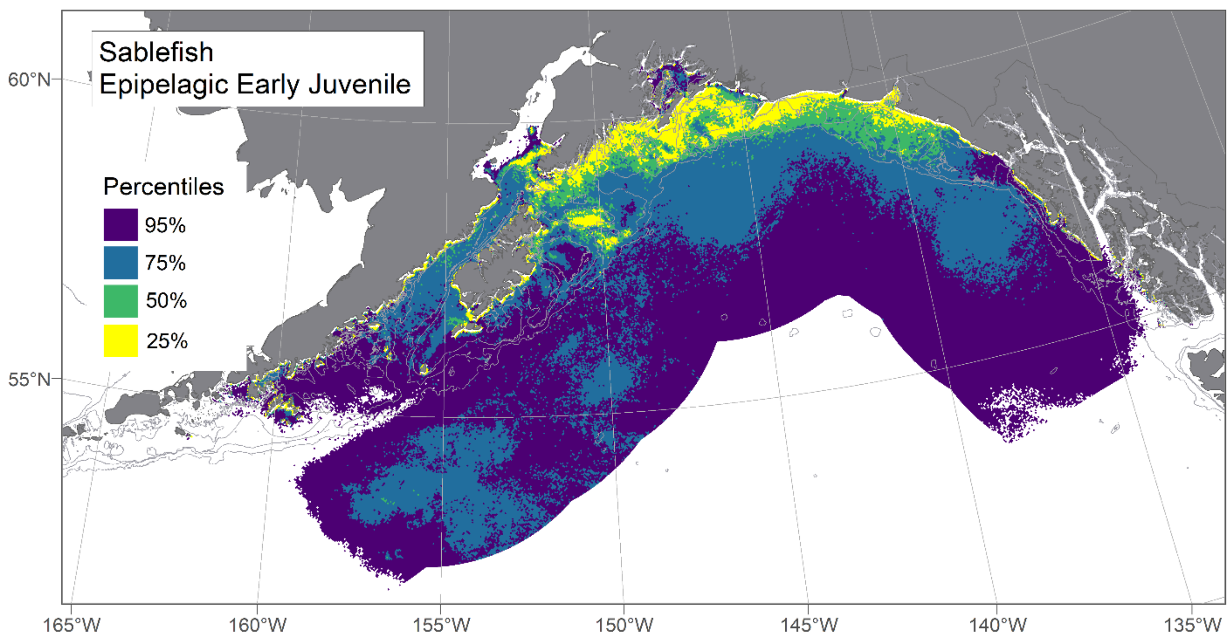

Figure 5-108 EFH area of epipelagic early juvenile sablefish, summer

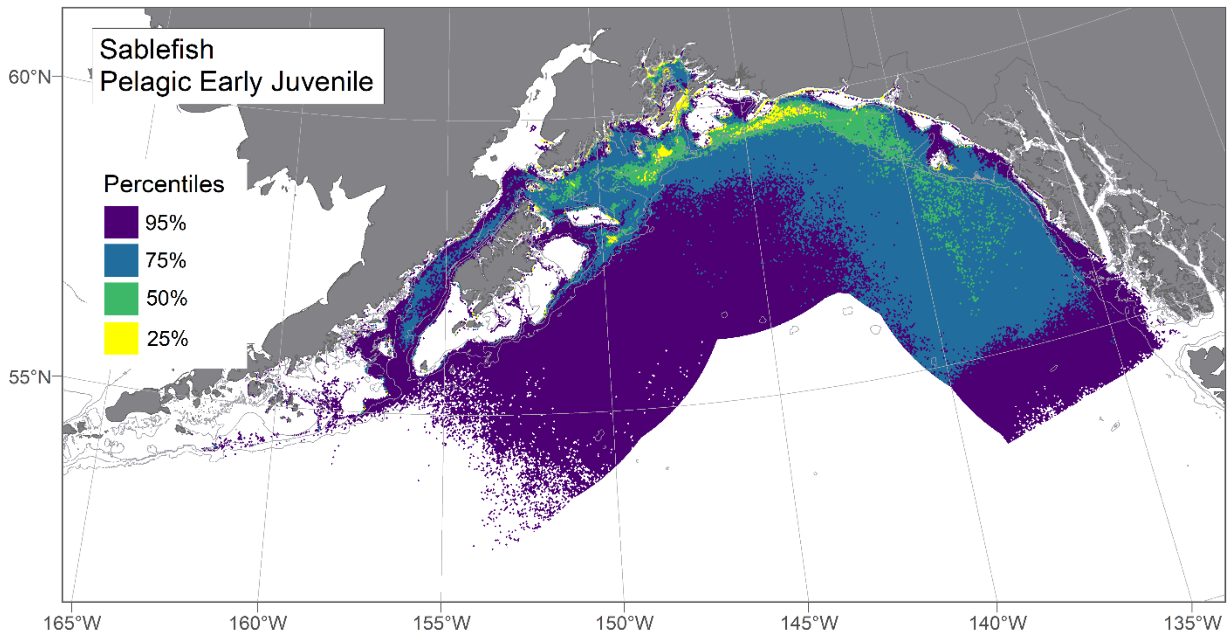

Figure 5-109 **EFH area of pelagic early juvenile sablefish, summer**

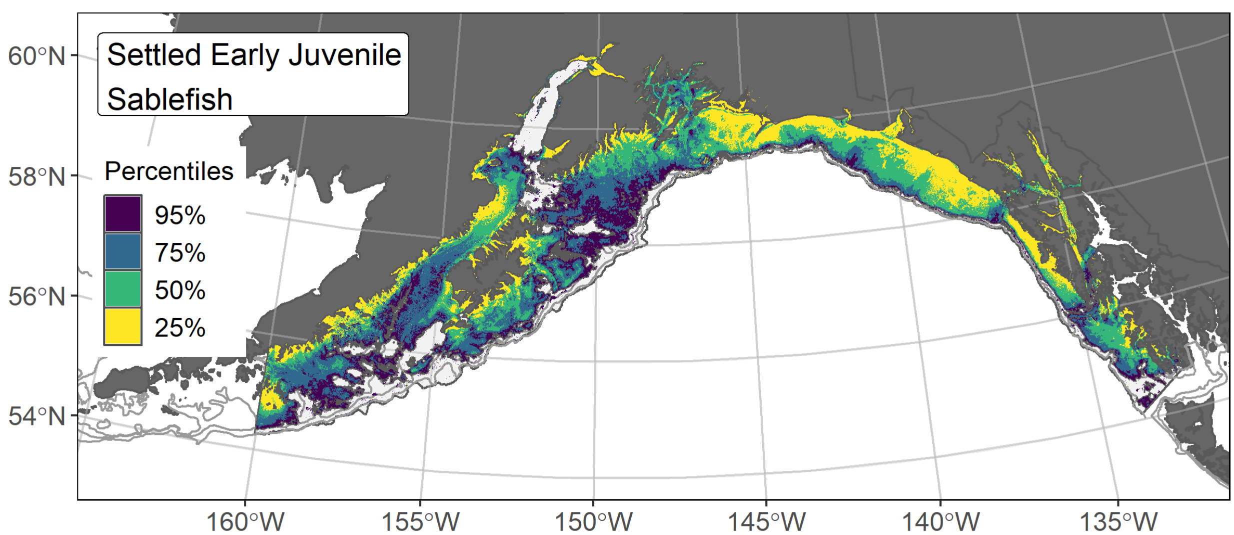

Figure 5-110 **EFH area of settled early juvenile sablefish, summer**

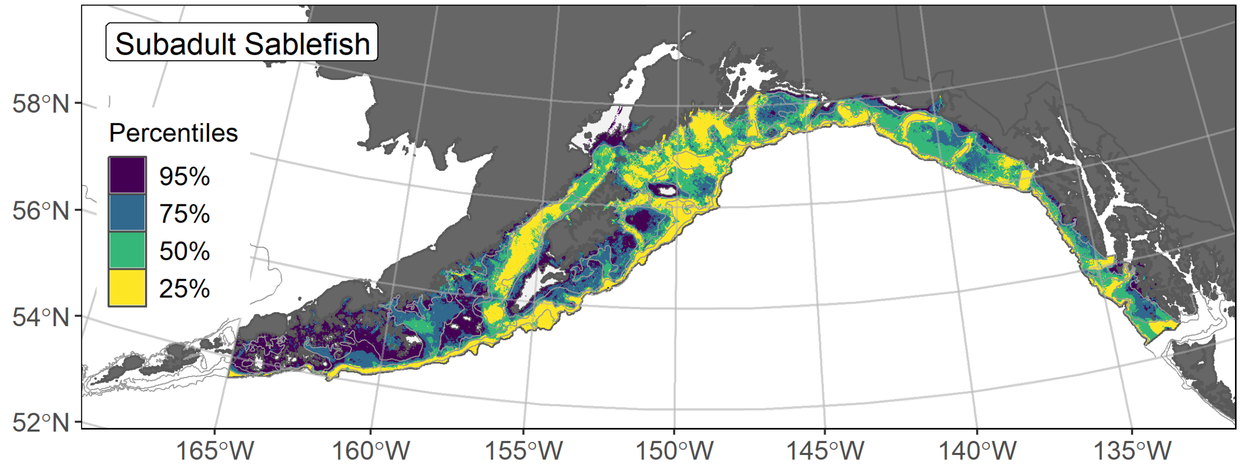

Figure 5-111 EFH area of subadult sablefish, summer

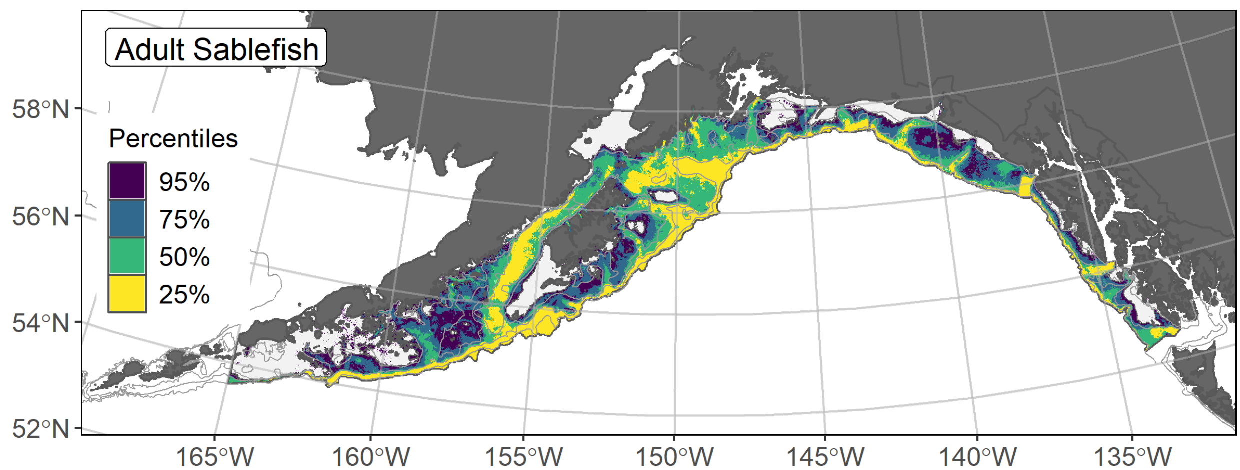

Figure 5-112 EFH area of adult sablefish, summer

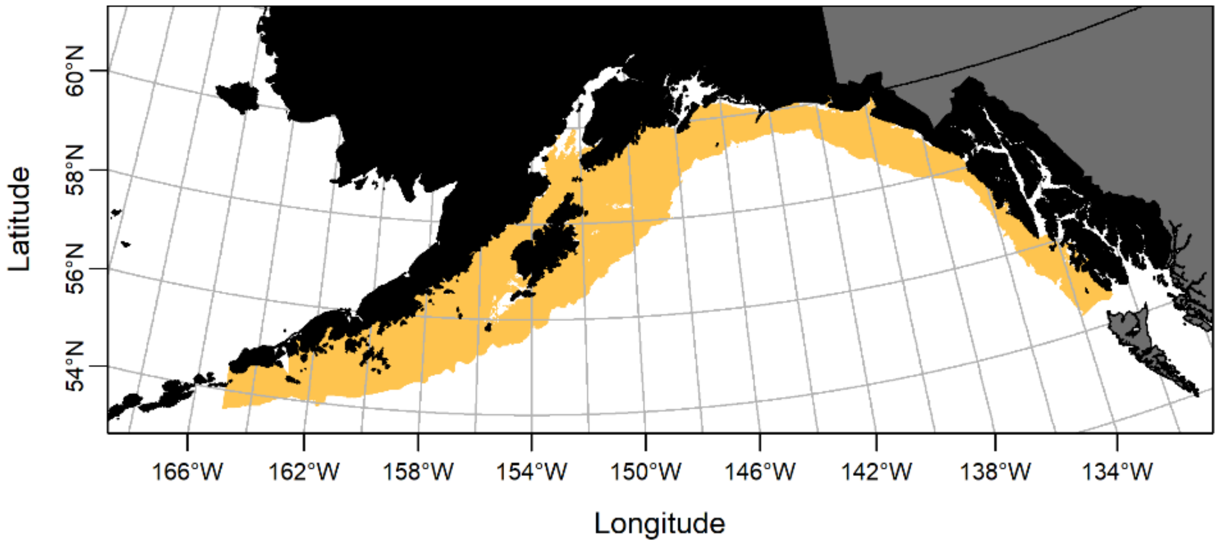

Figure 5-113 EFH area of adult sablefish, fall

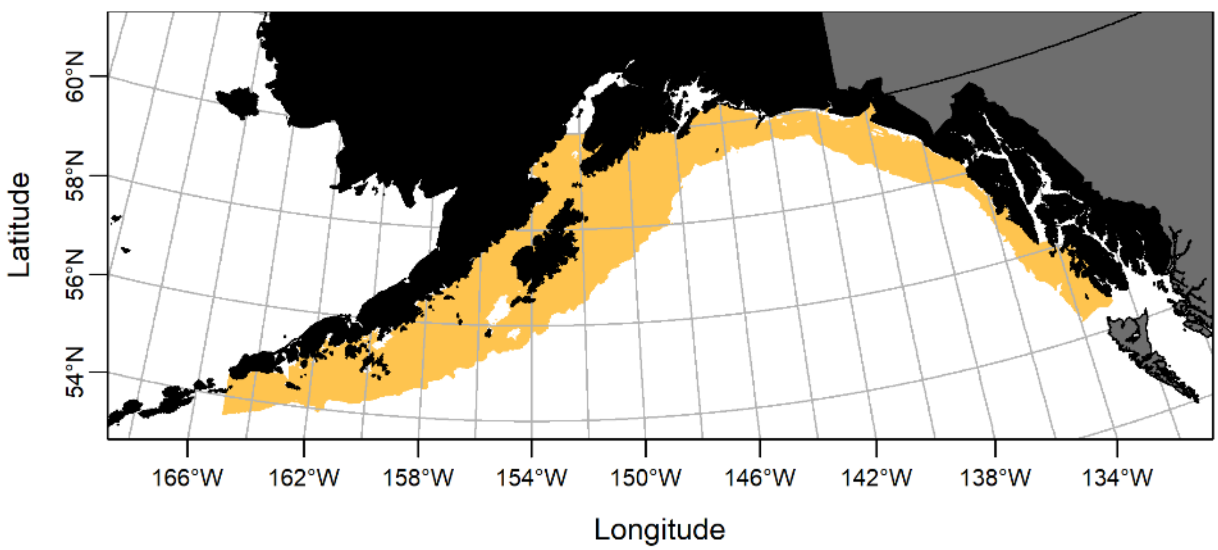

Figure 5-114 EFH area of adult sablefish, winter

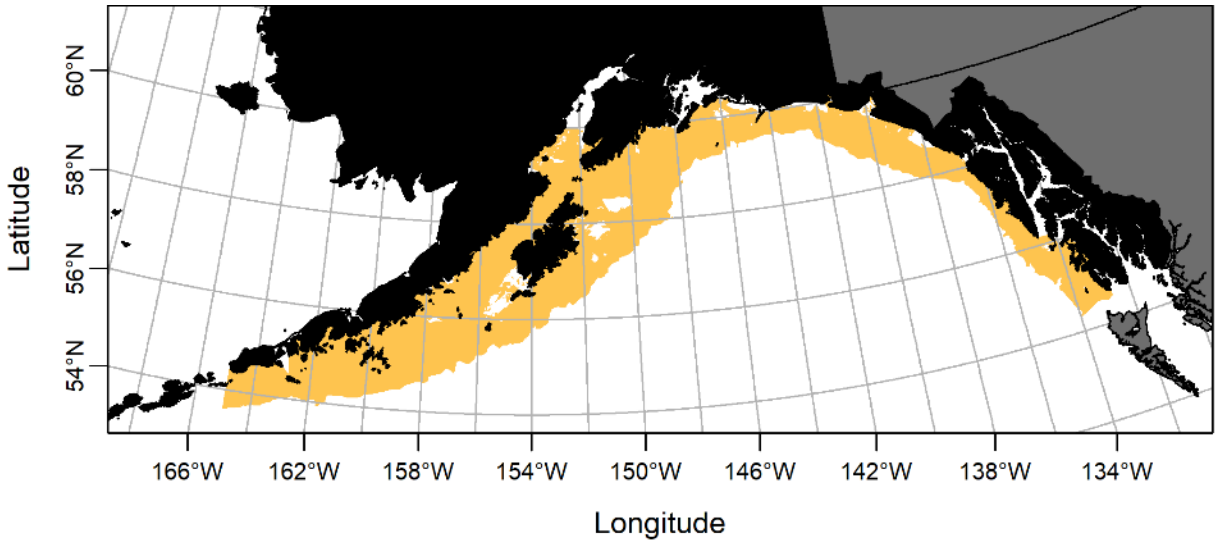

Figure 5-115 EFH area of adult sablefish, spring

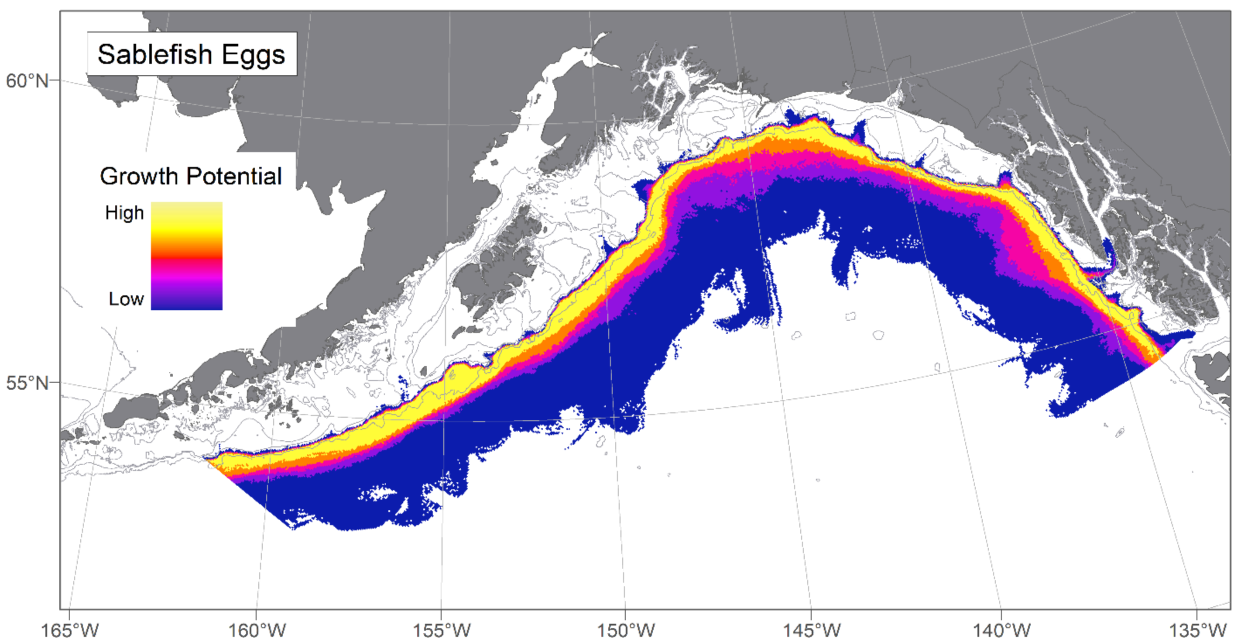

Figure 5-116 EFH area of sablefish eggs, habitat-related growth potential, summer

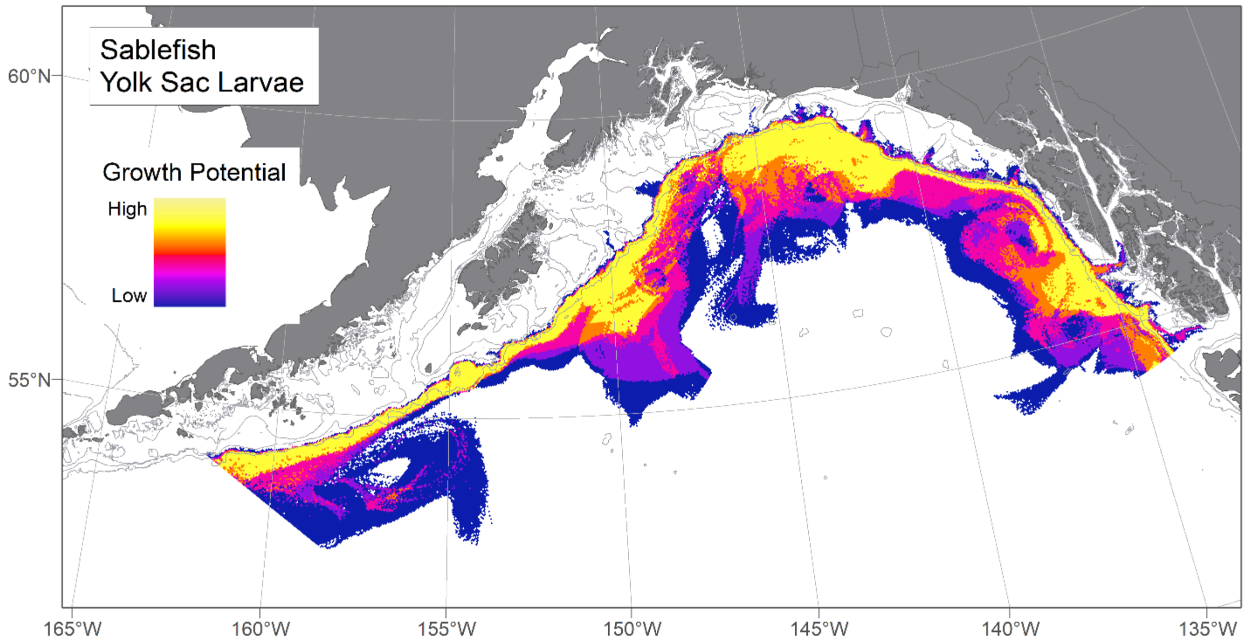

Figure 5-117 EFH area of sablefish yolk sac larvae, habitat-related growth potential, summer

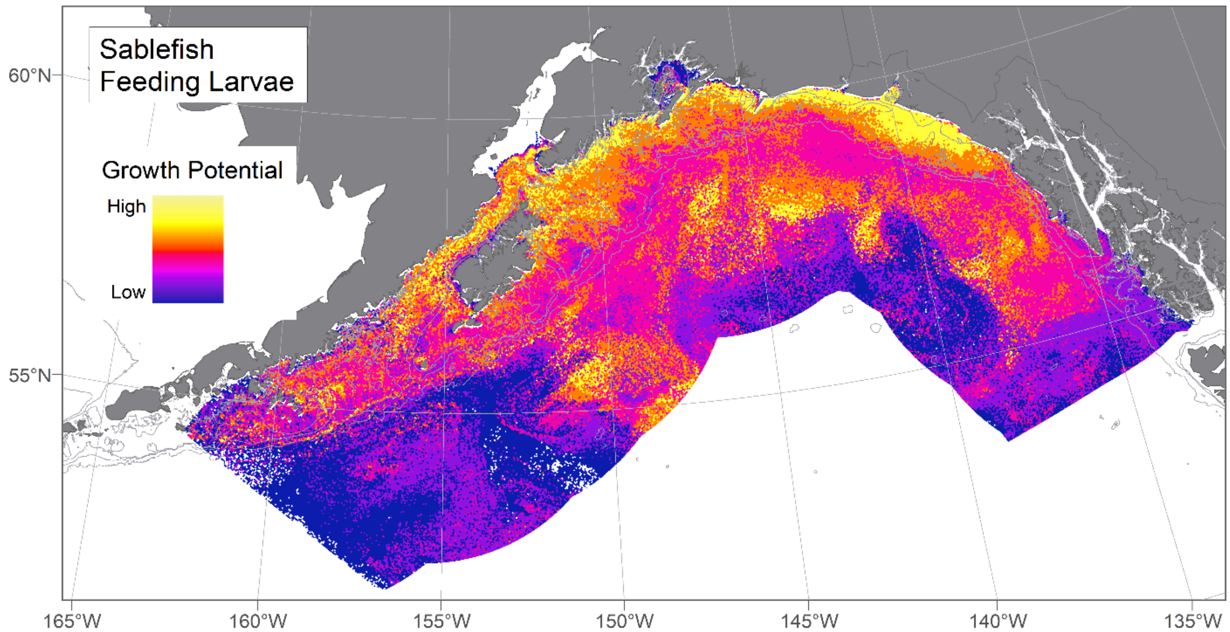

Figure 5-118 **EFH area of sablefish larvae feeding, habitat-related growth potential, summer**

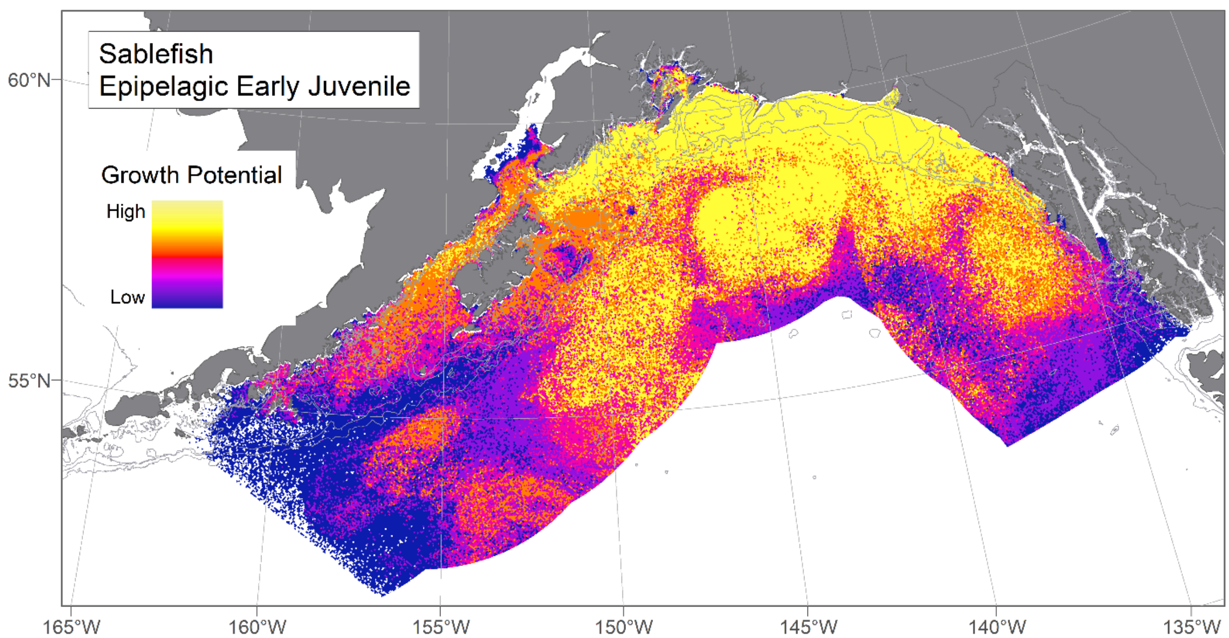

Figure 5-119 **EFH area of epipelagic early juvenile sablefish, habitat-related growth potential, summer**

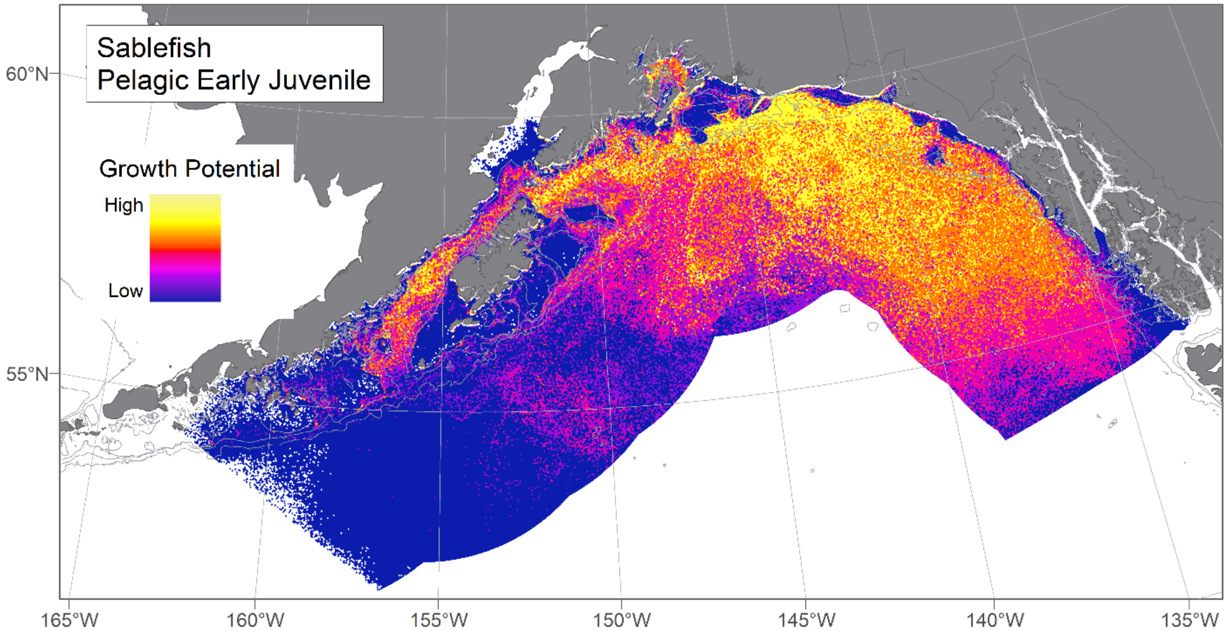

Figure 5-120 EFH area of pelagic early juvenile sablefish, habitat-related growth potential, summer

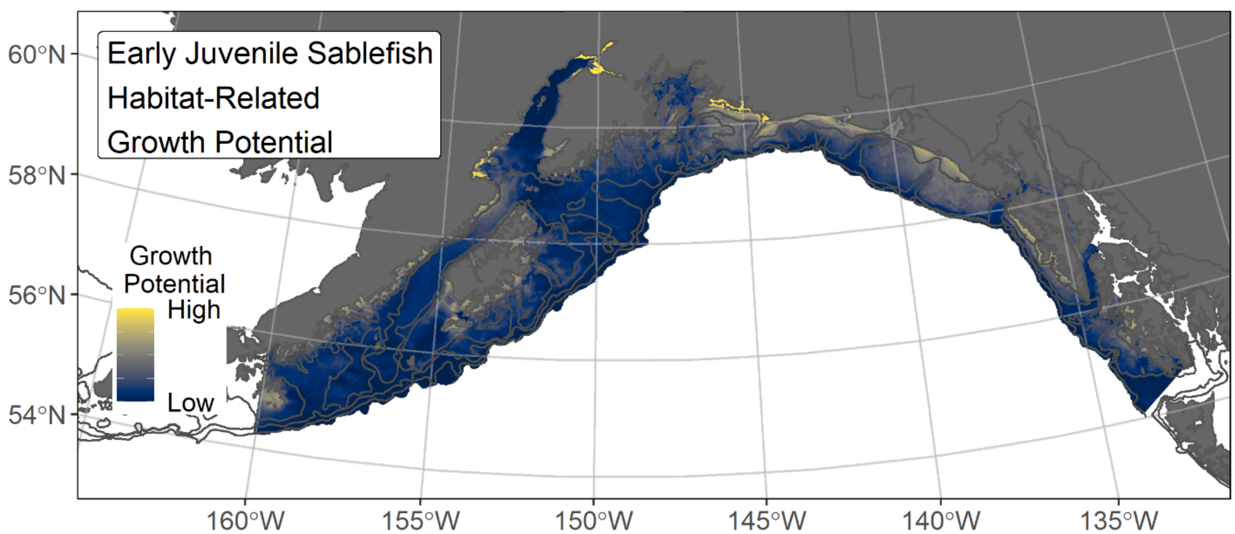

Figure 5-121 EFH area of settled early juvenile sablefish, habitat-related growth potential, summer

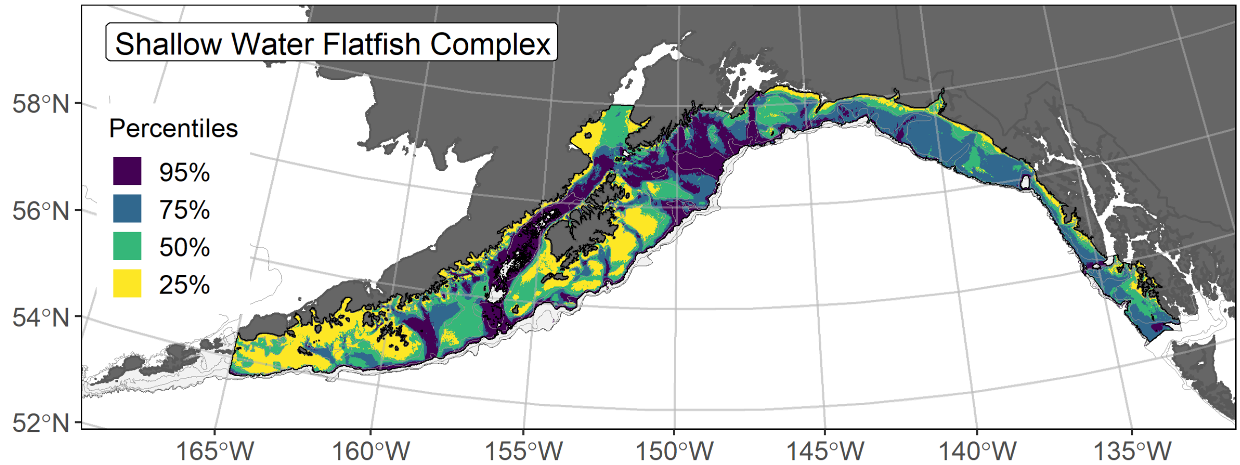

Figure 5-122 EFH area of subadult/adult shallow water flatfish complex, summer

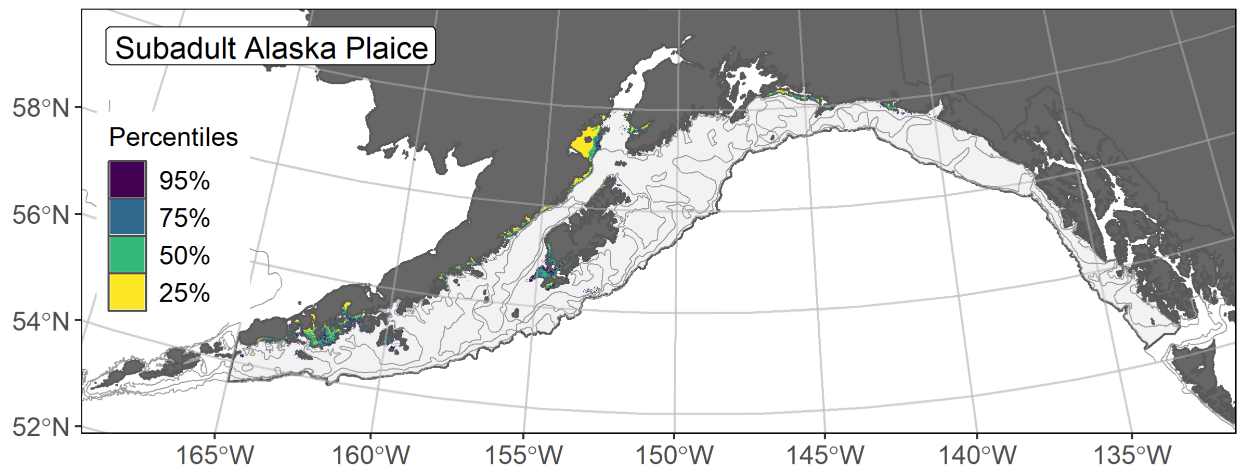

Figure 5-123 EFH area of subadult Alaska plaice, summer

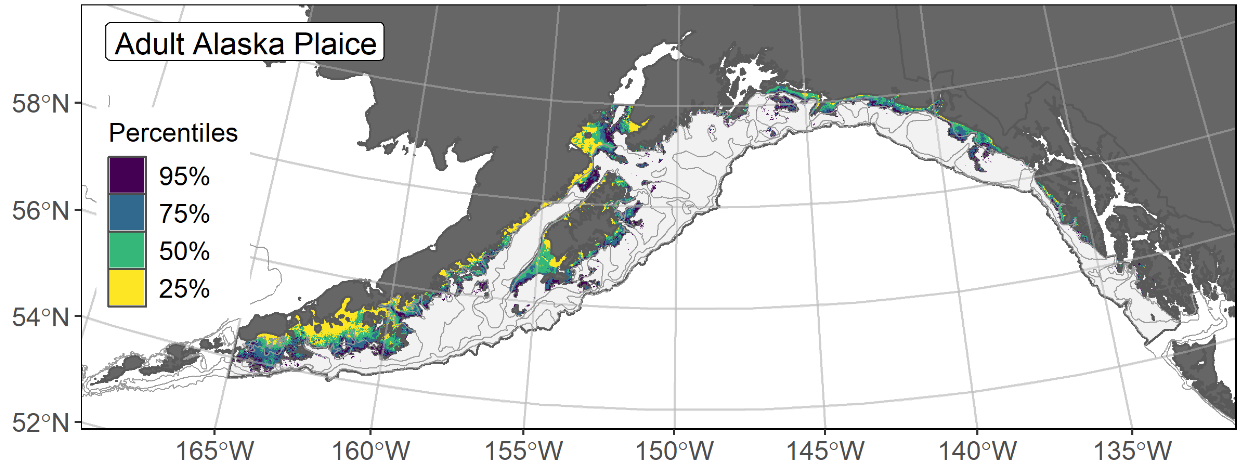

Figure 5-124 EFH area of adult Alaska plaice, summer

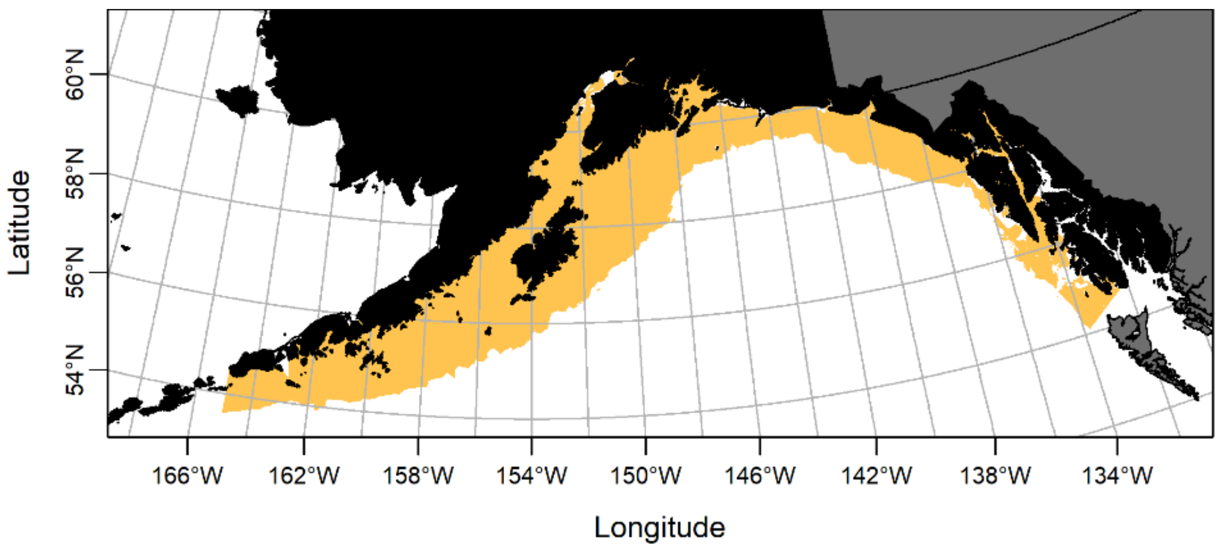

Figure 5-125 EFH area of Alaska plaice eggs, summer

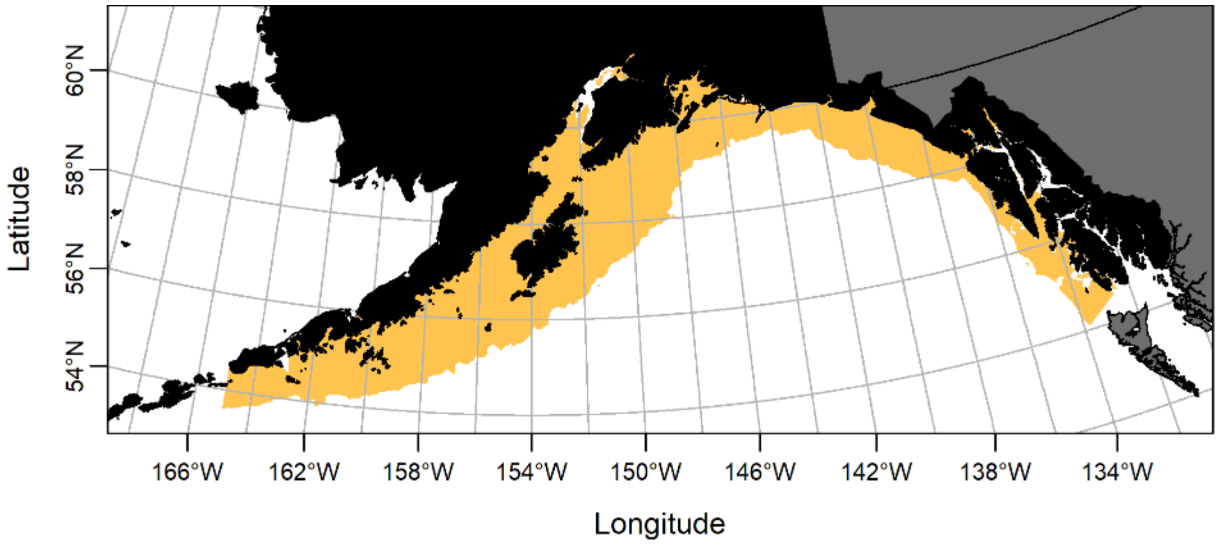

Figure 5-126 EFH area of Alaska plaice larvae, summer

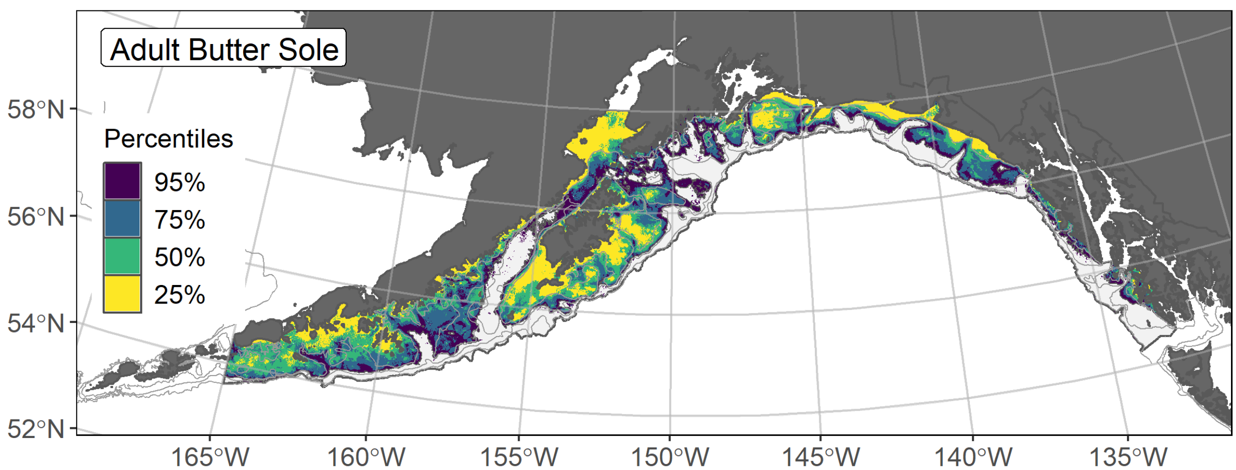

Figure 5-127 EFH area of subadult/adult butter sole, summer

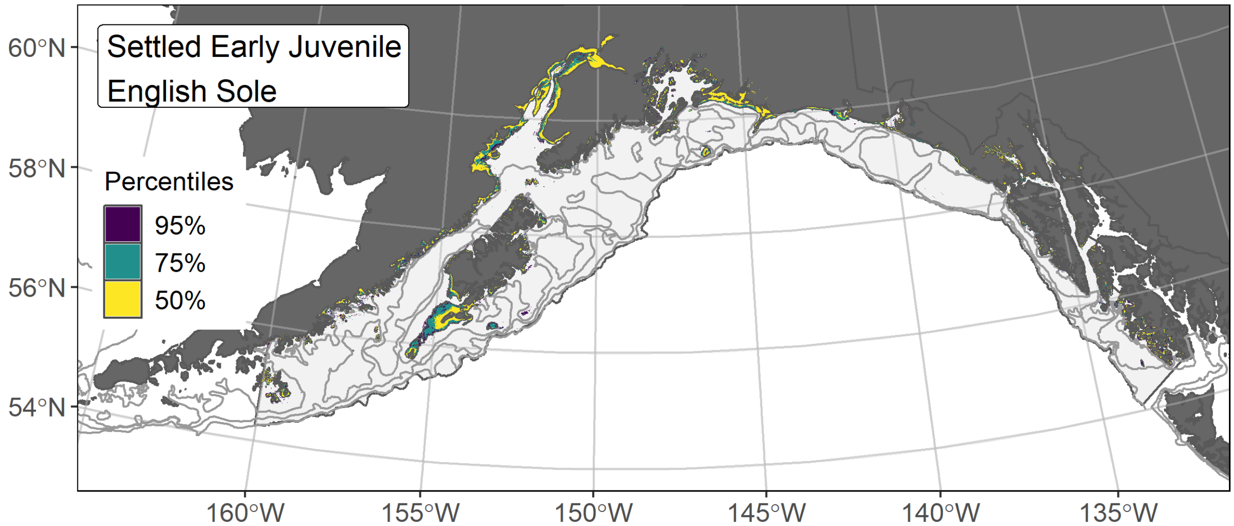

Figure 5-128 **EFH area of settled early juvenile English sole, summer**

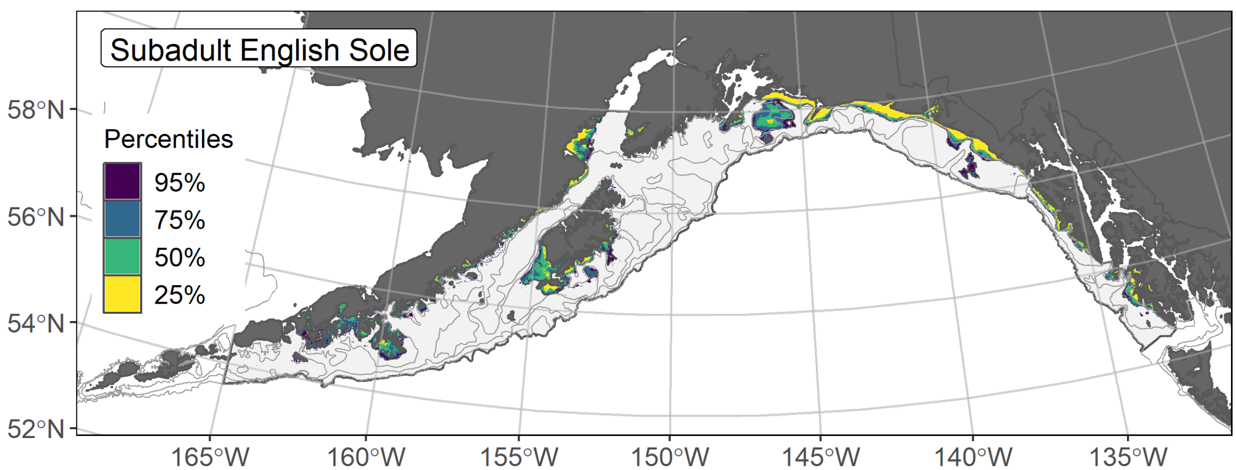

Figure 5-129 **EFH area of subadult English sole, summer**

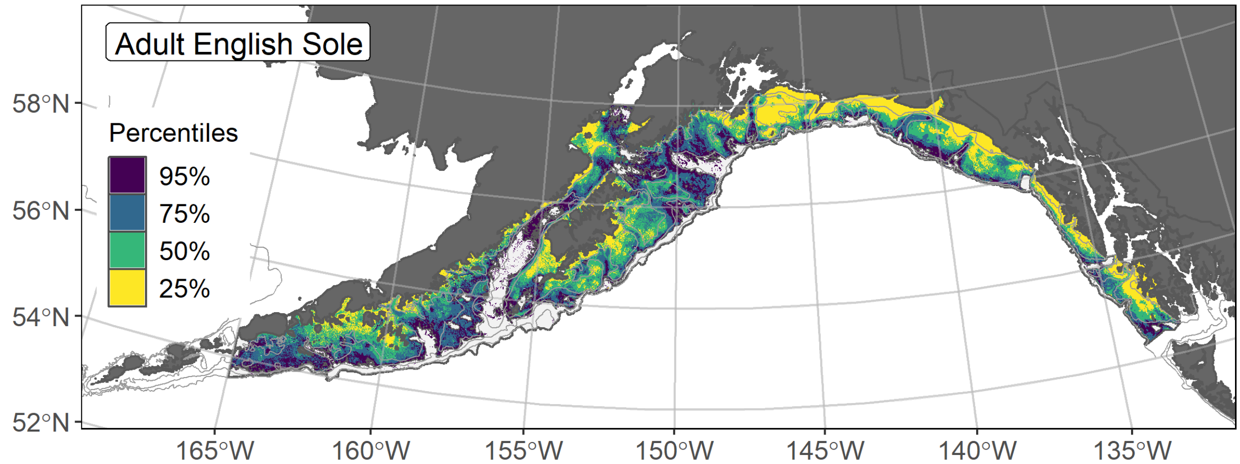

Figure 5-130 EFH area of adult English sole, summer

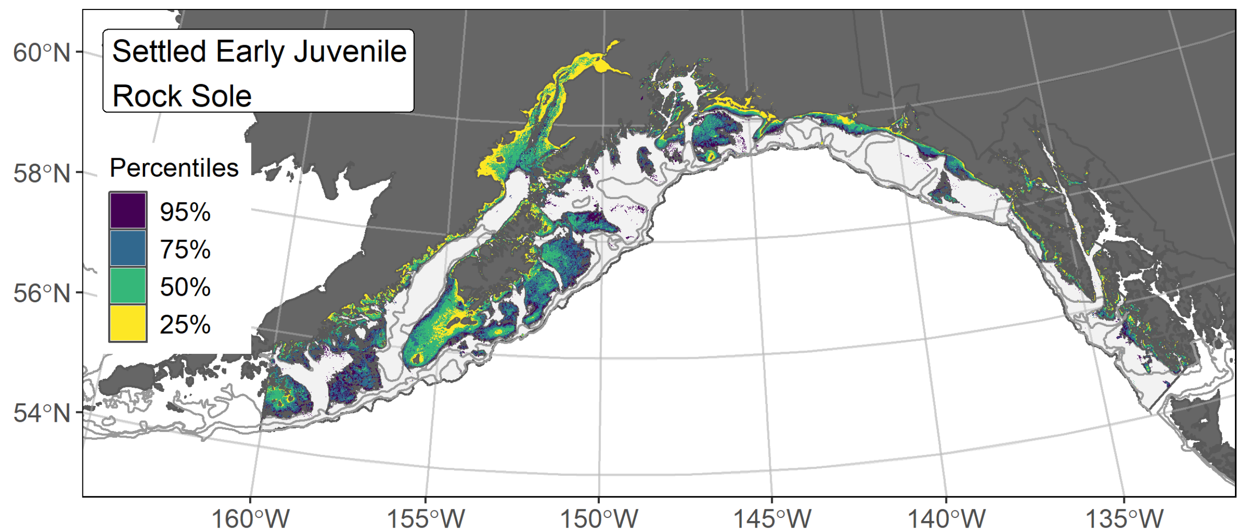

Figure 5-131 EFH area of settled early juvenile rock sole, summer

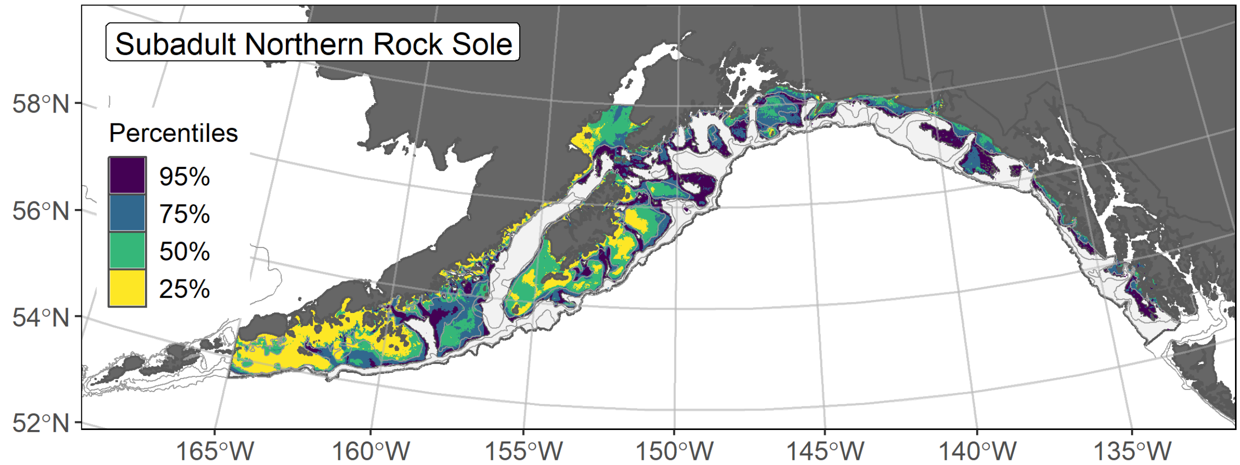

Figure 5-132 EFH area of subadult northern rock sole, summer

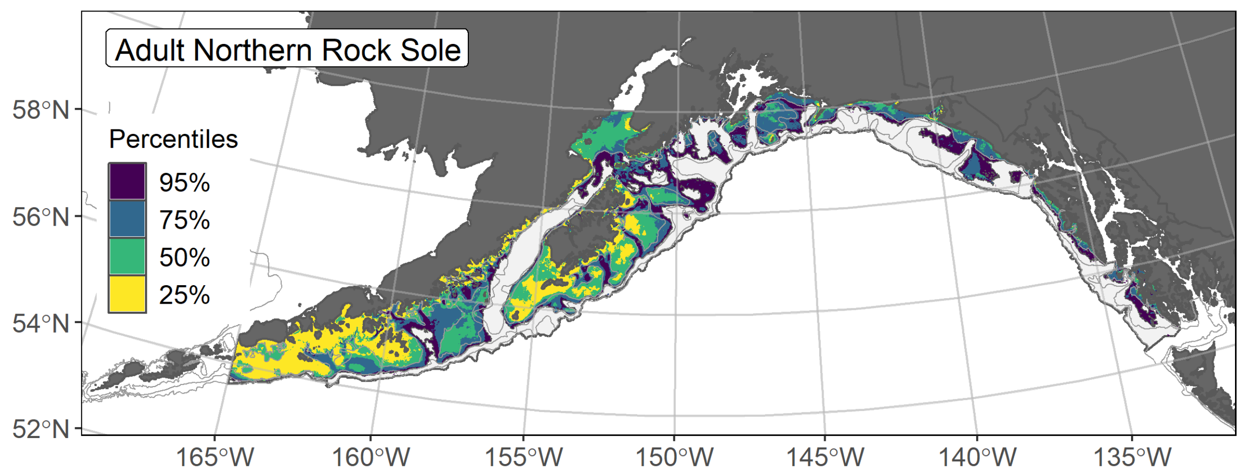

Figure 5-133 EFH area of adult northern rock sole, summer

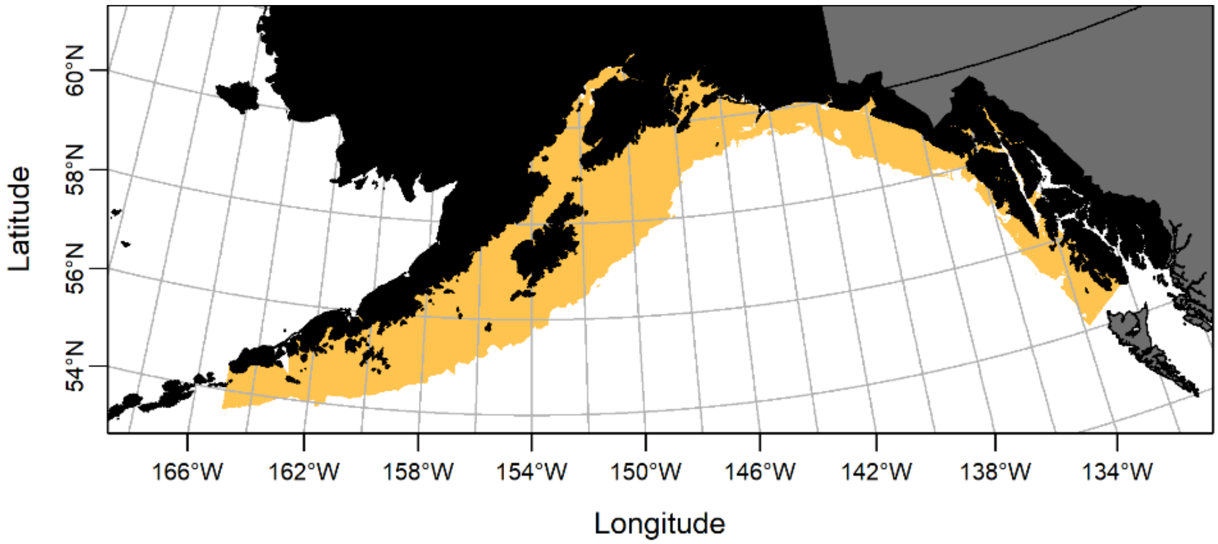

Figure 5-134 EFH area of northern rock sole larvae, summer

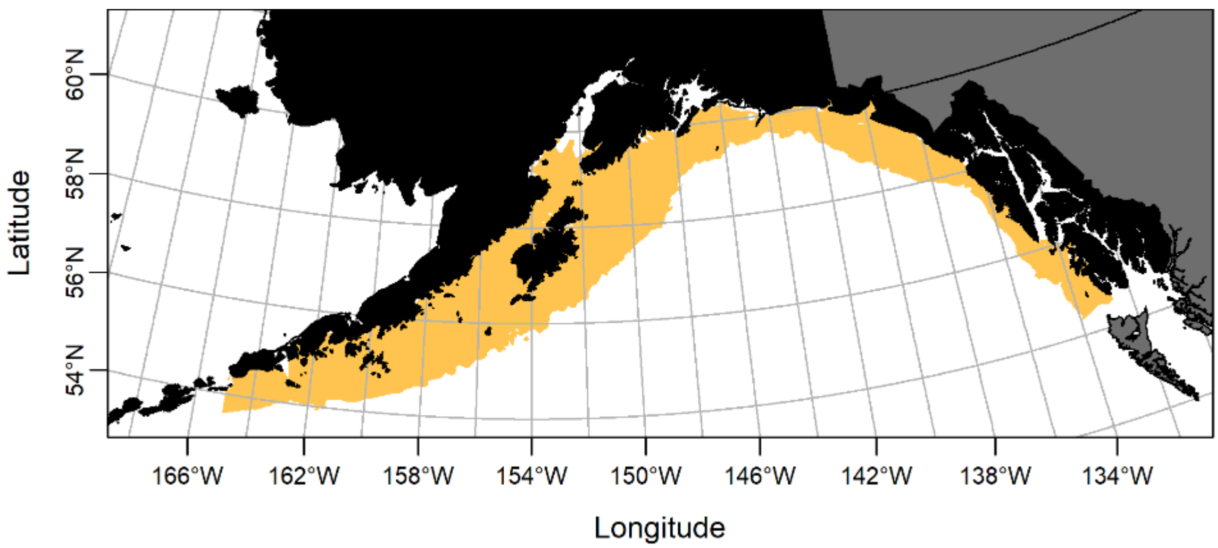

Figure 5-135 EFH area of adult northern rock sole, fall

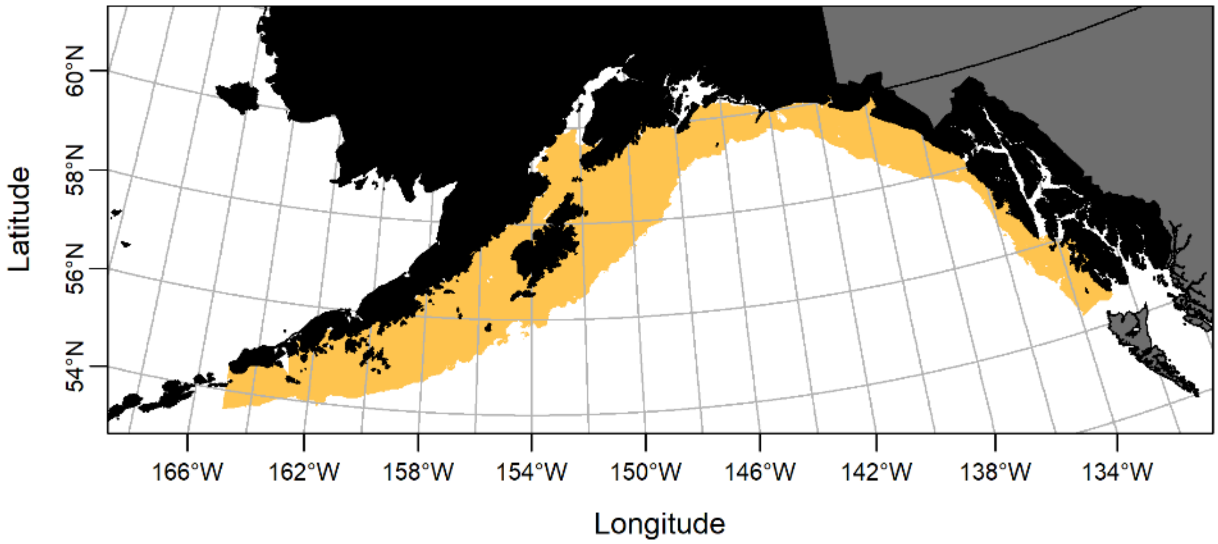

Figure 5-136EFH area of adult northern rock sole, winter

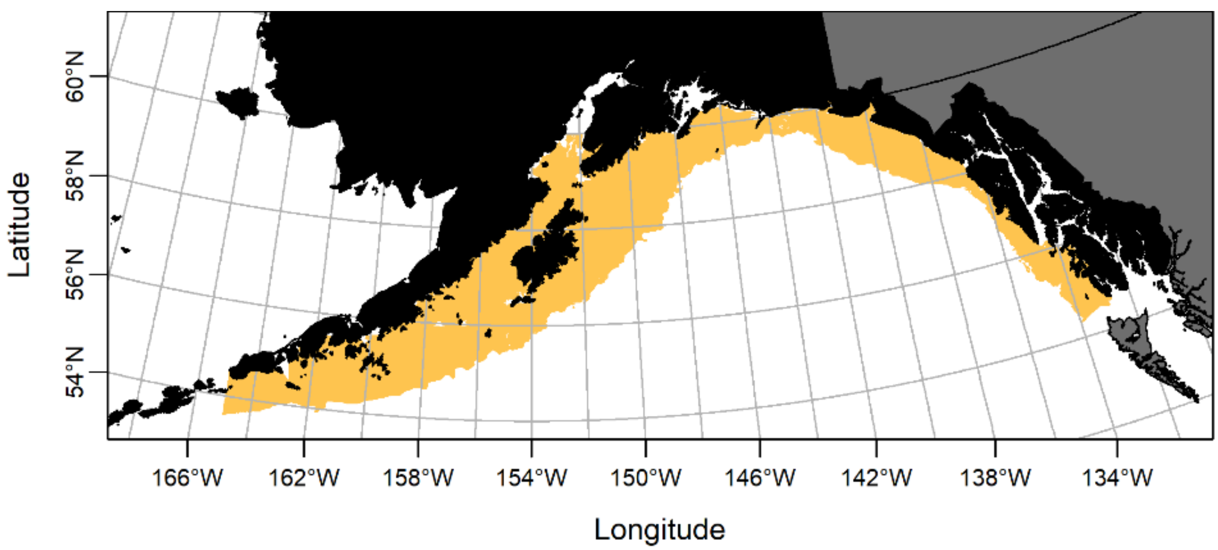

Figure 5-137 EFH area of adult northern rock sole, spring

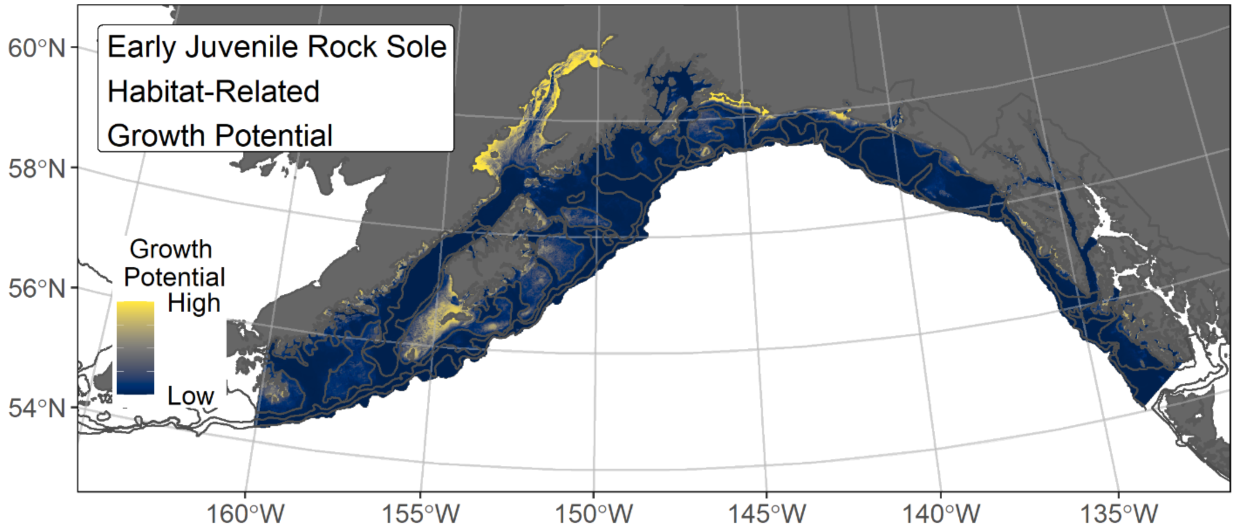

Figure 5-138 EFH area of settled early juvenile rock sole, habitat-related growth portential summer

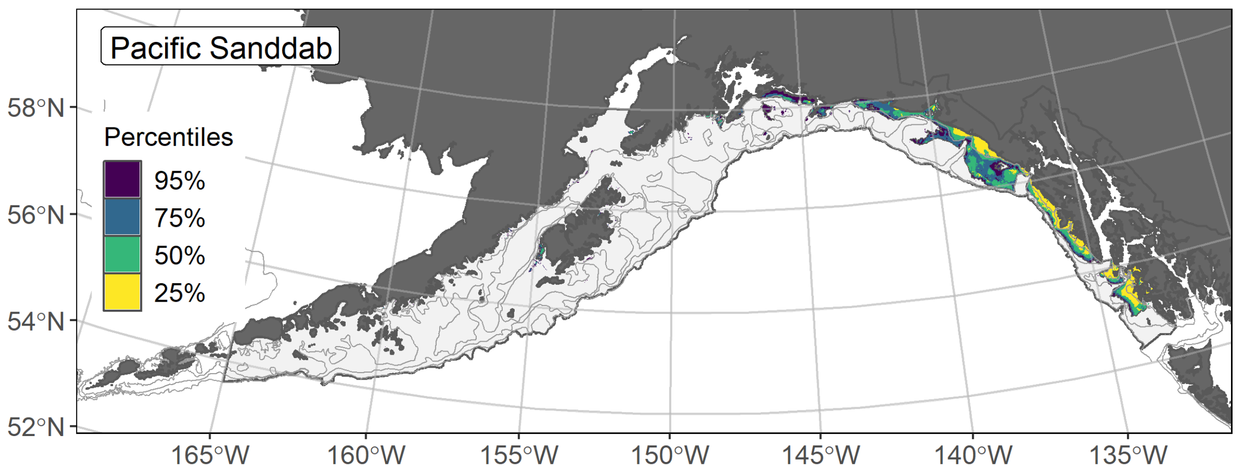

Figure 5-139 EFH area of subadult/adult Pacific sanddab, summer

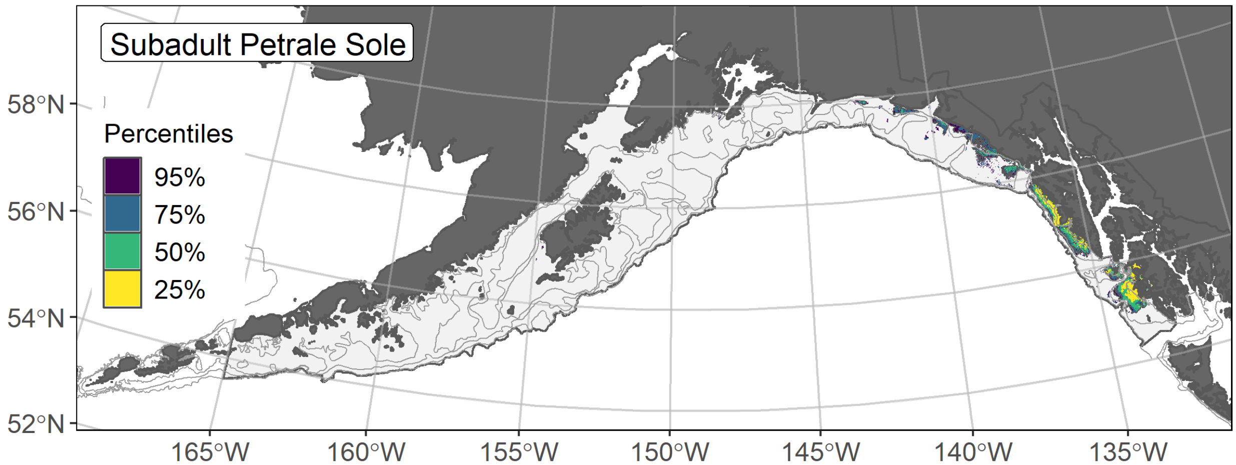

Figure 5-140 EFH area of subadult Petrale sole, summer

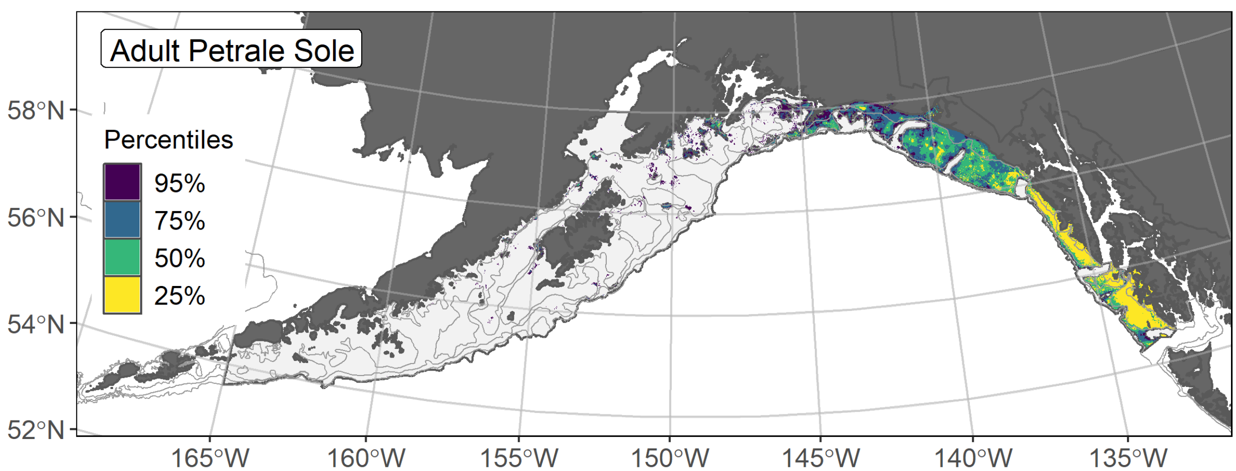

Figure 5-141 EFH area of adult Petrale sole, summer

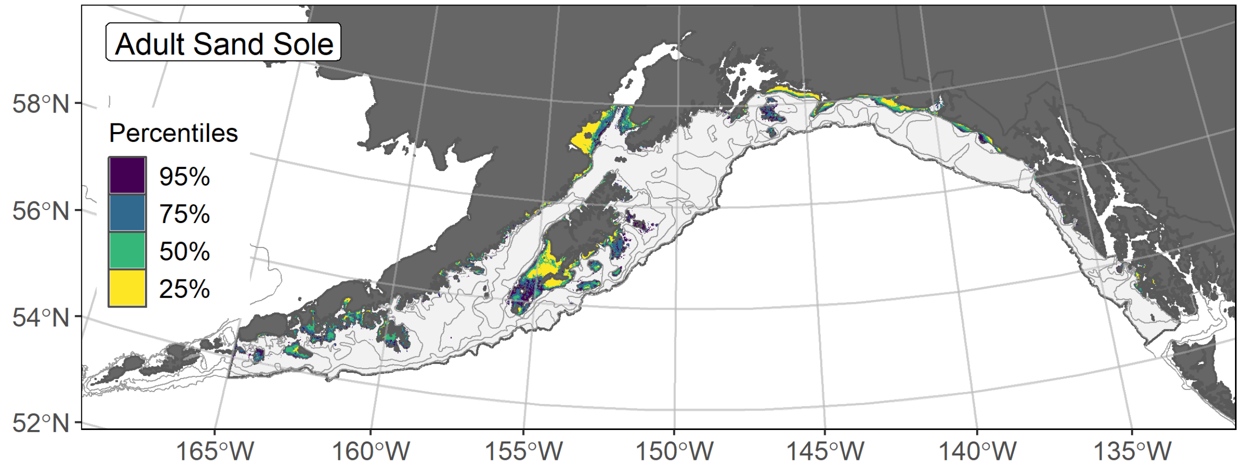

Figure 5-142 EFH area of adult sand sole, summer

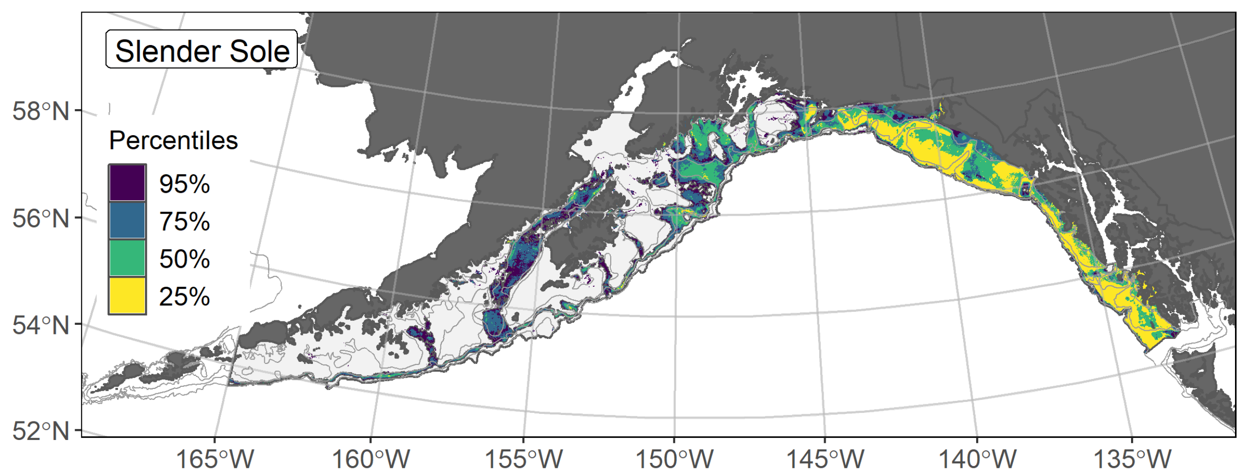

Figure 5-143 EFH area of subadult/adult slender sole, summer

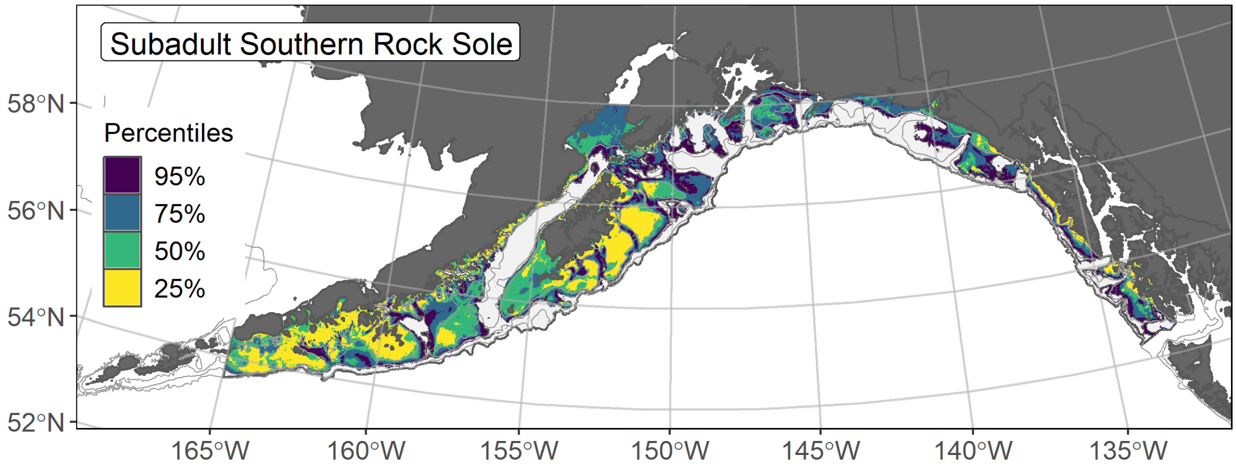

Figure 5-144EFH area of subadult southern rock sole, summer

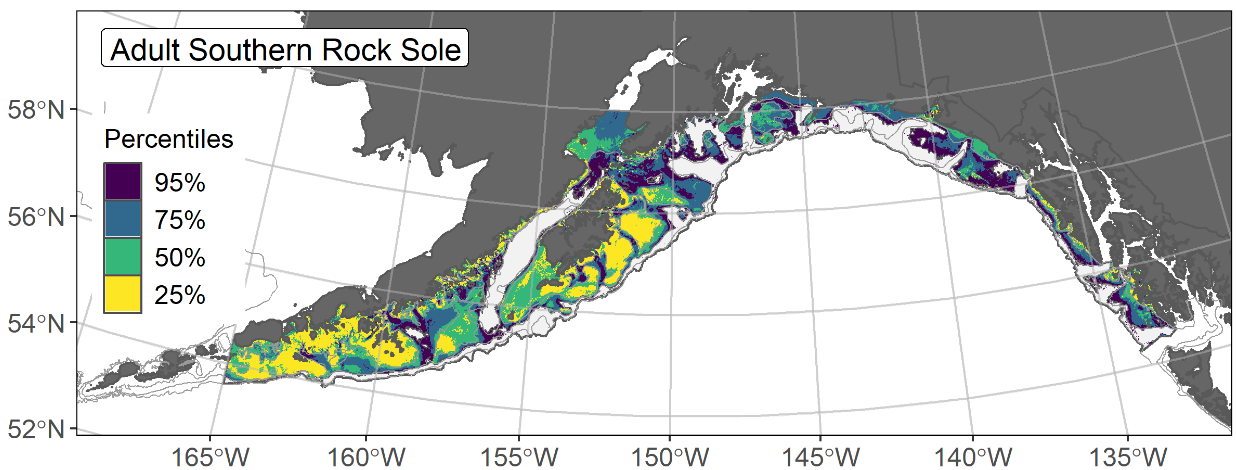

Figure 5-145EFH area of adult southern rock sole, summer

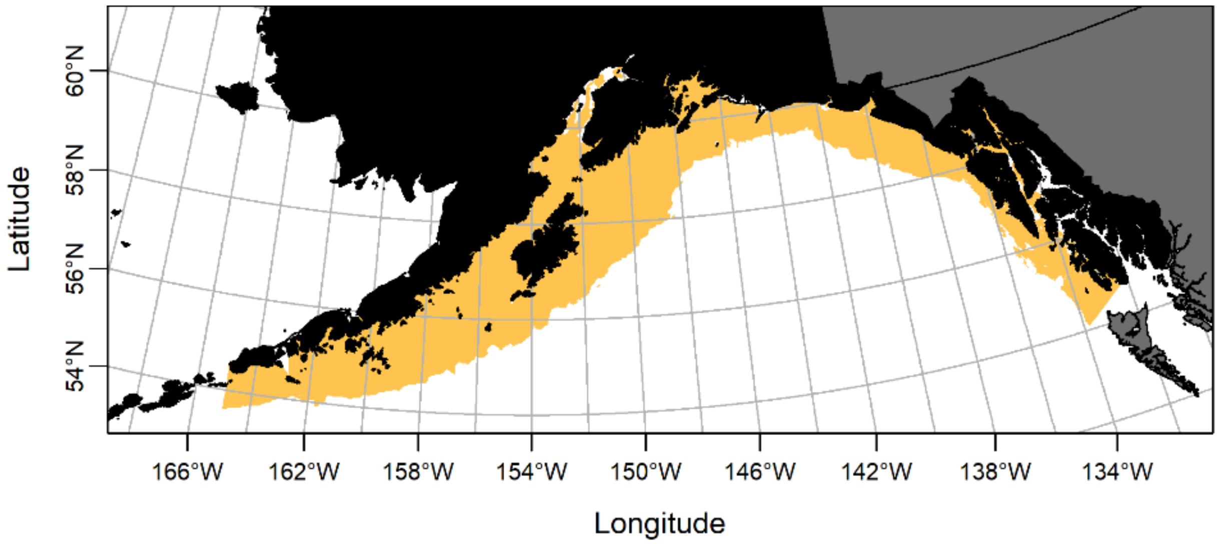

Figure 5-146 EFH area of southern rock sole larvae, summer

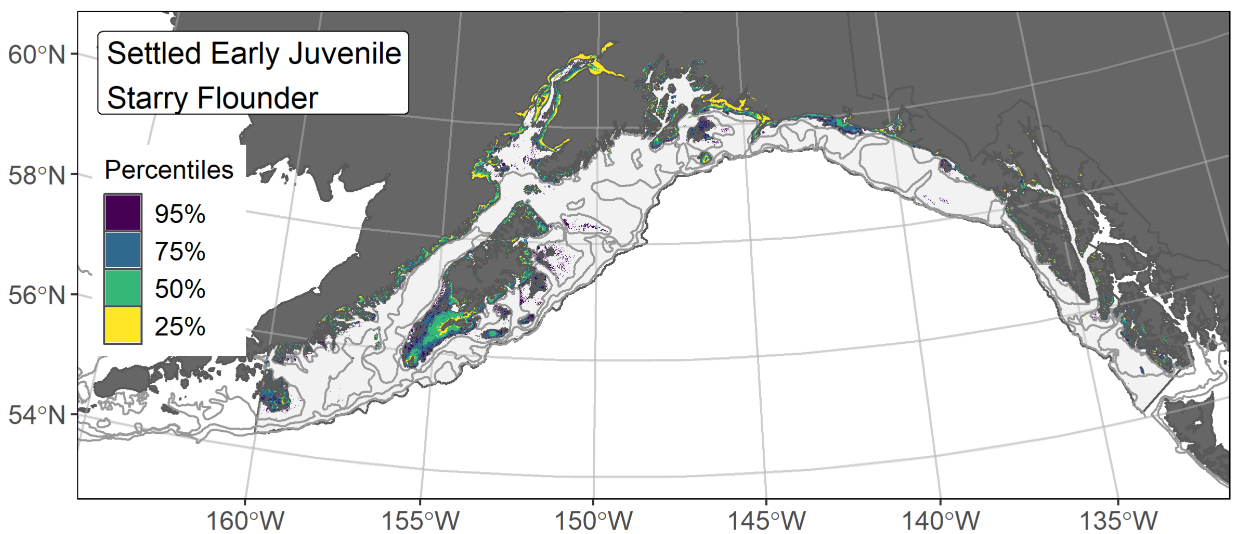

Figure 5-147 EFH area of settled early juvenile starry flounder, summer

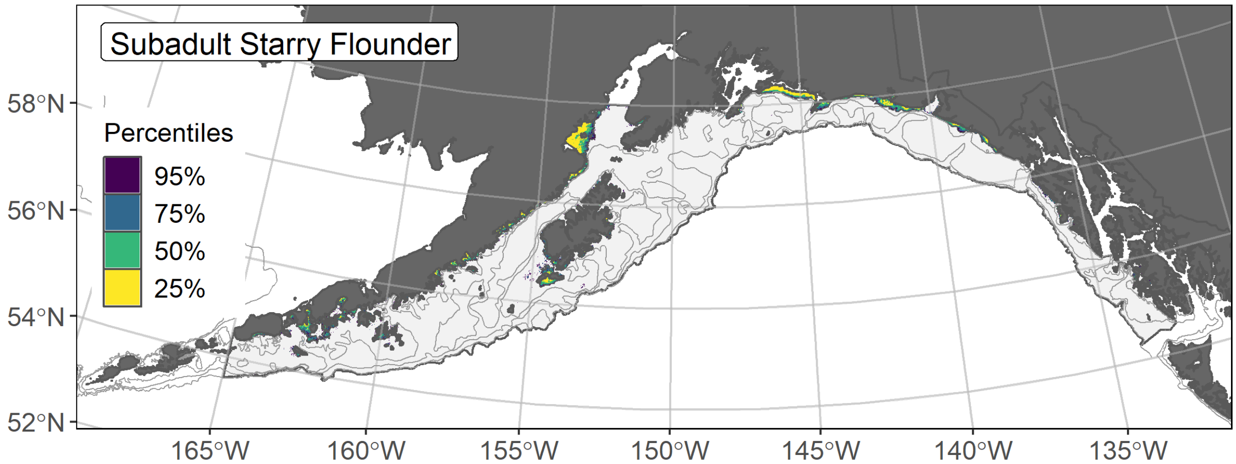

Figure 5-148 EFH area of subadult starry flounder, summer

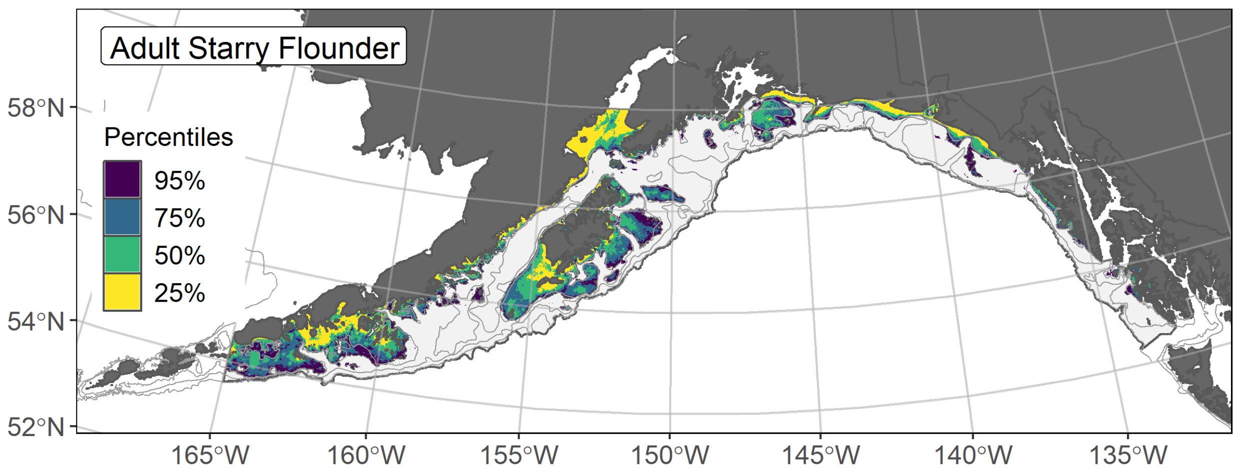

Figure 5-149 EFH area of adult starry flounder, summer

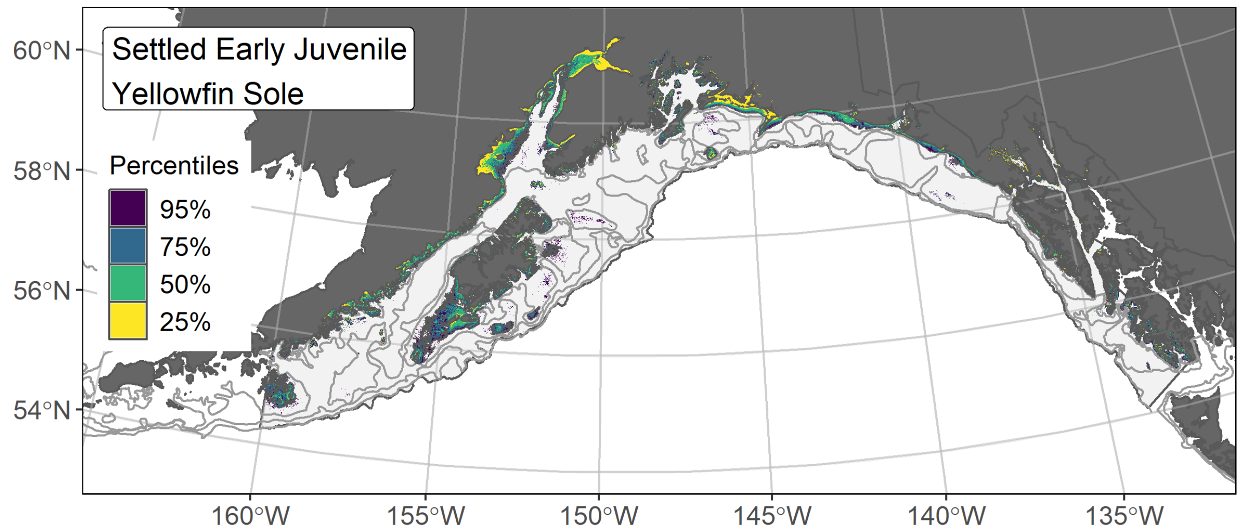

Figure 5-150EFH area of settled early juvenile yellowfin sole, summer

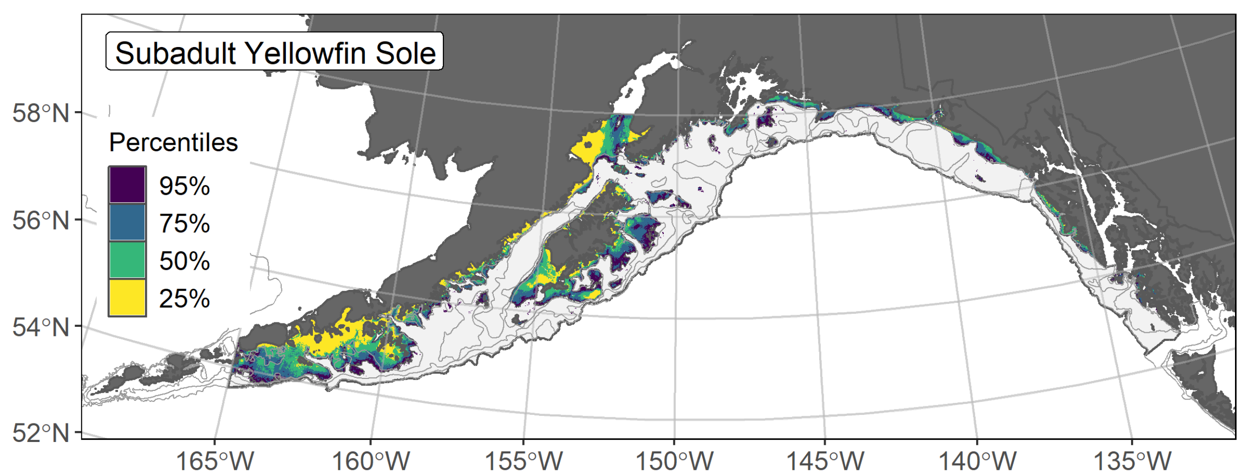

Figure 5-151EFH area of subadult yellowfin sole, summer

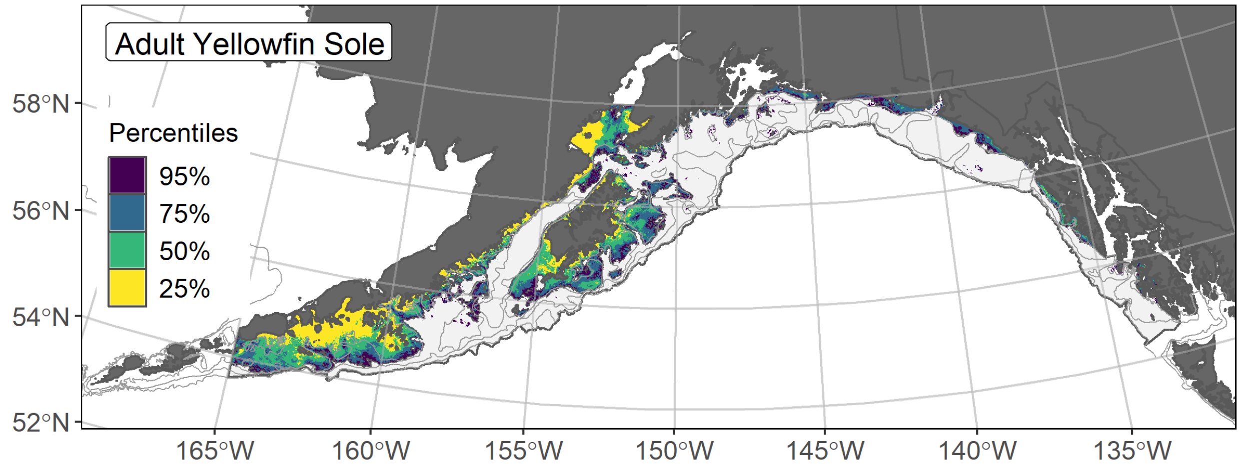

Figure 5-152EFH area of adult yellowfin sole, summer

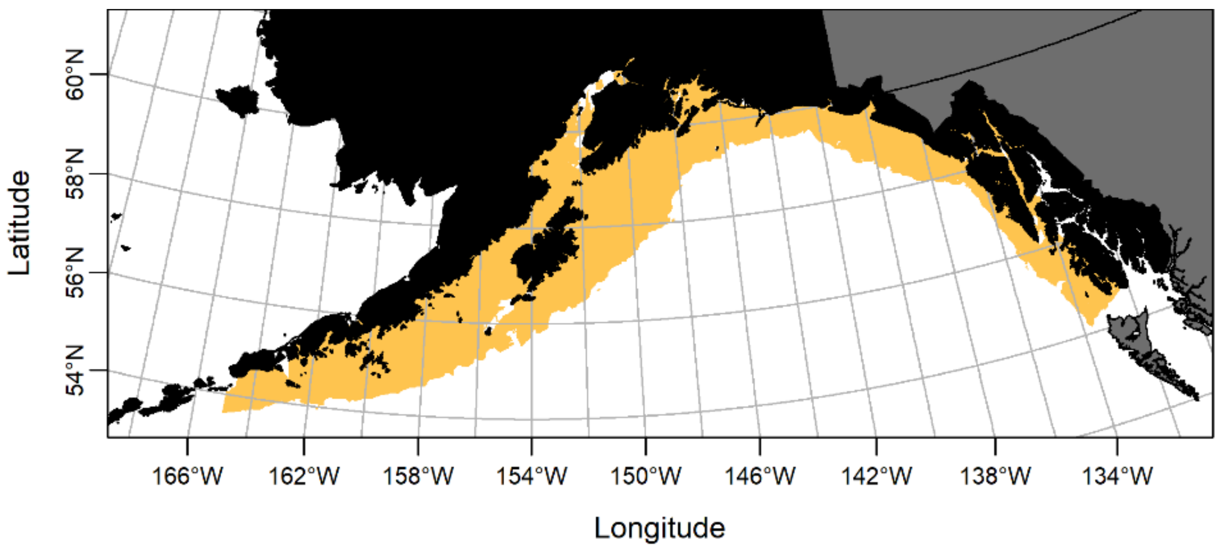

Figure 5-153 EFH area of yellowfin sole eggs, summer

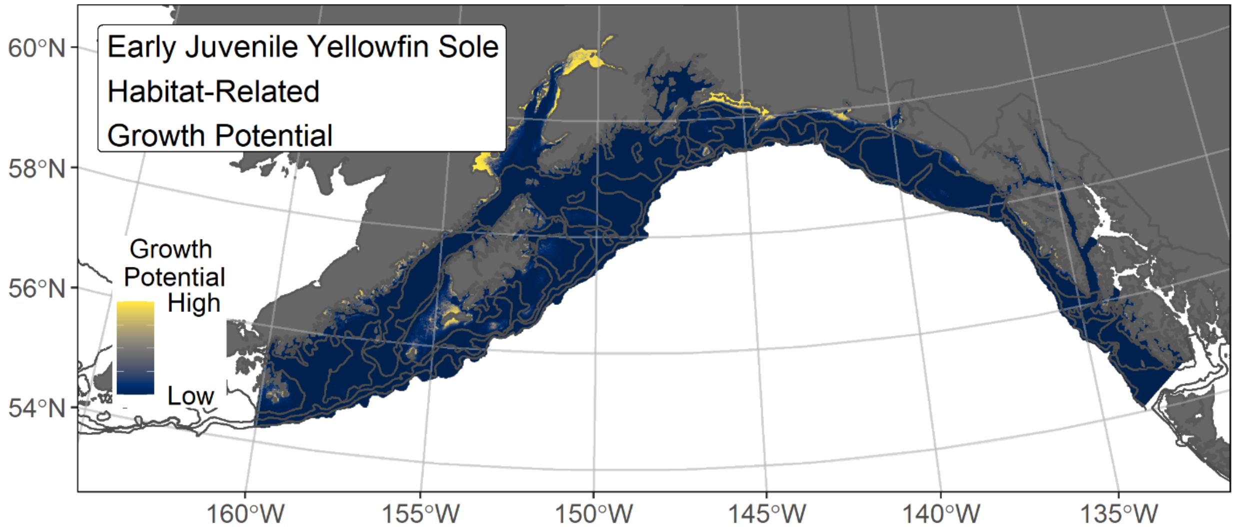

Figure 5-154 EFH area of settled early juvenile yellowfin sole, habitat-related growth potential, summer

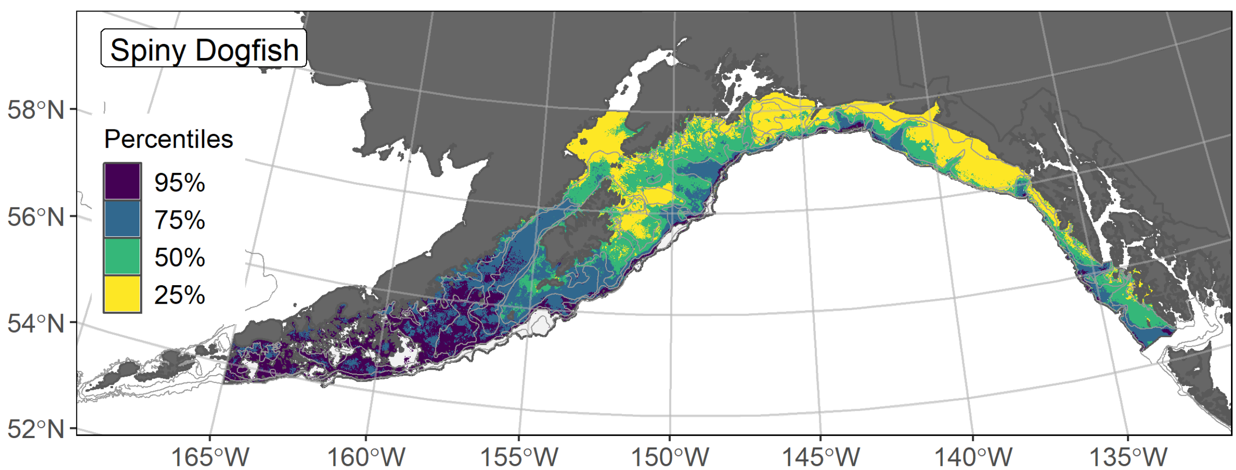

Figure 5-155 EFH area of subadult/adult spiny dogfish, summer

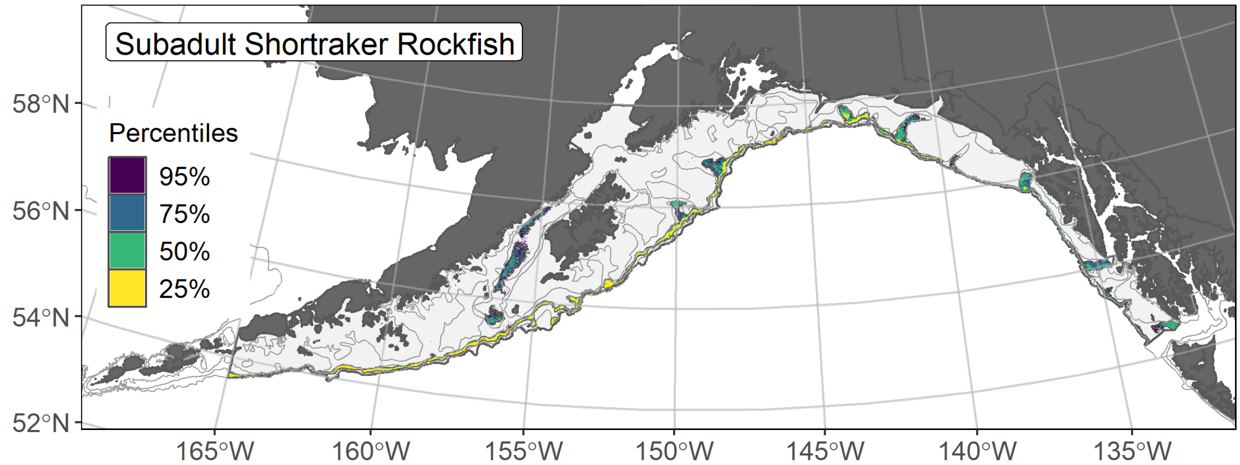

Figure 5-156 EFH area of subadult shortraker rockfish, summer

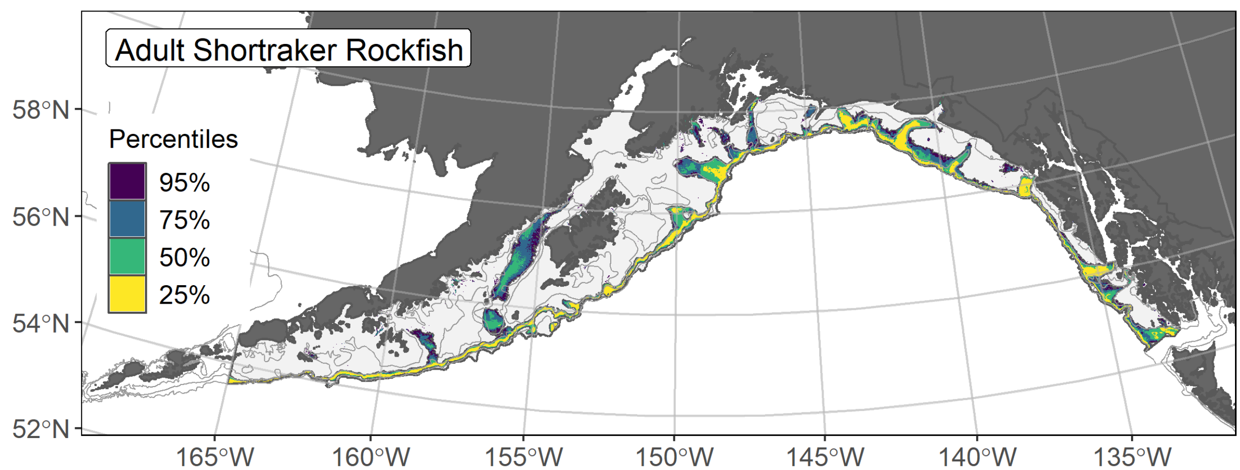

Figure 5-157 EFH area of adult shortraker rockfish, summer

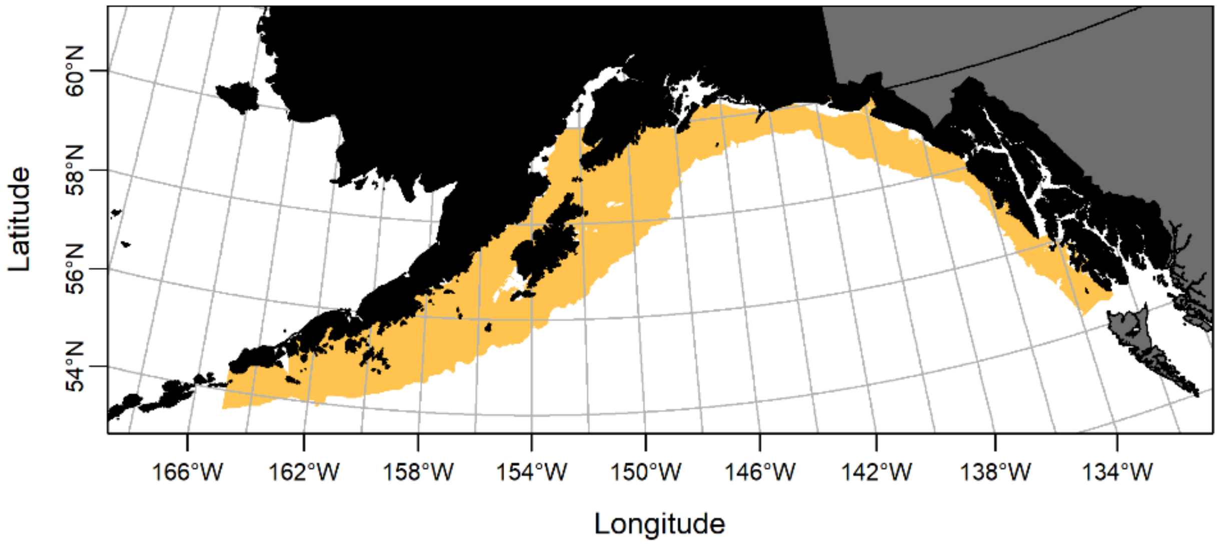

Figure 5-158 **EFH area of adult shortraker rockfish, fall**

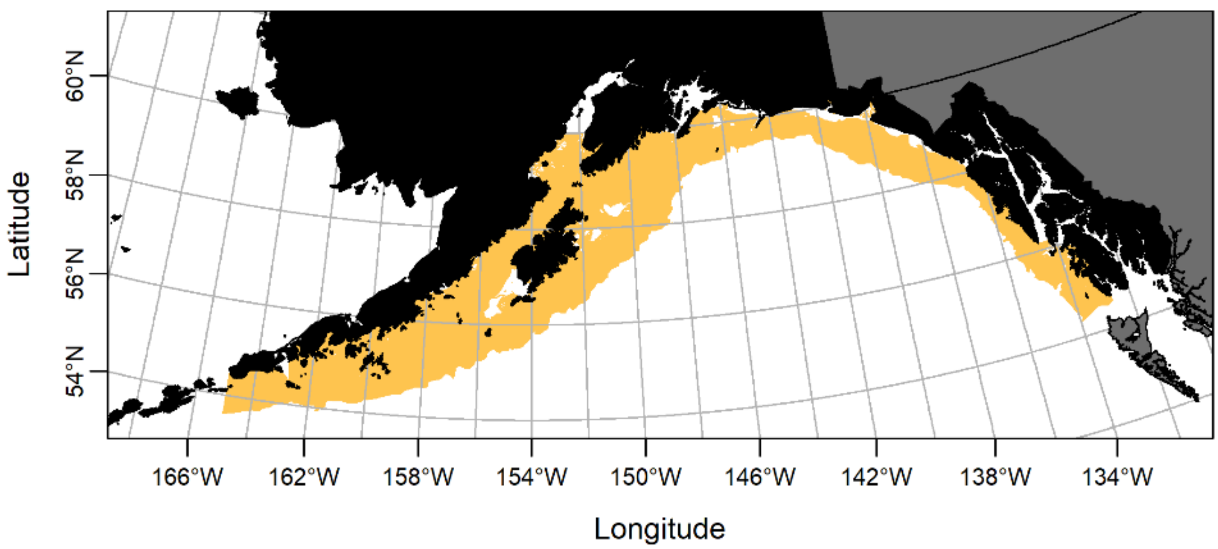

Figure 5-159 **EFH area of adult shortraker rockfish, spring**

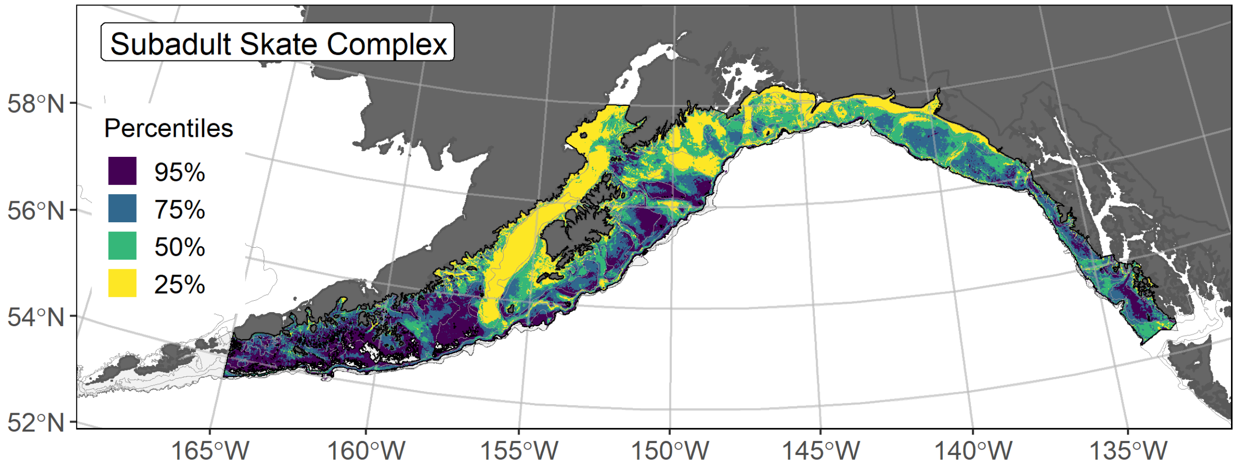

Figure 5-160 EFH area of subadult skate complex, summer

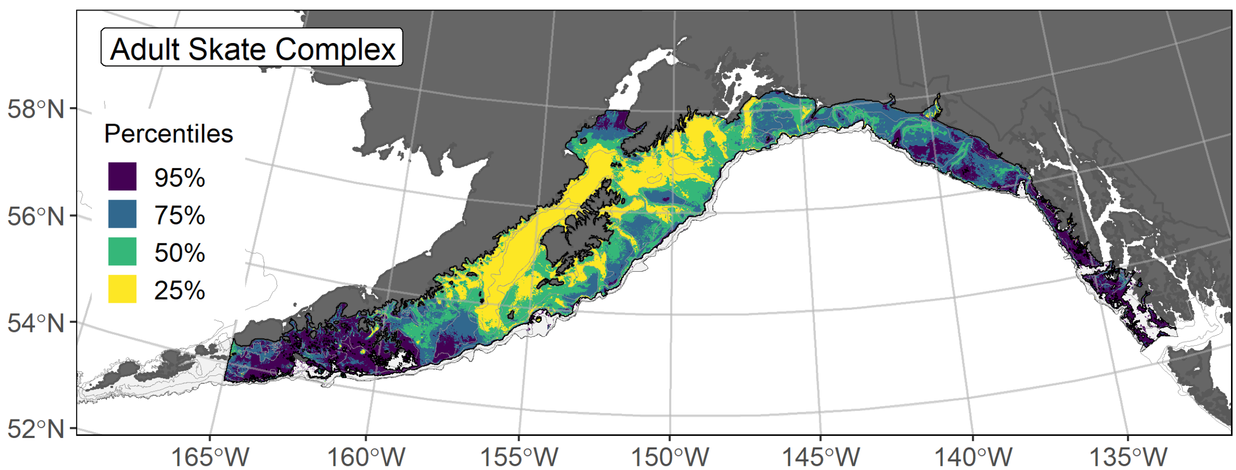

Figure 5-161 EFH area of adult skate complex, summer

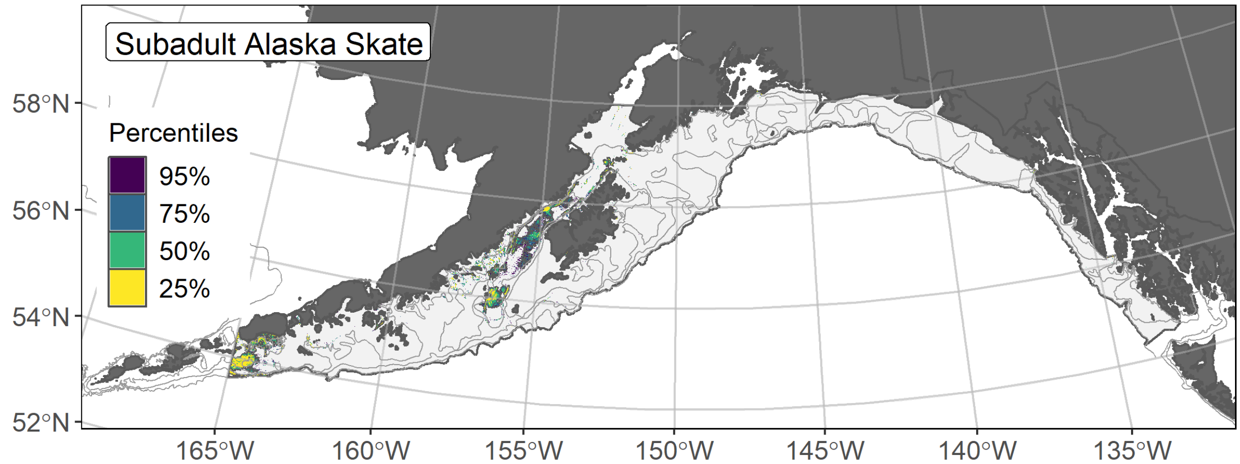

Figure 5-162 EFH area of subadult Alaska skate, summer

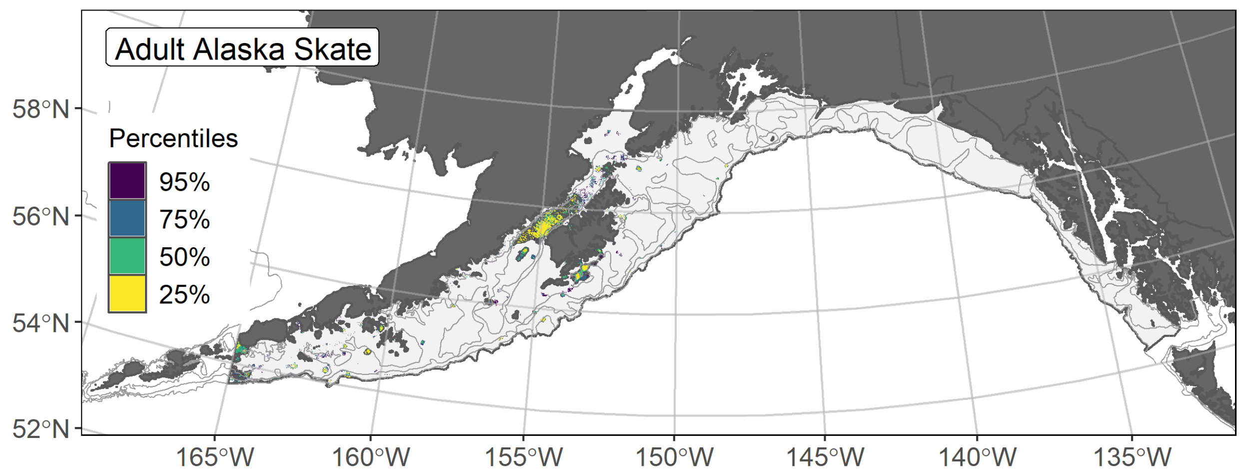

Figure 5-163 EFH area of adult Alaska skate, summer

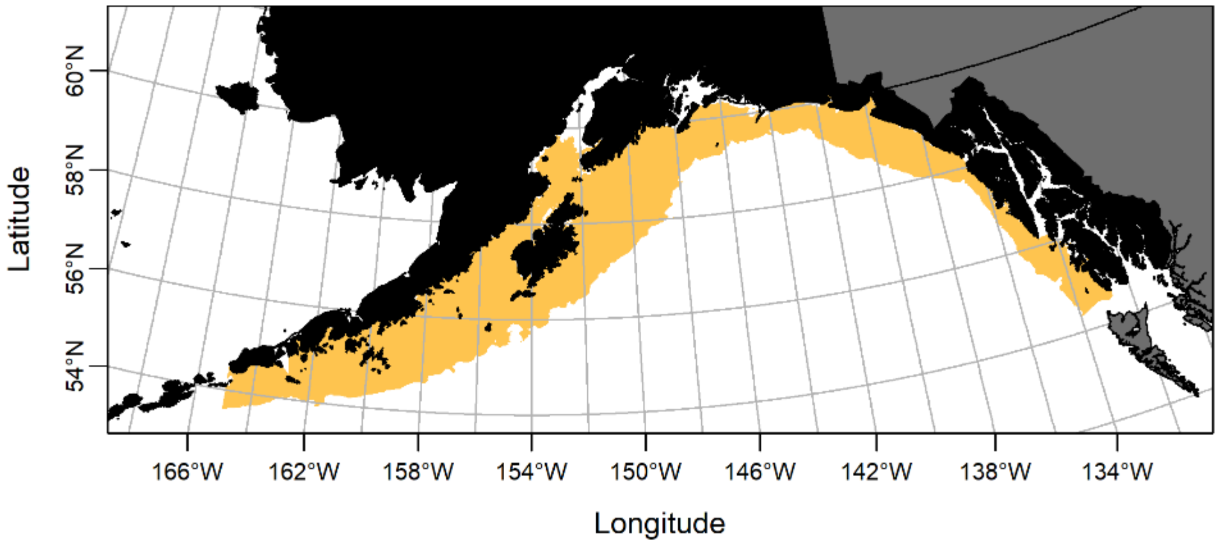

Figure 5-164 EFH area of adult Alaska skate, fall

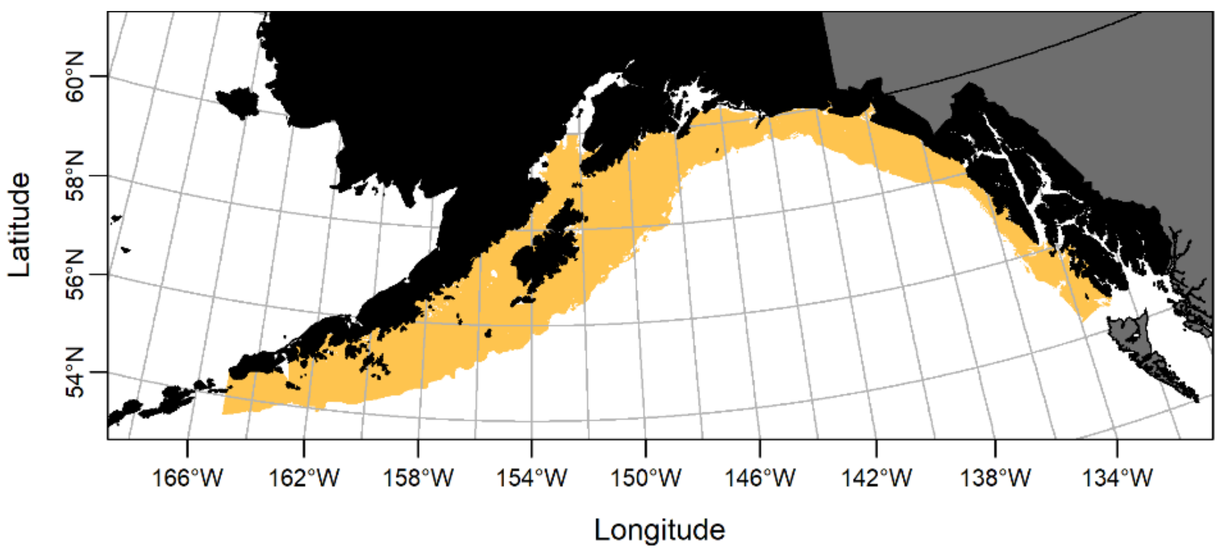

Figure 5-165 EFH area of adult Alaska skate, winter

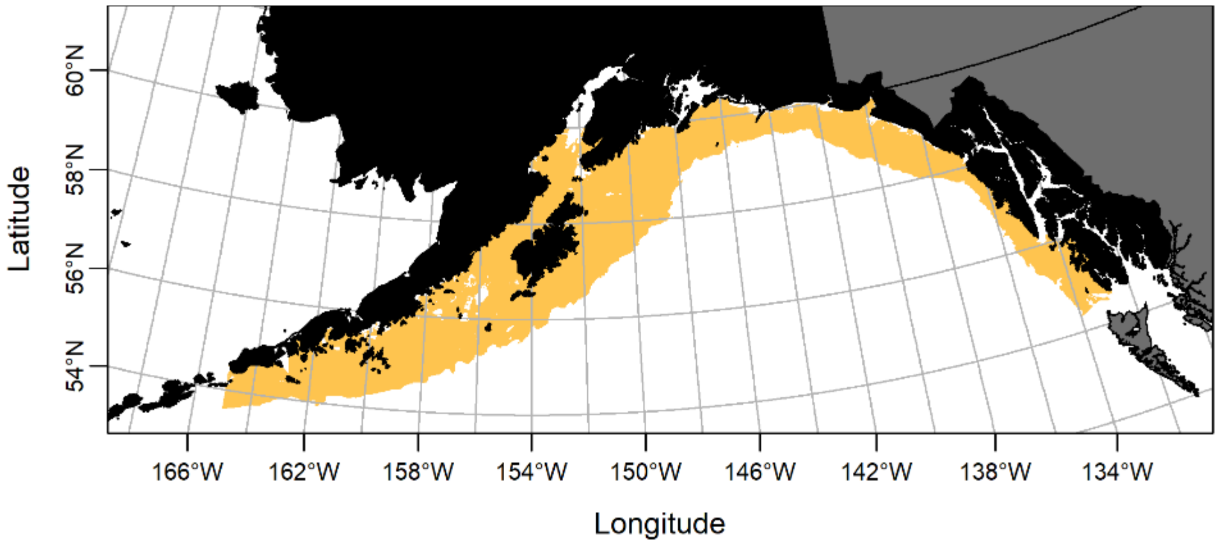

Figure 5-166 **EFH area of adult Alaska skate, spring**

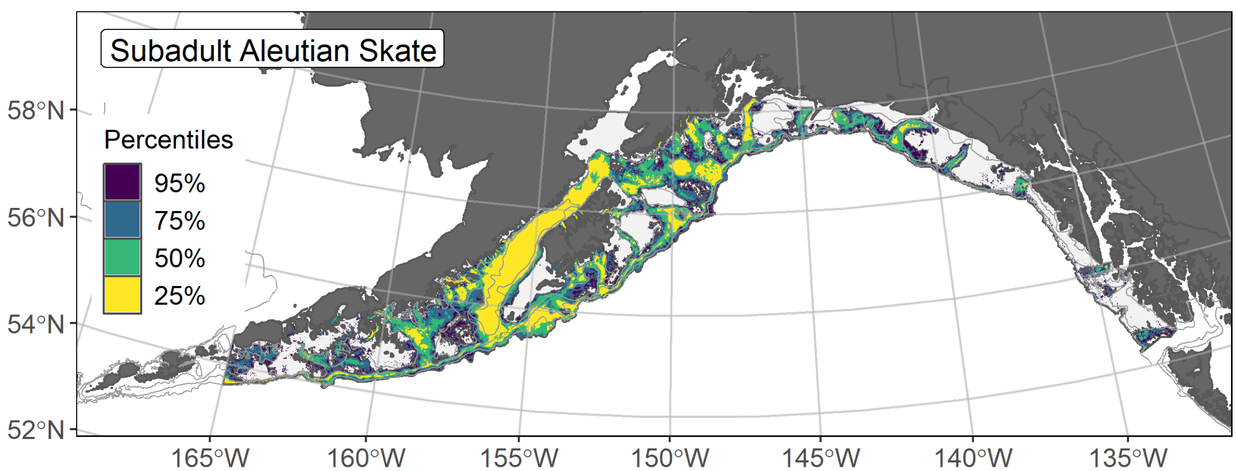

Figure 5-167 **EFH area of subadult Aleutian skate, summer**

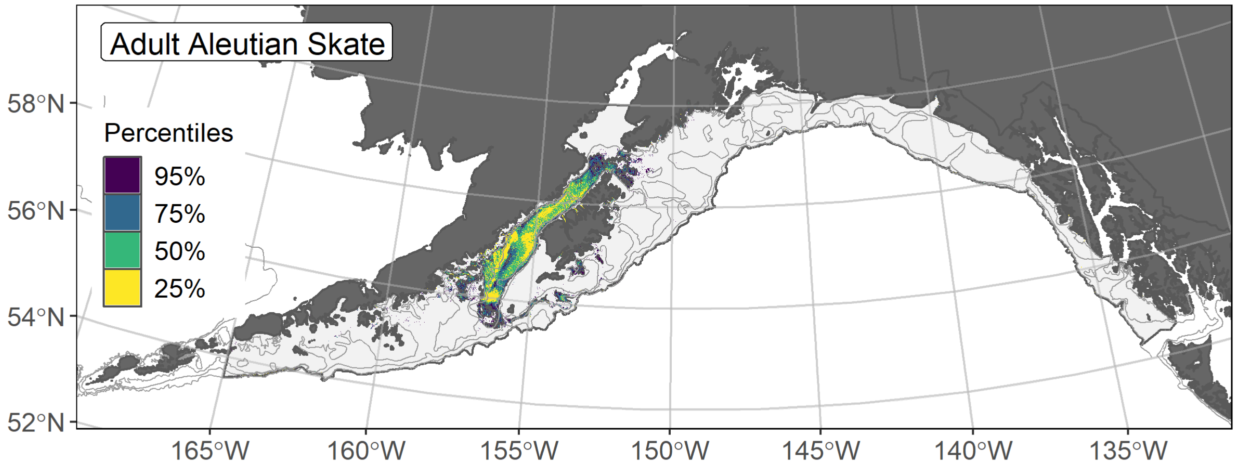

Figure 5-168 EFH area of adult Aleutian skate, summer

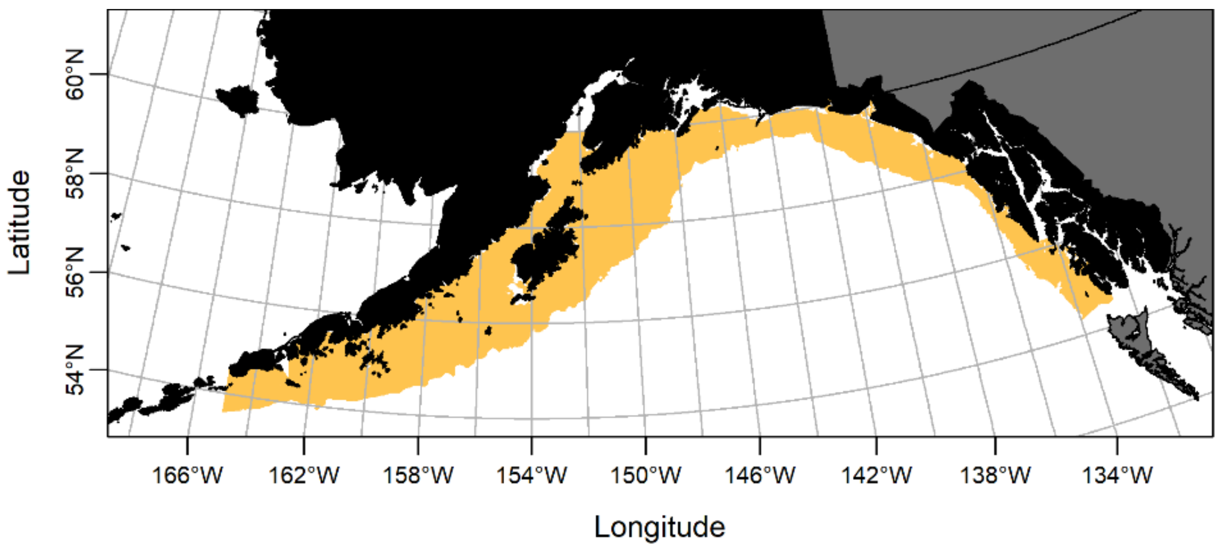

Figure 5-169 EFH area of adult Aleutian skate, fall

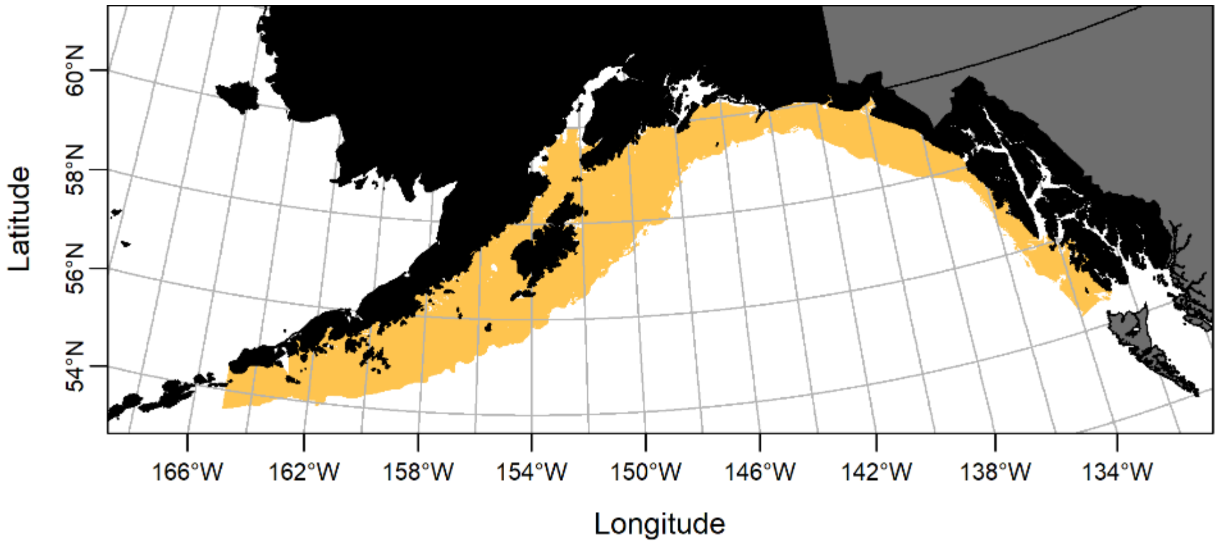

Figure 5-170 **EFH area of adult Aleutian skate, winter**

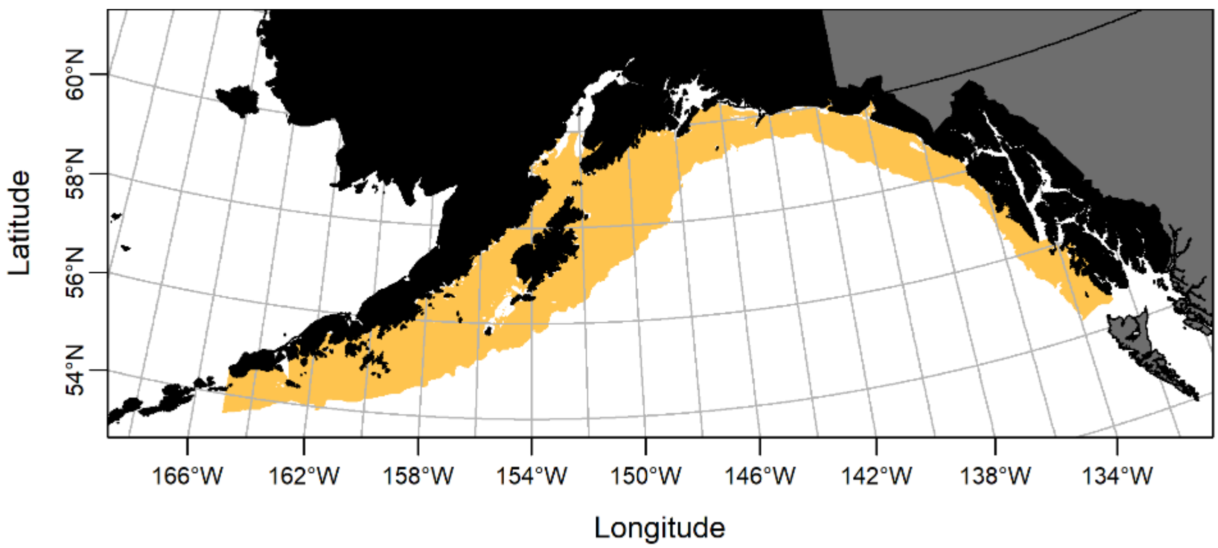

Figure 5-171 **EFH area of adult Aleutian skate, spring**

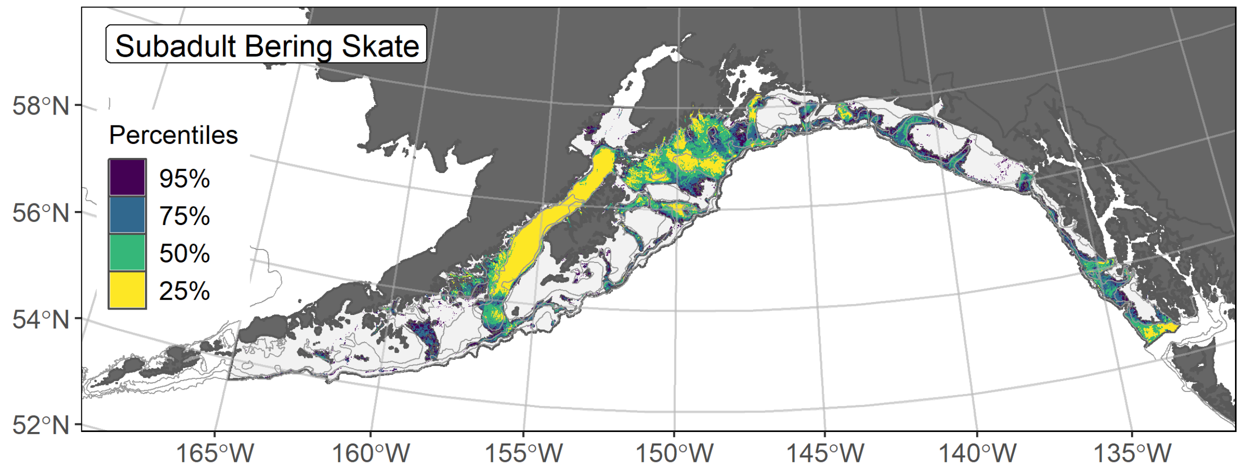

Figure 5-172 EFH area of subadult Bering skate, summer

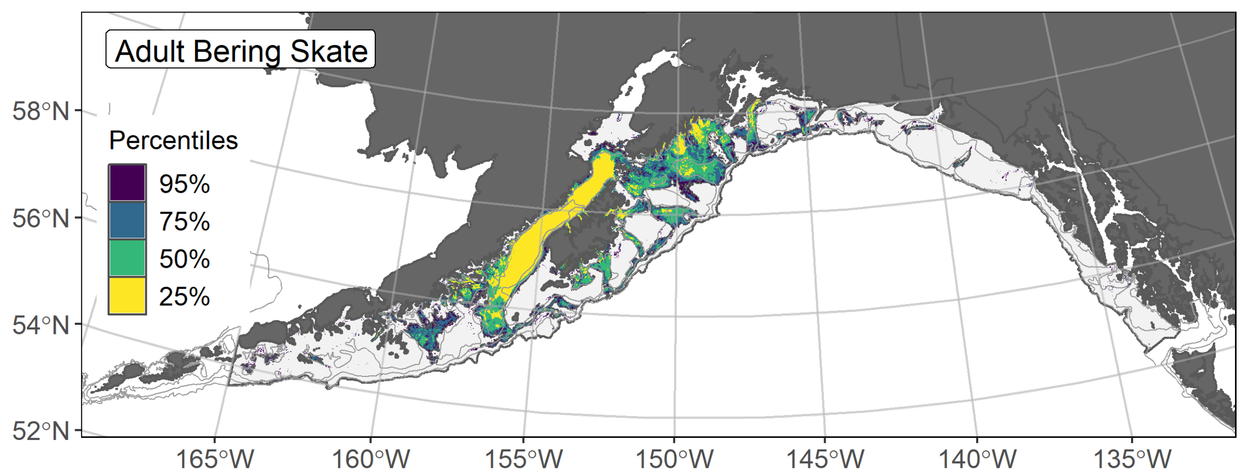

Figure 5-173 EFH area of adult Bering skate, summer

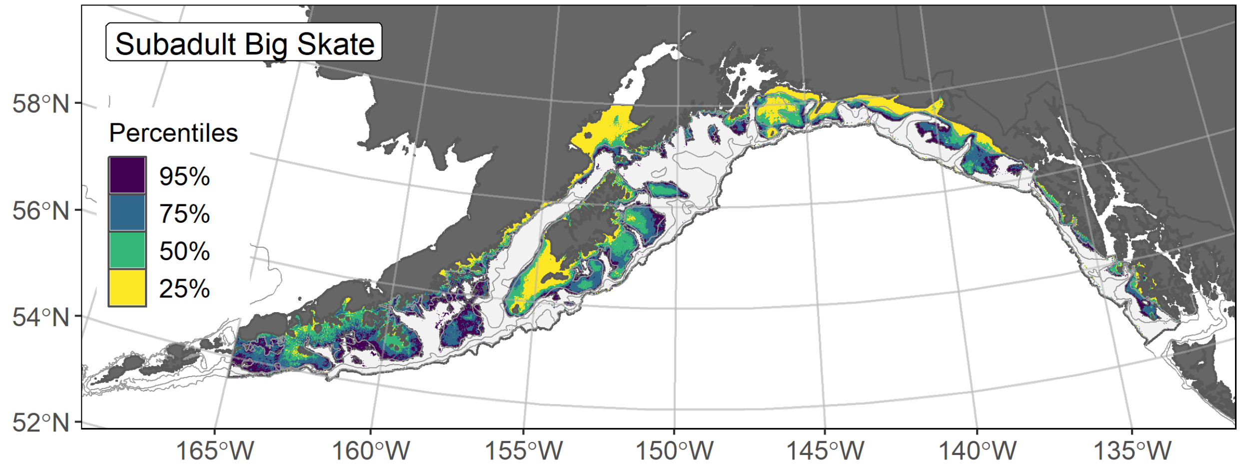

Figure 5-174 EFH area of subadult big skate, summer

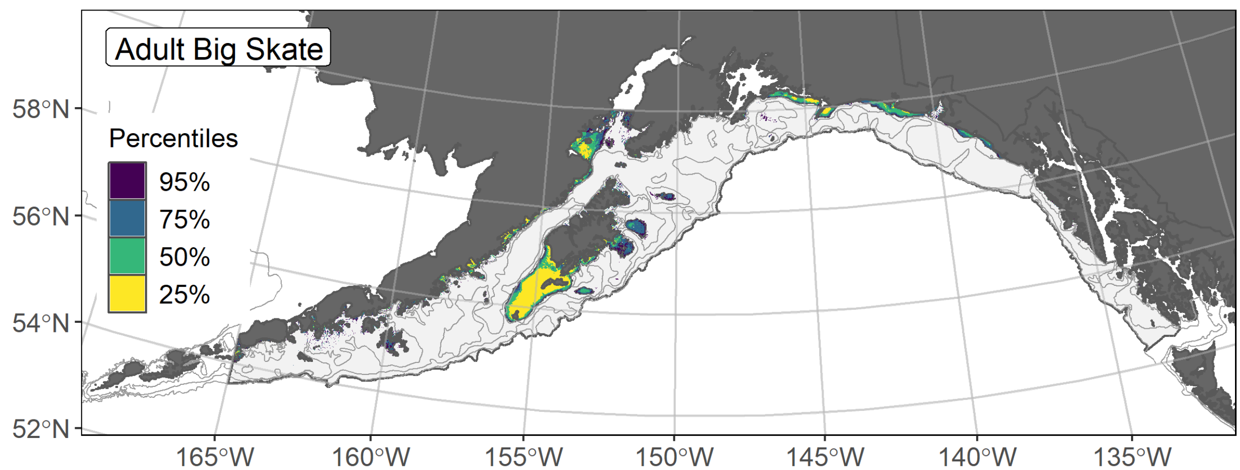

Figure 5-175 EFH area of adult big skate, summer

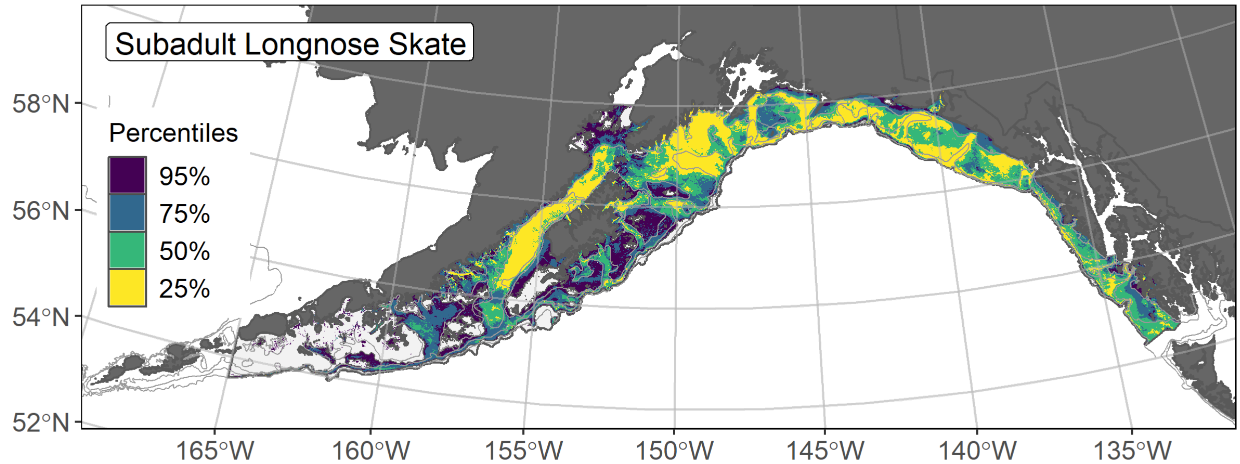

Figure 5-176 EFH area of subadult longnose skate, summer

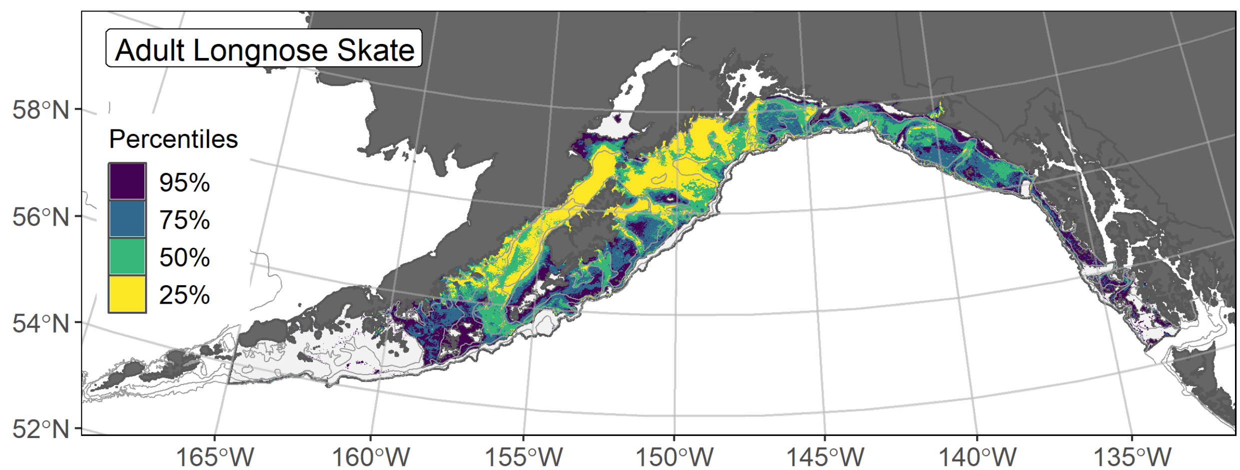

Figure 5-177 EFH area of adult longnose skate, summer

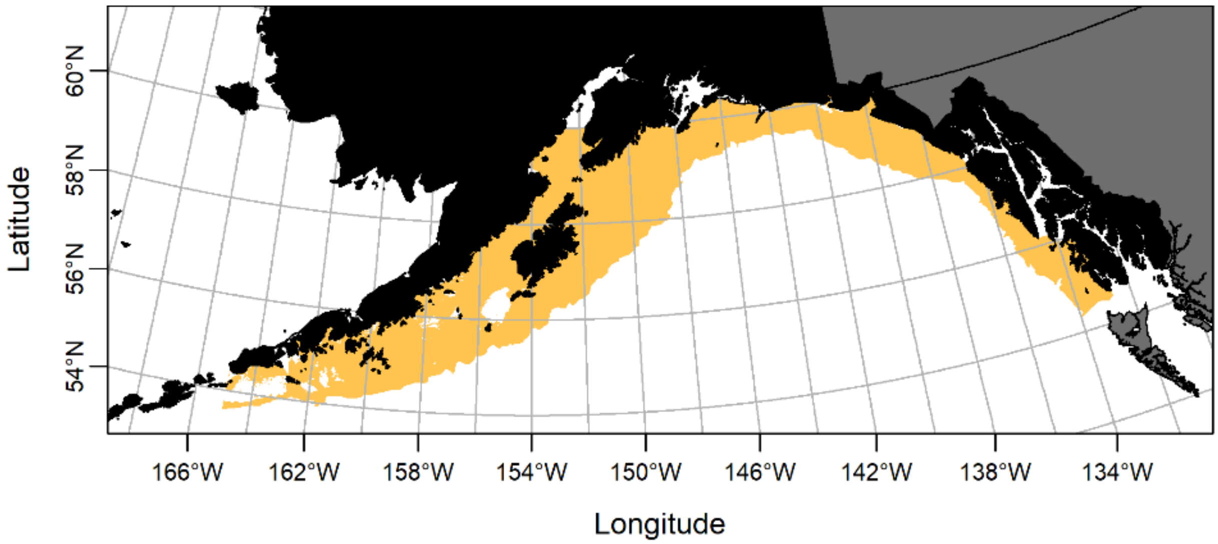

Figure 5-178 EFH area of adult longspine thornyhead rockfish, spring

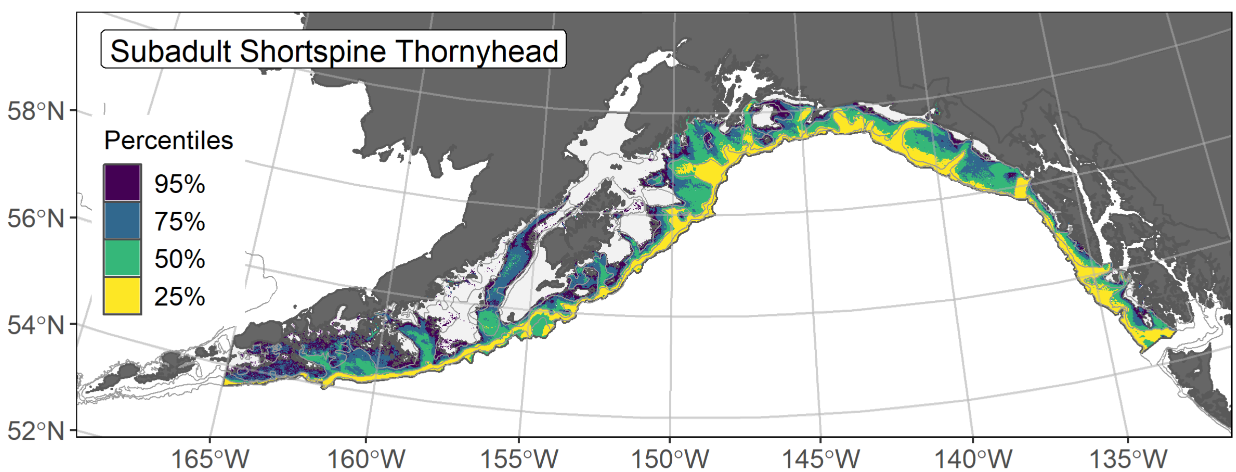

Figure 5-179 EFH area of subadult shortspine thornyhead rockfish, summer

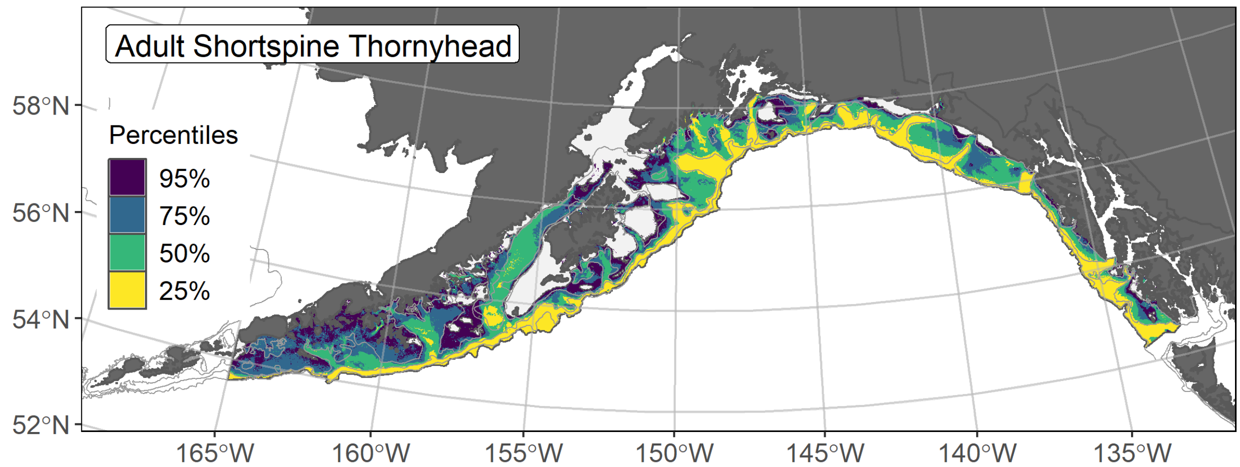

Figure 5-180 EFH area of adult shortspine thornyhead rockfish, summer

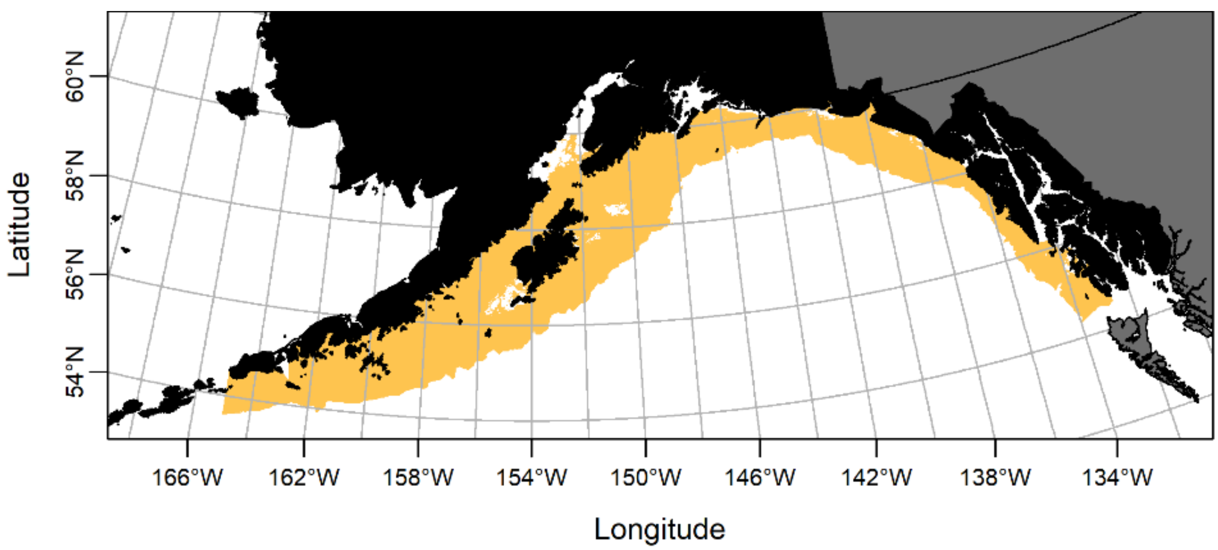

Figure 5-181 EFH area of adult shortspine thornyhead rockfish, fall

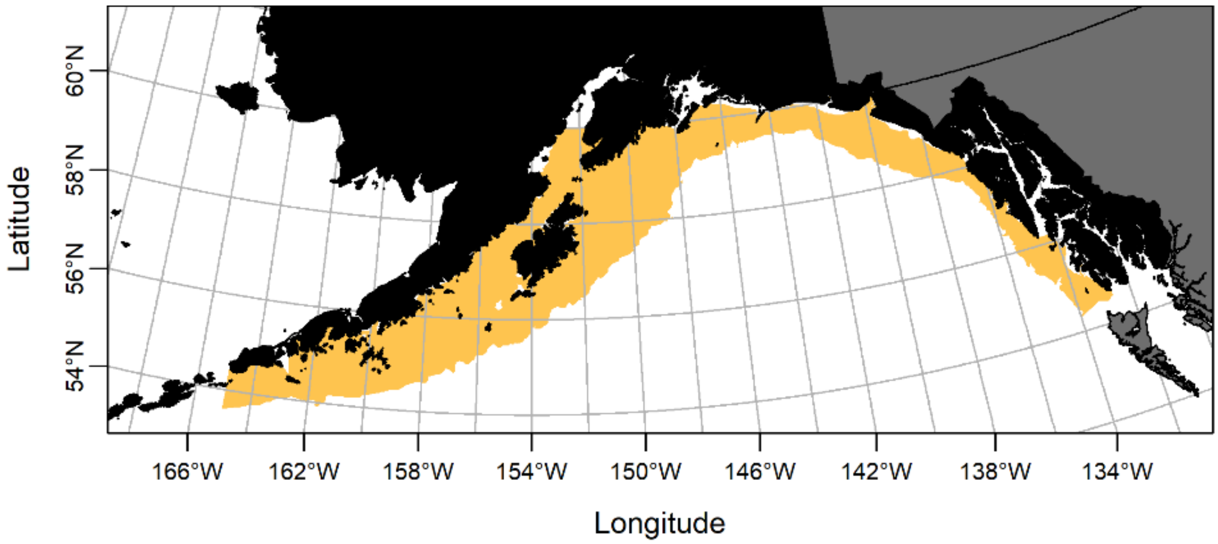

Figure 5-182 EFH area of adult shortspine thornyhead rockfish, winter

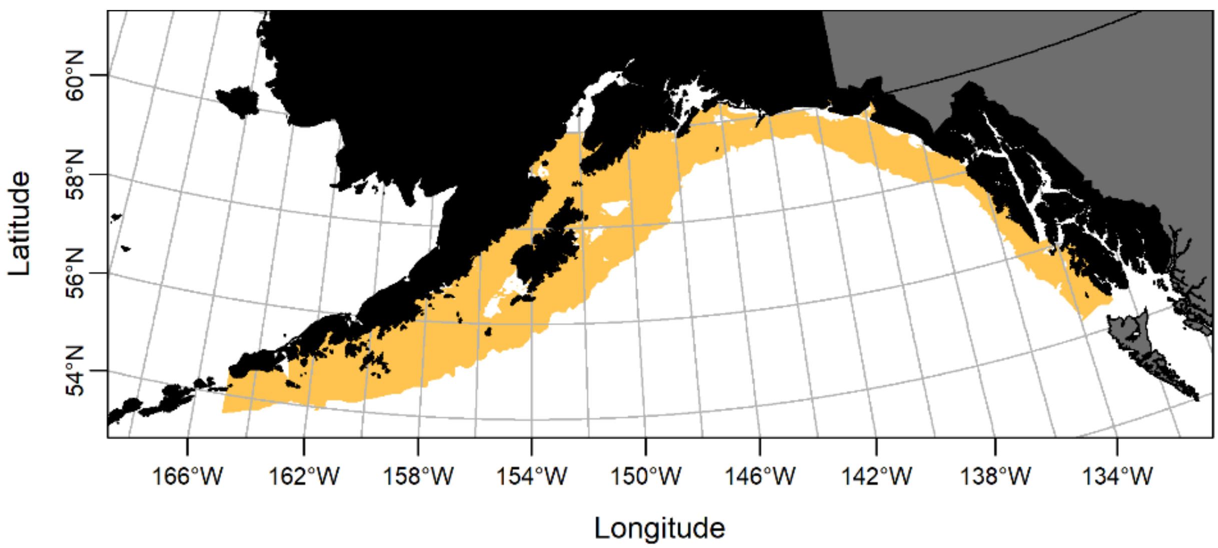

Figure 5-183 EFH area of adult shortspine thornyhead rockfish, spring

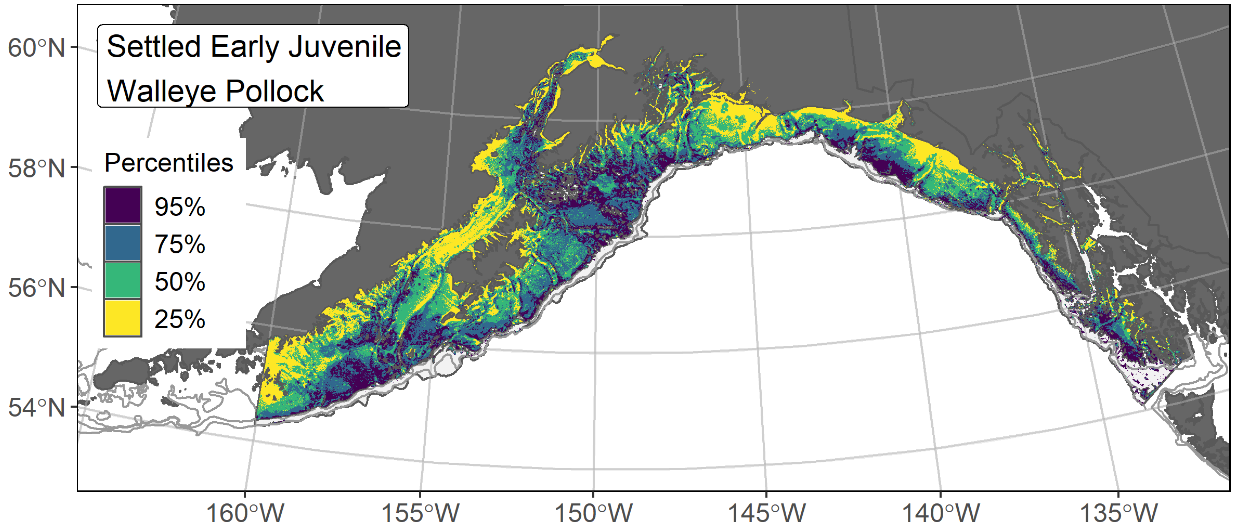

Figure 5-184 EFH area of settled early juvenile walleye pollock, summer

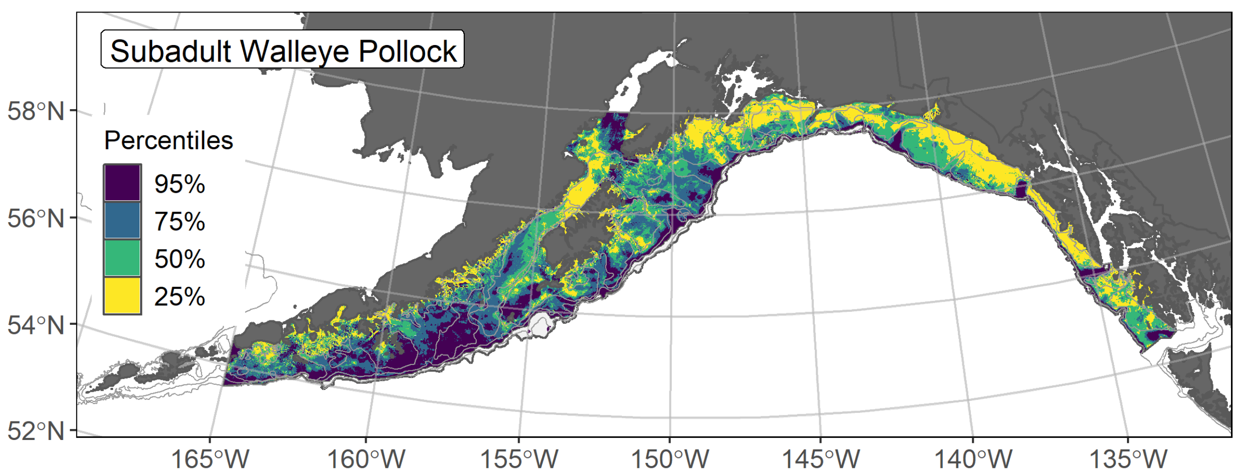

Figure 5-185 EFH area of subadult walleye pollock, summer

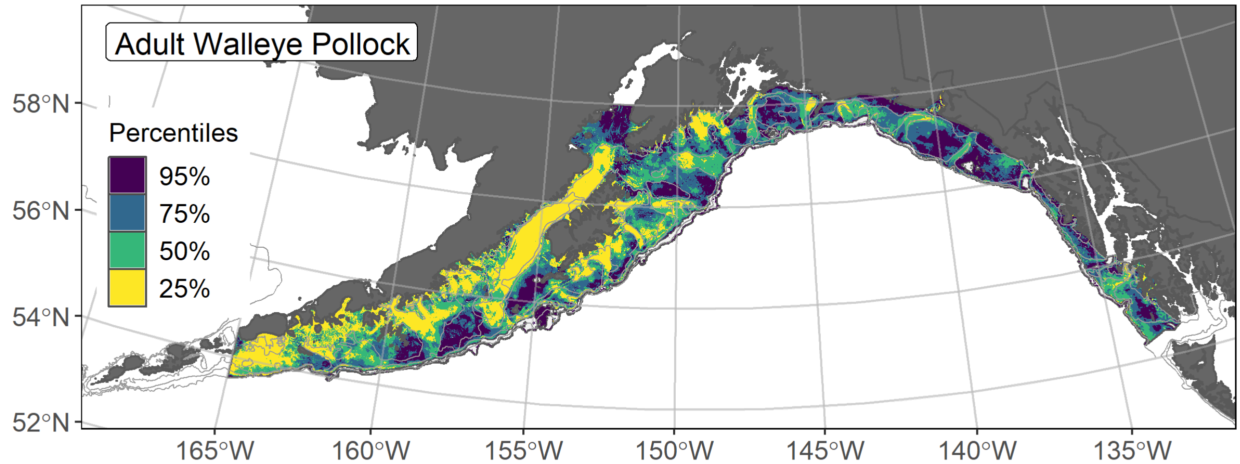

Figure 5-186 EFH area of adult walleye pollock, summer

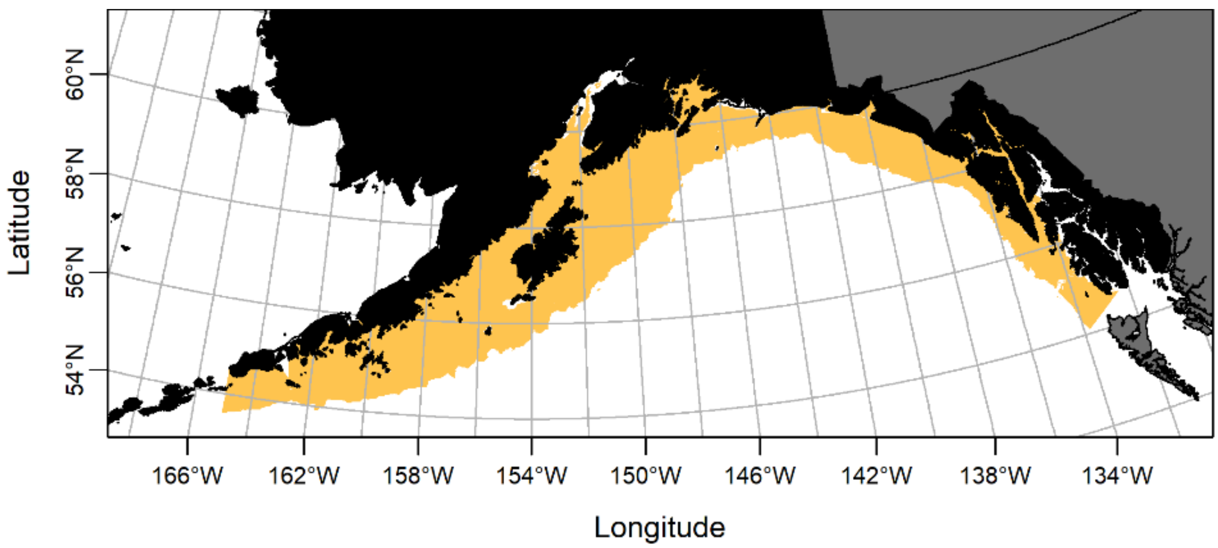

Figure 5-187 EFH area of walleye pollock eggs, summer

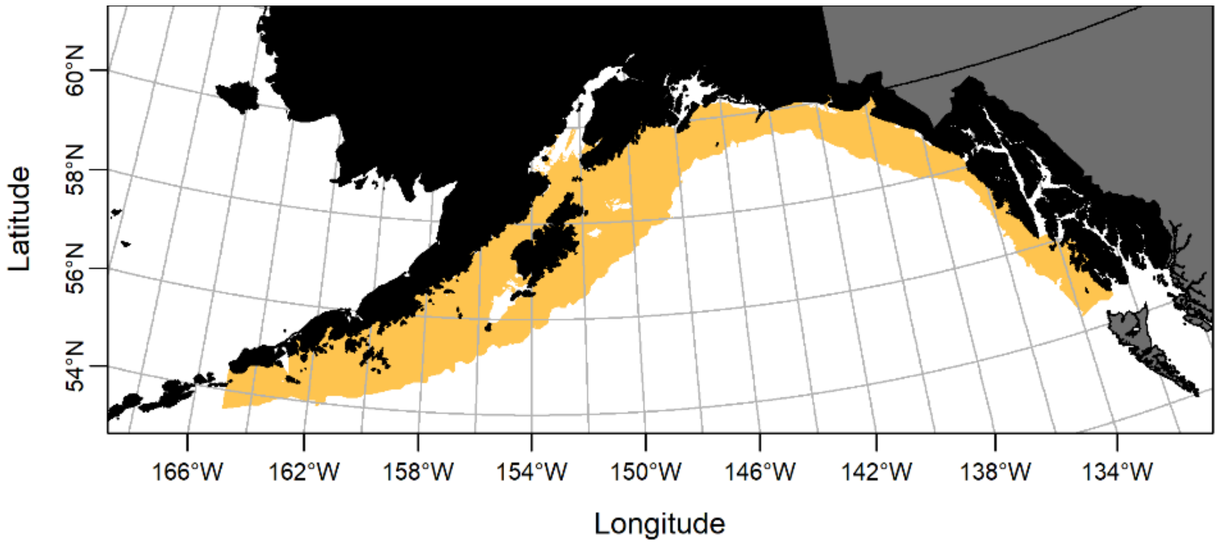

Figure 5-188 EFH area of adult walleye pollock, fall

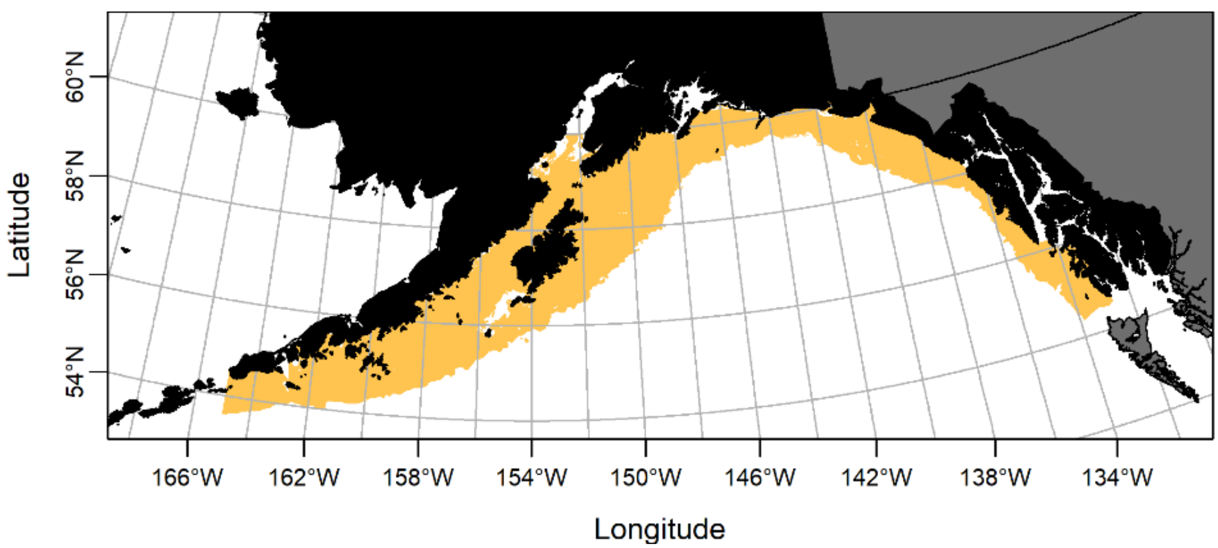

Figure 5-189 EFH area of adult walleye pollock, winter

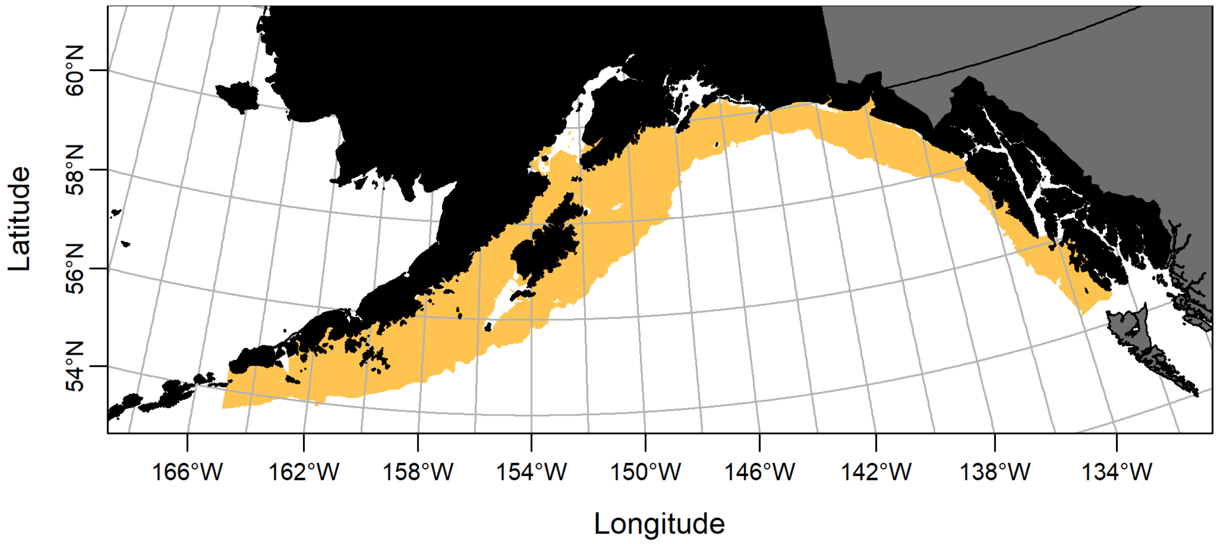

Figure 5-190 EFH area of adult walleye pollock, spring

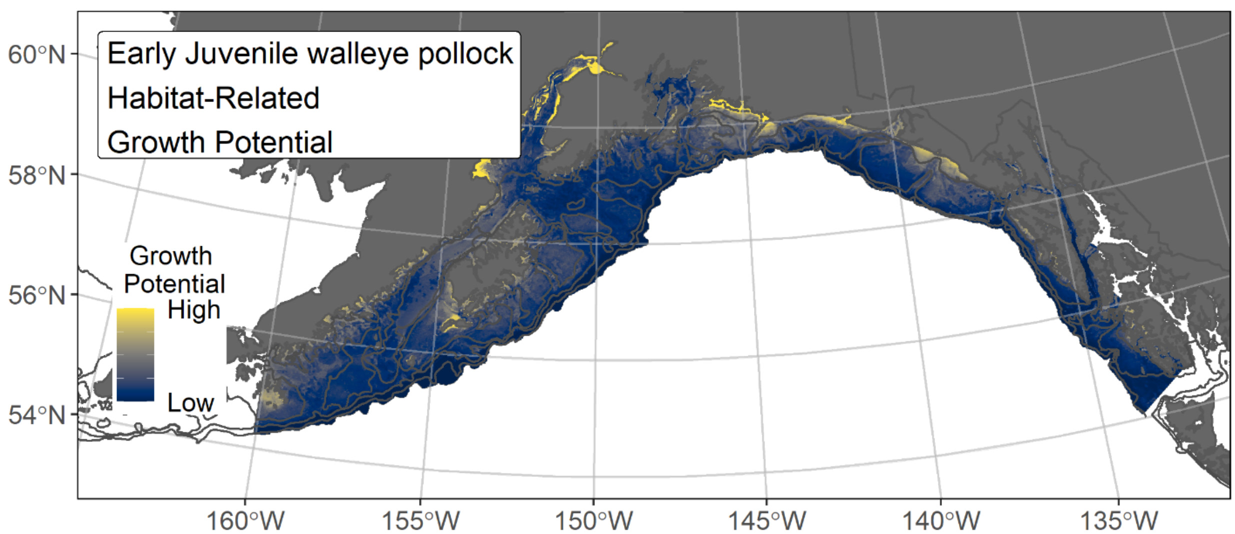

Figure 5-191 EFH area of settled early juvenile walleye pollock, habitat-related growth potential, summer

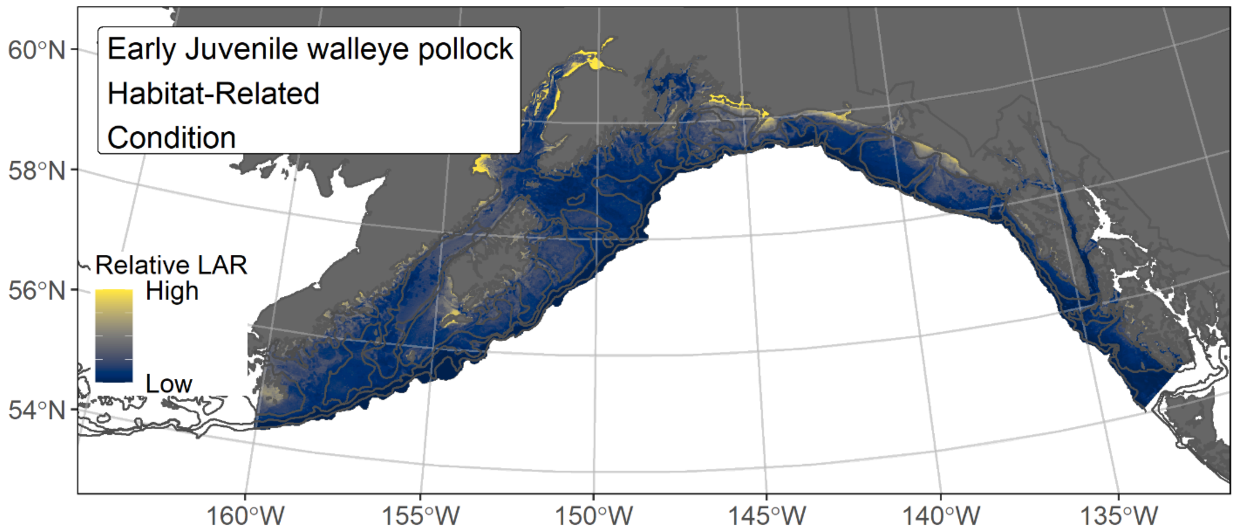

Figure 5-192 EFH area of settled early juvenile walleye pollock, habitat-related condition, summer

5.4 References

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Hinckley, S., W. Stockhausen, K. Coyle, B. Laurel, G. Gibson, C. Parada, A. Hermann, M. Doyle, and T. Hurst. 2019. Connectivity between spawning and nursery areas for Pacific cod (Gadus macrocephalus) in the Gulf of Alaska. Deep Sea Res. Pt. II. 165: 113–126. https://doi.org/10.1016/j.dsr2.2019.05.007

Pirtle, J. L., E. A. Laman, J. Harris, M. C. Siple, C. N. Rooper, T. P. Hurst, C. L. Conrath, and G. A. Gibson. 2023. Advancing model-based essential fish habitat descriptions for North Pacific species in the Gulf of Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-468, 541 p. https://doi.org/10.25923/ygdf-5f65

Shotwell, S. K., G. A.Gibson, W. T. Stockhausen, J. L. Pirtle, C. N. Rooper, A. L. Deary, K. O. Coyle, and A. J. Hermann, A.J. In preparation. Developing a novel approach to estimate habitat-related survival rates for early life history stages using individual-based models.

6 Appendix F Adverse Effects on Essential Fish Habitat

6.1 Fishing Effects on Essential Fish Habitat

6.1.1 Overview

This appendix addresses the requirement in Essential Fish Habitat (EFH) regulations (50 Code of Federal Regulations [CFR] 600.815(a)(2)(i)) that each FMP must contain an evaluation of the potential adverse effects of all regulated fishing activities on EFH. This evaluation should consider the effects of each fishing activity on each type of habitat found within EFH. FMPs must describe each fishing activity, review and discuss all available relevant information (such as information regarding the intensity, extent, and frequency of any adverse effect on EFH; the type of habitat within EFH that may be affected adversely; and the habitat functions that may be disturbed), and provide conclusions regarding whether and how each fishing activity adversely affects EFH.

The EFH regulations base the evaluation of the adverse effects of fishing on EFH on a 'more than minimal and not temporary' standard (50 CFR 600.815). Fishing operations may change the abundance or availability of certain habitat features (e.g., the presence of living or non-living habitat structures) used by managed fish species to accomplish spawning, breeding, feeding, and growth to maturity. The outcome of these changes depends on the characteristics of the fishing activities, the habitat, fish use of the habitat, and fish population dynamics. The duration and degree of fishing effects on habitat features depend on the intensity of fishing, the distribution of fishing with different gears across habitats, and the sensitivity and recovery rates of habitat features. The fishing effects model developed for this evaluation takes all of those variables into consideration (Smeltz et al. 2019).

6.1.2 Evaluation of fishing effects on EFH

The fishing effects (FE) model was developed by the NMFS Alaska Regional Office – HCD and scientists at Alaska Pacific University for the 2017 EFH 5-year Review. Updates and corrections to the model were made in 2022. The full FE model description can be found in the technical memorandum 2022 Evaluation of Fishing Effects on Essential Fish Habitat (Zaleski et al. 2024). The technical memorandum also includes the full process for estimating habitat disturbance within the core EFH areas (upper 50th percentile of EFH) modeled for each species or species complex within this FMP and the result of those estimates.

The full evaluation of the estimated fishing effects on species' core EFH areas are in the FE Report (Zaleski et al. 2024). It includes a description of the stock assessment author review process, whereby stock authors were provided with the FE model output and requested to quantitatively or qualitatively evaluate if the estimated habitat disturbance was adversely affecting EFH more than minimally and not temporarily. The FE Report includes each stock author's evaluations in Appendix 5. For the GOA (Figure 6-1) groundfish species or species complexes, none had estimates of habitat disturbance ≥ 10% of their core EFH area, and no species were elevated for possible mitigation to reduce fishing effects to EFH.

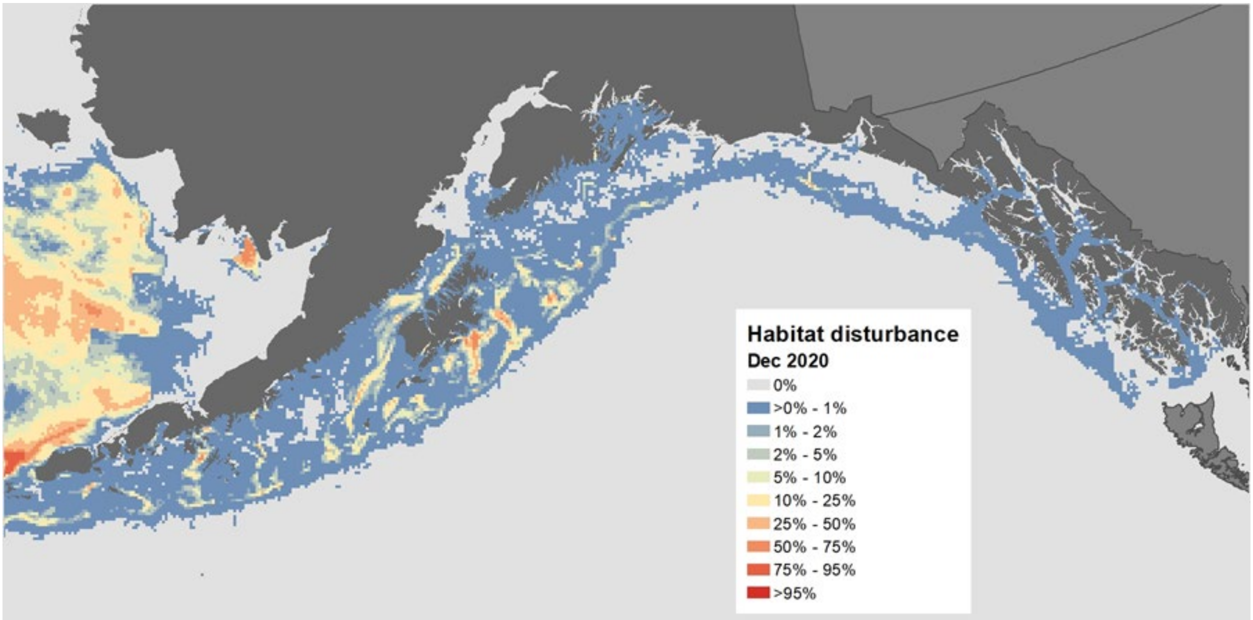

Figure 6-1 Gulf of Alaska cumulative percentage habitat disturbed. All gears combined.

6.2 Non-Fishing Activities That May Adversely Affect Essential Fish Habitat

The waters, substrates, and ecosystem processes that support EFH and sustainable fisheries are susceptible to a wide array of human activities and climate-related influences unrelated to the act of fishing. These activities range from easily identified, point source discharges in watersheds or nearshore coastal zones to less visible influences of changing ocean conditions, and increased variability in regional temperature or weather patterns. Broad categories of such activities include mining, dredging, fill, impoundments, water diversions, thermal additions, point source and nonpoint source pollution, sedimentation, introduction of invasive species, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH. For Alaska, non-fishing impacts are reviewed in the Non-Fishing Impacts Report, which NMFS updates during an EFH 5-year Review.

6.2.1 Non-Fishing Impacts and EFH 5-year Review from 2018-2023

The most recent report, Impacts to Essential Fish Habitat from Non-Fishing Activities in Alaska (Limpinsel et al. 2023), presents a brief history of the Magnuson-Stevens Act and the language, provisions, and purpose supporting conservation of EFH. The report emphasizes the growing importance and implementation of Ecosystem Based Fisheries Management. This iteration recognizes climate change as an anthropogenic threat influencing EFH. Chapter 2 provides a discussion on how greenhouse gas emissions are warming the Arctic and influencing the atmosphere, ocean, and fisheries across Alaska. Chapters 3, 4 and 5 of this report address watersheds, estuaries and nearshore zones, and offshore zones, starting by highlighting the more commonly recognized physical, chemical, and biological processes that make each zone distinct. Each chapter discusses ecosystem processes, EFH attributes, sources of anthropogenic impacts that could compromise EFH, and proposes conservation recommendations to reduce the severity of those impacts. This report reflects the best available science.

6.2.2 Regulatory Alignment

The purpose of this report is to assist in the identification of activities that may adversely impact EFH and provide general EFH conservation recommendations to avoid or minimize adverse impacts. Section 305(b) of the Magnuson-Stevens Act requires Federal agencies to consult with NMFS on any action that they authorize, fund, or undertake, or propose to authorize, fund, or undertake, that may adversely affect EFH. Each Council shall comment on and make recommendations to the Secretary of Commerce, through NMFS, and any Federal or State agency concerning any such activity that, in the view of the Council, is likely to substantially affect the habitat, including essential fish habitat, of an anadromous fishery resource under its authority. If NMFS or the Council determines that an action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by any State or Federal agency would adversely affect any EFH, NMFS shall recommend to the agency measures that can be taken to conserve EFH. Within 30 days after receiving EFH conservation recommendations from NMFS, a Federal agency shall provide a detailed response in writing regarding the matter. If the response is inconsistent with NMFS's recommendations, the Federal agency shall explain its reasons for not following the recommendations.

EFH conservation recommendations are non-binding to Federal and state agencies. EFH consultations do not supersede regulations or jurisdictions of Federal or state agencies. NMFS has no authority to issue permits for projects or mandate measures to minimize impacts of non-fishing activities. Most non-fishing activities identified in this report are subject to numerous Federal, state, and local environmental laws and regulations designed to minimize and mitigate impacts to fish, wildlife and habitat.

6.3 Cumulative Effects of Fishing and Non-Fishing Activities on EFH

This section summarizes the cumulative effects of fishing and non-fishing activities on EFH. Cumulative impacts analysis is Component 5 of the ten EFH components. The cumulative effects of fishing and non-fishing activities on EFH were considered in the 2005 EFH EIS, but insufficient information existed to accurately assess how the cumulative effects of fishing and non-fishing activities influence ecosystem processes and EFH. The 2017 5-year Review reevaluated potential impacts of fishing and non-fishing activities on EFH using recent technologies and literature, and the current understanding of marine and freshwater fisheries science, ecosystem processes, and population dynamics (Simpson et al. 2017). Cumulative impacts analysis was not a component of focus for the 2023 EFH 5-year Review. The 2017 evaluation is summarized below with updated references for the new reports.

Historical fishing practices may have had effects on EFH that have led to declining trends in some of the criteria examined in the EFH EIS (see Table 4.4-1 in NMFS 2005). For fishing impacts to EFH, the FE model calculates habitat disturbance at a monthly time step since 2003 and incorporates susceptibility and recovery dynamics, allowing for an assessment of cumulative effects from fishing activities. During the 2017 EFH 5-year Review, the effects of fishing activities on EFH were considered as minimal and temporary or unknown. This conclusion is similar to the 2022 evaluations (Zaleski et al. 2024).

The cumulative effects from multiple non-fishing anthropogenic sources are increasingly recognized as having synergistic effects that may degrade EFH and associated ecosystem processes that support sustainable fisheries. Non-fishing activities may have potential long term cumulative impacts due to the long term additive and chronic nature of the activities combined with climate change (Limpinsel et al. 2023). However, the magnitude of the effects of non-fishing activities cannot currently be quantified with available information. NMFS does not have regulatory authority over non-fishing activities, but frequently provides recommendations to other agencies to avoid, minimize, or otherwise mitigate the effects of these activities.

Fishing and each activity identified in the analysis of non-fishing activities may or may not significantly affect the function of EFH. The synergistic effect of the combination of all of these activities is also a cause for concern. Unfortunately, available information is not sufficient to assess how the cumulative effects of fishing and non-fishing activities influence the function of EFH on an ecosystem or watershed scale. The magnitude of the combined effect of all of these activities cannot be quantified, so the 2017 EFH 5-year Review concluded that the cumulative level of concern is unknown.

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7 Appendix G Fishery Impact Statement

The Magnuson-Stevens Fishery and Conservation Management Act requires that a fishery management plan (FMP) include a fishery impact statement that assesses, specifies, and describes the likely effects of the FMP measures on participants in the fisheries and fishing communities affected by the FMP. A detailed analysis of the effects of the FMP on the human environment, including fishery participants and fishing communities, was conducted in the Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement (NMFS 2004). The following is a brief summary from this analysis.

- The FMP has instituted privilege-based management programs in the sablefish fishery, and fishery managers, under the guidance of the FMP management policy, are moving towards extending privilege-based allocations to other groundfish fisheries.
- The FMP promotes increased social and economic benefits through the promotion of privilege-based allocations to individuals, sectors and communities. For this reason, it is likely to increase the commercial value generated from the groundfish fisheries.
- As the race-for-fish is eliminated, the FMP could result in positive effects in terms of producer net revenue, consumer benefits, and participant health and safety.
- The elimination of the race-for-fish will likely result in a decrease in overall participation levels. In the long-run, communities are likely to see fewer persons employed in jobs related to the fishing industry (fishing, processing, or support sectors), but the jobs that remain could be more stable and provide higher pay.
- The FMP's promotion of privilege-based allocations is also expected to increase consumer benefits and health and safety of participants.

The FMP has adopted a variety of management measures to promote the sustainability of the groundfish fisheries and dependent fishing communities.

1. Management measures to account for uncertainty ensure the sustainability of the managed species by maintaining a spawning stock biomass for the target species with the potential to produce sustained yields.
2. The transition to privilege-based management in the short-term could disrupt stability, however in the long-term, the stability of fisheries would be increased in comparison to a derby-style fishery.
3. Communities would also tend to experience an increase in stability as a result of built-in community protections to the privilege-based management programs.

8 Appendix H Research Needs

Although research needs are expressed in this appendix to the Fishery Management Plan (FMP), ongoing research and research needs are constantly being updated. It may therefore be useful to the reader to access other sources in order to obtain the North Pacific Fishery Management Council (Council)'s most current description of research and research needs on the Gulf of Alaska (GOA) groundfish fisheries. A complete discussion of up-to-date sources is included in Chapter 6 of the FMP. In particular, the Council's Science and Statistical Committee regularly updates the Council research needs, and these can be found on the Council's website. Additionally, ongoing research by National Marine Fisheries Service (NMFS)'s Alaska Fisheries Science Center (AFSC) is also accessible through their website. Website addresses are in Chapter 6.

The FMP management policy identifies several research programs that the Council would like to encourage. These are listed in Section H.1. The Council relies on its Scientific and Statistical Committee (SSC) to assist the Council in interpreting biological, sociological, and economic information. The SSC also plays an important role in providing the Council with recommendations regarding research direction and priorities based on identified data gaps and research needs. The SSC and Council's research priorities are listed in Section H.2. Additionally, NMFS regularly develops a five-year strategy for fisheries research which is described in Section H.3. Research needs specific to essential fish habitat are described in Section H.4.

8.1 Management Policy Research Programs

The management objectives of the FMP (see Section 2.2.1) include several objectives that provide overarching guidance as to research programs that the Council would like to encourage.

1. Encourage research programs to evaluate current population estimates for non-target species with a view to setting appropriate bycatch limits as information becomes available.
2. Encourage programs to review status of endangered or threatened marine mammal stocks and fishing interactions and develop fishery management measures as appropriate.
3. Encourage development of a research program to identify regional baseline habitat information and mapping, subject to funding and staff availability.
4. Encourage a coordinated, long-term ecosystem monitoring program to collect baseline information and compile existing information from a variety of ongoing research initiatives, subject to funding and staff availability.

Other objectives in the management policy also contain research elements without which they cannot be achieved. Research initiatives that would support other FMP management objectives are discussed in Section H.1.2 below.

8.2 Council Research Priorities

At its March 2003 meeting, the SSC reviewed the list of research priorities as developed by the Council's GOA and Bering Sea and Aleutian Islands (BSAI) groundfish Plan Teams, and developed the following short list of research topics:

Critical Assessment Problems

For rockfish stocks there is a general need for better assessment data, particularly investigation of stock structure and biological variables.

a. Supplement triennial trawl survey biomass estimates with estimates of biomass or indices of biomass obtained from alternative survey designs.

b. Obtain age and length samples from the commercial fishery, especially for Pacific ocean perch, northern rockfish, and dusky rockfish.

c. Increase capacity for production ageing of rockfish so that age information from surveys and the fishery can be included in stock assessments in a timely manner.

d. Further research is needed on model performance in terms of bias and variability. In particular, computer simulations, sensitivity studies, and retrospective analyses are needed. As models become more complex in terms of parameters, error structure, and data sources, there is a greater need to understand how well they perform.

There is a need for life history information for groundfish stocks, e.g., growth and maturity data, especially for rockfish.

e. There is a need for information about stock structure and movement of all FMP groundfish species, especially temporal and spatial distributions of spawning aggregations.

Stock Survey Concerns

f. There is a need to explore ways for inaugurating or improving surveys to assess rockfish, including nearshore pelagics.

g. There is a need to develop methods to measure fish density in habitats typically inaccessible to NMFS survey gear, i.e., untrawlable habitats.

Expanded Ecosystem Studies

h. Research effort is required to develop methods for incorporating the influence of environmental and climate variability, and there influence on processes such as recruitment and growth into population models, especially for crab stocks.

i. Forage fish are an important part of the ecosystem, yet little is known about these stocks. Effort is needed on stock status and distribution for forage fishes such as capelin, eulachon, and sand lance.

j. Studies are needed to identify essential habitat for groundfish and forage fish. Mapping of nearshore and shelf habitat should be continued for FMP species.

Social and Economic Research

k. Development of time series and cross-sectional databases on fixed and variable costs of fishing and fish processing.

l. Pre- and post-implementation economic analyses of crab and GOA groundfish rationalization.

m. Identification of data needed to support analyses of community level consequences of management actions.

n. Development of integrated multispecies and multifishery models for use in analyses of large scale management actions, such as the *Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement and the Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska.*

Bycatch

o. Identify sources of variability in actual and estimated bycatch rates.

Monitoring

p. Promote advancement in video monitoring of otherwise unobserved catch for improved estimation of species composition of total catch and discrimination of retained and discarded catch

Research Priorities Identified by the National Research Council's Steller Sea Lion Committee

The SSC held a brief discussion on the research and monitoring recommendations of the National Research Council's Steller Sea Lion Committee, as presented in the Executive Summary of their report. The SSC noted that their recommendations are consistent with recognized needs, but also that there is considerable ongoing Steller sea lion research. Among the National Research Council's recommendations, the SSC wishes to particularly identify their recommendation for a spatially-explicit, adaptive management experiment to definitively conclude whether fishing is playing a role in the current lack of Steller sea lion recovery. As noted in the SSC's February 2003 minutes, there are a number of scientific, economic, and Endangered Species Act regulatory considerations that must be addressed before such a plan can be seriously considered for implementation. However, the SSC supports further exploration of the merits of this adaptive management approach.

8.3 National Marine Fisheries Service

NMFS is responsible for ensuring that management decisions are based on the best available scientific information relevant to the biological, social, and economic status of the fisheries. As required by the Magnuson-Stevens Act, NMFS published the *NMFS Strategic Plan for Fisheries Research* in December 2001, outlining proposed research efforts for fiscal years 2001-2006. The Strategic Plan outlines the following broad goals and objectives for NMFS: 1) to improve scientific capability; 2) to increase science quality assurance; 3) to improve fishery research capability; 4) to improve data collection; 5) to increase outreach/information dissemination; and 6) to support international fishery science. The document also outlines the NMFS AFSC's research priorities for this time period. Summarized below are the AFSC's research priorities grouped into four major research areas: research to support fishery conservation and management; conservation engineering research; research on the fisheries themselves; and information management research.

Research to Support Fishery Conservation and Management

Biological research concerning the abundance and life history parameters of fish stocks

q. Conduct periodic (annual, biennial, triennial) bottom trawl, midwater trawl-acoustic, hydroacoustic bottom trawl, longline surveys on groundfish in the BSAI and GOA.

r. Conduct field operations to study marine mammal-fish interactions, with particular emphasis on sea lion and pollock, Pacific cod, and Atka mackerel interactions in the GOA and the BSAI management areas.

s. Observer programs for groundfish fisheries that occur off Alaska.

t. Assessments of the status of stocks, including their biological production potentials (maximum sustainable yield, acceptable biological catch, overfishing levels), bycatch requirements, and other parameters required for their management.

u. Assessments of the population dynamics, ecosystem interactions, and abundance of marine mammal stocks and their incidental take requirements.

Social and economic factors affecting abundance levels

Interdependence of fisheries or stocks of fish

Identifying, restoring, and mapping of essential fish habitat

Assessment of effects of fishing on essential fish habitat and development of ways to minimize adverse impacts.

Conservation Engineering Research

v. Continue to conduct research to measure direct effects of bottom trawling on seafloor habitat according to a five-year research plan.

w. Conduct fishing gear performance and fish behavioral studies to reduce bycatch and bycatch mortality of prohibited, undersized, or unmarketable species, and to understand performance of survey gear.

x. Work with industry and the Council to develop bycatch reduction techniques.

Research on the Fisheries

- Social and economic research
- Seafood safety research
- Marine aquaculture

Information Management Research

y. Continue to build data infrastructure and resources for easy access and data processing. The AFSC's key data bases are its survey data bases from the 1950s (or earlier) and the scientific observer data base that extends back to the foreign fishing days of the 1960s.

z. Continue to provide information products based on experts and technical data that support NMFS, the Council, international scientific commissions, and the overall research and management community.

8.4 Essential Fish Habitat Research and Information Need

One of the required components of the EFH provisions of each FMP is to include research and information needs. Each FMP should contain recommendations for research efforts that the Councils and NMFS view as necessary to improve upon the description and identification of EFH, the identification of threats to EFH from fishing and other activities, and the development of conservation and enhancement measures for EFH.

8.4.1 Alaska EFH Research Plan

A new Alaska EFH Research Plan that revises and supersedes earlier plans will guide research to support the next EFH 5-year Review and other fishery management information needs where advancements in habitat science are helpful (Pirtle et al. 2024). The Alaska EFH Research Plans have included five long term research goals that remain consistent with minor, meaningful updates since 2005. EFH research recommendations were informed during the 2023 EFH 5-year Review by contributing researchers, stock assessment scientists, and Council advisory bodies. These recommendations were summarized as three objectives for the new Alaska EFH Research Plan. In addition, as part of the 2023 EFH 5-year Review, each stock assessment author provided a stock-specific evaluation of EFH research needs. Table 1 identifies these needs by species. These research needs also contributed to the research objectives in the revised Alaska EFH Research Plan. These long term research goals, timely objectives, and species specific recommendations are informative as updates to the EFH research recommendations in the GOA Groundfish FMP.

8.4.2 EFH Research Recommendations

Five long-term research goals have been included in Alaska EFH Research Plans since 2005 (e.g., Sigler et al. 2017, Pirtle et al. 2024)—

1. Characterize habitat utilization and productivity at regional scales;
2. Assess sensitivity, impact, and recovery of disturbed benthic habitat;
3. Improve modeling and validation of human impacts on marine habitat;
4. Improve information regarding habitat and seafloor characteristics; and
5. Assess coastal and marine habitats facing human development.

These goals represent the need to understand habitat characteristics and their influence on observed habitat utilization and productivity for fishes and invertebrates. These goals also emphasize the importance of understanding human impacts on habitat (e.g., fishing, coastal development, and ongoing climate change), how these impacts in turn affect habitat utilization and productivity, and assessing the consequences of these impacts at regional scales.

To achieve these goals the complementary role and equal importance of targeted field and laboratory experiments, long-term monitoring, and analytical work should be emphasized to model and map the progressive levels of EFH information (EFH component 1) and impacts at a regional scale (EFH components 2, 4, and 5). In particular:

- Field and laboratory experiments are necessary to understand ecological mechanisms that underlie habitat association, vital rates and productivity, and how human activities (including fishing, development, and climate change) cause changes in habitat conditions and resulting utilization and productivity. In particular, understanding causality is not possible without experimental support. Understanding ecological mechanisms (i.e., causality) is also necessary to predict the likely impact of human impacts that have not previously been observed;
- Long-term monitoring is necessary to understand habitat utilization and productivity at regional scales;
- Analysis including statistical and mathematical modeling is needed to map the geographic distribution of the area of occupied habitat (EFH) for life stages of targeted FMP species and their prey and is also necessary to identify changes in habitat utilization likely resulting from human activities and climate change.

Without these three elements, applied habitat research cannot be successful.

In addition to the five long term research goals, three objectives are emphasized as important for research progress and preparation for future EFH 5-year Reviews and are described in the Alaska EFH Research Plan (Pirtle et al. 2024). These objectives were informed by recommendations from contributing researchers, stock assessment scientists, and Council advisory bodies during the 2023 EFH 5-year Review and are written with consideration of research needs across FMPs.

Objective 1: Improve EFH information for targeted species and life stages

The first objective seeks to improve EFH information for species and life stages that were identified as requiring further research during the 2023 EFH 5-year Review, as well as other targeted FMP species that were not updated in 2023 (i.e., salmon ocean life stages and scallops) under EFH component 1. Studies should focus on methods development with practical application to improve EFH information for a select set of species life stages, where the following pathways are recommended:

1. **Additional field data:** Collecting and incorporating additional field data in the models used to identify and describe EFH, beyond the large-mesh bottom trawl summer survey data that were

used primarily during the 2017 and 2023 EFH 5-year Reviews. The importance of including alternative gear types to the extent practicable is emphasized, including longlines, pots, small-mesh and pelagic trawls, focusing on under-sampled life stages and habitats. The application of alternative data sources such as predator stomach contents and fishery-dependent catch and effort data is also encouraged. Sampling may also be used to improve understanding of seasonal variation in habitat use. This will presumably involve measuring (via paired experiments) or estimating a fishing-power correction between multiple sampling gears. When analyzed properly, these additional data sources can provide complementary information to characterize habitat profiles for life stages of targeted FMP species.

2. **Demographic processes driving variation over time:** Research focused on identifying processes that drive shifts in habitat use and productivity is recommended. This may involve hindcasting and forecasting methods, including (but not limited to) fitting models with covariates that vary over time, conditioning predictions upon spatio-temporal residuals, incorporating information about trophic interactions, and separately analyzing numerical density and size information. This might also involve process research, e.g., incorporating information about individual movement from tags, behavioral and eco-physiological experiments, or other process research. This likely requires methodological development and testing and could be focused on a few case-study species or species' life stages that are likely to be shifting substantially, for consideration during the future 5-year Reviews.
3. **Improved methods to integrate both monitoring and process research:** Continued development of new analytical methods to integrate process research is recommended when identifying species habitat utilization, vital rates, and productivity. Analytical methods might include individual- and agent-based models (IBMs) that "scale up" laboratory measurements, particularly when IBM output is used as a covariate or otherwise combined with survey and other species sampling information. This process research might include juvenile survival, growth, and movement experiments and habitat-specific observations. Ideally, these new methods would include process information and monitoring data simultaneously, rather than either a. seeking to validate an IBM via comparison with monitoring data without explicitly incorporating these data, or b. fitting to monitoring data without incorporating field or laboratory experimental data.

Objective 2: Improve fishing effects assessment

The second objective addresses the ongoing need to develop and improve methods to assess fishing impacts on habitat utilization and productivity (EFH component 2). Research pathways might include:

1. **Advance methods to assess fishing impacts:** It is often helpful to compare results from a variety of analytical methods and approaches. Advancing the existing Fishing Effects model (Smeltz et al. 2019) is recommended as well as developing new analytical approaches to address potential impacts of fishing to EFH.
2. **Cumulative effects:** Methods development is recommended to identify the cumulative effect of fishing and non-fishing human activities to EFH, including ongoing climate change (EFH component 5).

Objective 3: Improve understanding of nearshore habitat and forage species

The third objective acknowledges that additional research is needed regarding critical nearshore life stages and for the prey species that represent an important component of habitat suitability and EFH. Research may include the following pathways:

1. **Nearshore habitat:** Ongoing and expanded scientific efforts to understand habitat utilization and productivity into nearshore environments (EFH component 1). This nearshore habitat is critical for juvenile life stages of many targeted FMP species (e.g., Pacific cod, flatfishes, salmonids) and prey species (EFH component 7) and is also subject to substantial impacts from human

development. Improved understanding of nearshore habitat is intended to support the EFH consultations that are done near areas with human development (urban areas as well as shipping activities) (EFH components 4 and 5). Understanding nearshore habitat may also support improved understanding of recruitment processes and population connectivity. Data are available in the Nearshore Fish Atlas of Alaska and ShoreZone, and analytical methods have already been demonstrated (e.g., Grüss et al. 2021), but there remains substantial work to scale these methods to more species and within geographic areas of specific interest.

2. **Prey species:** Increased efforts are recommended to understand habitat utilization and productivity for those species that represent the primary prey for targeted FMP species (EFH component 7). This can include pelagic forage fishes (e.g., herring, eulachon, sand lance, etc.), juvenile stages of numerically abundant species (e.g., pollock, Pacific cod, salmonids), as well as invertebrates (e.g., Euphausiids, snow crab). Improved understanding of habitat-specific densities (i.e., Level-2 EFH information) can then be used as a covariate for understanding habitat suitability for their predators (i.e., targeted FMP species).

As part of the 2023 EFH Review, each stock assessment author provided a stock-specific evaluation of EFH research needs. Table 1 identifies these needs by species and FMP. These research needs also contributed to the research objectives in the revised Alaska EFH Research Plan (Pirtle et al. 2024).

Table 8-1 Stock assessment author research recommendations for Gulf of Alaska groundfish species. These include focus areas of research and identify data sources for future EFH map iterations.

Gulf of Alaska Species	Research notes from Stock Assessment Authors
arrowtooth flounder	Incorporate other data sources like longline survey and IPHC survey data to supplement the slope bottom trawl survey. When evaluating FE, referencing habitat specificity variables in the climate vulnerability assessment and the habitat assessment prioritization for Alaska stocks could allow for a more targeted approach.
Atka mackerel	Explore EFH over different time blocks representing different environmental conditions, and also regulations in place over the time series.
Dover sole	The length-stage definitions should be revisited and future maps and descriptions should try to account for subregional growth and size-at-age differences.
dusky rockfish	Prioritize research into fishery location data and early life history information. Include fishery observer data for additional species distribution data.
flathead sole	Research impacts of environmental indicators such as temperature on growth and/or distribution of recruits, since we don't see these in the surveys.
northern rockfish	Research early life history. Incorporate stakeholder/fleet understanding of fish locations.
other rockfish complex, demersal subgroup	ADF&G currently uses their ROV surveys to assess and manage this stock in the EGOA and recommend incorporating data from those surveys into the SDM ensemble framework.
other rockfish complex, slope subgroup	Research should include data from the AFSC and IPHC longline surveys, the GOA rockfish fishery data, and underwater images from untrawlable habitats in future EFH mapping efforts for these rockfish species.
greenstriped rockfish	Incorporate AFSC longline survey data and IPHC survey data as additional species distribution data.
harlequin rockfish	Incorporate GOA fishery data to more accurately represent the spatial extent of the population.
pygmy rockfish	Incorporate GOA fishery data for additional distribution data.
silvergray rockfish	Incorporate AFSC longline survey data and IPHC survey data as additional species distribution data.

Gulf of Alaska Species	Research notes from Stock Assessment Authors
redbanded rockfish	Incorporate both longline survey indices and length data when available.
rex sole	Reevaluate the length categories for subadults and adults with regard to regional and temporal growth differences.
rougheye/ blackspotted rockfish complex	Incorporate AFSC longline survey data as additional species distribution data.
sablefish	Incorporate longline survey data into the SDM. Collect data to better understand spawning areas (requires winter sampling) and ELH [early life history] habitat preferences. Develop a better understanding of connectivity among management units within the Alaska-wide sablefish population, particularly the dynamics of juvenile fish and how they utilize the EBS shelf.
Shark complex	(Note: only spiny dogfish maps were advanced by EFH analysts, however Pacific sleeper shark maps were reviewed and the stock assessment author provided the research recommendation below.)
Pacific sleeper shark	Research the spatial distribution of length data collected during surveys.
spiny dogfish	Incorporate the AFSC and IPHC longline surveys, with their length data, as additional data sources.
shortraker rockfish	Incorporate AFSC longline survey data as additional species distribution data.

8.4.3 References

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9 Appendix I Information on Marine Mammal and Seabird Populations

This appendix contains information on the marine mammal and seabird populations in the Gulf of Alaska (GOA) and Bering Sea and Aleutian Islands (BSAI) management areas. Much of the information in this appendix is from the Programmatic Supplemental Environmental Impact Statement for Alaska Groundfish Fisheries, published by National Marine Fisheries Service (NMFS) in 2004.

9.1 Marine Mammal Populations

Marine mammals occur in diverse habitats, including deep oceanic waters, the continental slope, and the continental shelf (Lowry et al. 1982). In the areas fished by the federally managed groundfish fleets, twenty-six species of marine mammals are present from the orders Pinnipedia (seals, sea lion, and walrus), Carnivora (sea otter and polar bear), and Cetacea (whales, dolphins, and porpoises) (Lowry and Frost 1985). Most species are resident throughout the year, while others seasonally migrate into and out of Alaskan waters.

9.1.1 Potential impacts of fisheries on marine mammals

9.1.1.1 Direct Mortality from Intentional Take

Commercial harvests of marine mammals have occurred at various times and places, sometimes with devastating impacts on the populations of particular species. In some cases, such as the northern right whale, the species have not recovered to pre-exploitation population levels even though commercial whaling was halted decades ago.

9.1.1.2 Direct Mortality from Incidental Take in Fisheries

Some types of fisheries are much more likely to catch marine mammals incidentally than others. High seas driftnet fishing killed thousands of mammals before it was prohibited in 1991. Longline and pot fisheries very rarely catch marine mammals directly.

9.1.1.3 Indirect Effects through Entanglement

The following effects are classified as indirect because the impacts are removed in time and/or space from the initial action although in the analysis, these effects are considered together with the direct effect of incidental take. In some cases, individual marine mammals may be killed outright by the effect. In other cases, individuals are affected in ways that may decrease their chances of surviving natural phenomenon or reproducing successfully. These sub-lethal impacts may reduce their overall “fitness” as individuals and may have population-level implications if enough individuals are impacted.

Although some fisheries have no recorded incidental take of marine mammals, all of them probably contribute to the effects of entanglement in lost fishing gear. Evidence of entanglement comes from observations of animals trailing ropes, buoys, or nets or bearing scars from such gear. Sometimes stranded marine mammals also have evidence of entanglement but it my not be possible to ascertain whether the entanglement caused the injury or whether the corpse picked up gear as it floated around after death. Sometimes an animal is observed to become entangled in specific fishing gear, in which case an incidental take or minor injury may be recorded for that particular fishery, but many times the contributions of individual fisheries to the overall effects of entanglement are difficult to document and quantify.

The Marine Plastic Pollution Research and Control Act of 1987 (33 USC §§ 1901 et seq.), implements the provisions relating to garbage and plastics of the Act to Prevent Pollution from Ships (MARPOL Annex V). These regulations apply to all vessels, regardless of flag, on the navigable waters of the U.S. and in the exclusive economic zone of the U.S. It applies to U.S. flag vessels wherever they are located. The discharge of plastics into the water is prohibited, including synthetic ropes, fishing nets, plastic bags, and biodegradable plastics.

9.1.1.4 Indirect Effects through Changes in Prey Availability

The availability of prey to marine mammals depends on a large number of factors and differs among species and seasons. Among these factors are oceanographic processes such as upwellings, thermal stratification, ice edges, fronts, gyres, and tidal currents that concentrate prey at particular times and places. Prey availability also depends on the abundance of competing predators and the ecology of prey species, including their natural rates of reproduction, seasonal migration, and movements within the water column. The relative contributions of factors that influence prey availability for particular species and areas are rarely known. Most critical is the lack of information on how events outside an animal's foraging range or in a different season may influence the availability of prey to animals in a particular place and time.

Marine mammal species differ greatly from one another in their prey requirements and feeding behaviors, leading to substantial differences in their responses to changes in the environment. For some species, such as the baleen whales, diets consist largely of planktonic crustaceans or small squid and have no overlap of prey with species that are targeted or taken as bycatch in the groundfish fisheries. For other species, notably Steller sea lions, there is a high degree of overlap between their preferred size and species of prey and the groundfish catch. Many other species are in between, perhaps feeding on the same species but smaller sizes of fish than what is typically taken in the fisheries. Although they may take a wide variety of prey species during the year, many species may depend on only one or a few prey species in a given area and season. In addition, the prey requirements and foraging capabilities of nursing females and subadult animals may be much more restricted than for non-breeding adults, with implications for reproductive success and survival.

The question of whether different types of commercial fisheries have had an effect on the availability of prey to marine mammals has been addressed by examining the degree of direct competition (harvest) of prey and by looking for potential indirect or cascading effects of the fisheries on the food web of the mammals. For marine mammals whose diets overlap to some extent with the target or bycatch species of the fisheries, fishery removals could potentially decrease the density of prey fields or cause changes in the distribution of prey such that the foraging success of the marine mammals is affected. If alternate prey is not available or is of poorer nutritional quality than the preferred species, or if the animal must spend more time and energy searching for prey, reproductive success and/or survival can be compromised. In the case of marine mammals that do not feed on fish or feed on different species than are taken in the fisheries, the removal of a large number of target fish from the ecosystem may alter the predator and prey dynamics and thus the abundance of another species that is eaten by marine mammals. The mechanisms and causal pathways for many potential food web effects are poorly documented because they are very difficult to study scientifically at sea.

Although reductions in the availability of forage fish to marine mammals have been attributed to both climatic cycles and commercial fisheries, a National Research Council study on the Bering Sea ecosystem (NRC 1996) concluded that both factors probably are significant. Regime shifts are major changes in atmospheric conditions and ocean climate that take place on multi-decade time scales and trigger community-level reorganizations of the marine biota (Anderson and Piatt 1999). Two cycles of warm and cold regimes have been documented in the GOA in the past 100 years, with the latest shift being from a cold regime to a warm regime in 1977. The consequences of this shift on fish and crustacean populations have been documented, including major improvements in groundfish recruitment and the collapse of some high-value forage species such as shrimp, capelin, and Pacific sand lance (Anderson and Piatt 1999). Directed fisheries on forage fish can deepen and prolong their natural low population cycles

(Duffy 1983, Steele 1991), with potential effects on marine mammal foraging success. There is some evidence that another regime shift may have begun in 1998 with colder water temperatures and increases in certain forage populations (NPFMC 2002), but the implications for marine mammals are still unclear. Climate change may also affect the dynamics of the ice pack, with serious consequences for the marine mammals associated with the ice pack, such as bowhead whales, the ice seals, and walrus.

9.1.1.5 Direct Effects through Disturbance by Fishing Vessels

The effects of disturbance caused by vessel traffic, fishing operations, engine noise, and sonar pulses on marine mammals are largely unknown. With regard to vessel traffic, many baleen and toothed whales appear tolerant, at least as suggested by their reactions at the surface. Observed behavior ranges from attraction to the vessel to course modification or maintenance of distance from the vessel. Dall’s porpoise, Pacific white-sided dolphins, and even beaked whales have been observed adjacent to vessels for extended periods of time. Conversely, harbor porpoise tend to avoid vessels. However, a small number of fatal collisions with various vessels have been recorded in California and Alaska in the past decade and others likely go unreported or undetected (Angliss et al. 2001).

Reactions to some fishing gear, such as pelagic trawls, are poorly documented, although the rarity of incidental takes suggests either partitioning of foraging and fishing areas or avoidance. Given their distribution throughout the fishing grounds, at least some individuals may be expected to occasionally avoid contact with vessels or fishing gear, which would constitute a reaction to a disturbance. Assuming these instances occur, the effects are likely temporary. Sonar devices are used routinely during fishing activity as well as during vessel transit. The sounds produced by these devices may be audible to marine mammals and may thus constitute disturbance sources. Wintering humpback whales have been observed reacting to sonar pulses by moving away (Maybaum 1990, 1993), although few other cases of reaction have been documented.

9.1.1.6 Indirect Effects through Contamination by Oil Spills

For species such as the pinnipeds and sea otters that spend a substantial amount of time on the surface of the water or hauled out on shore, oil spills pose a significant environmental hazzard, even in small amounts. The toxicological effects of ingested oil, ranging from potential organ damage to weakening of the immune system, are poorly known for most species, especially in regard to chronic low doses. Sea otters are particularly susceptible to oil spills because they depend on their thick fur to protect them from cold water, rather than layers of fat, and oil destroys the insulative properties of their fur. Thousands of sea otters died over a large expanse of the GOA as a result of the Exxon Valdez oil spill in 1989 (Garshelis 1997, Garrot et al. 1993, DeGange et al. 1994). There is very little data on the mortality of marine mammals from the much smaller volumes of oil that are more typical of marine vessel spills, resulting from fuel transfer accidents and bilge operations.

9.1.2 Statutory protection for marine mammals

There are two major laws that protect marine mammals and require the North Pacific Fishery Management Council (Council) to address their conservation in the FMPs. The first is the Marine Mammal Protection Act of 1972 (amended 1994) (MMPA). Management responsibility for cetaceans and pinnipeds other than walrus is vested with NMFS Protected Resources Division (PRD). The USFWS is responsible for management of walrus and sea otters. The goal of the MMPA is to provide protection for marine mammals so that their populations are maintained as a significant, functioning element of the ecosystem. The MMPA established a moratorium on the taking of all marine mammals in the United States with the exception of subsistence use by Alaska Natives. Under the authority of this Act, NMFS PRD monitors populations of marine mammals to determine if a species or population stock is below its optimum sustainable population. Species that fall below this level are designated as “depleted.”

Populations or stocks (e.g., the western stock of Steller sea lions) listed as threatened or endangered under the Endangered Species Act (ESA), are automatically designated as depleted under the MMPA.

The ESA was enacted in 1973 and reauthorized in 1988. This law provides broad protection for species that are listed as threatened or endangered under the Act. The species listed under the ESA that spend all or part of their time in the GOA or BSAI and that may be affected by the groundfish fisheries are included in the table below. There are eight whale species, and two distinct population segments of Steller sea lions.

Listed Species	Population or Distinct Population Segment (DPS)	Latin Name	Status
Blue whale	North Pacific	*Balaenoptera musculus*	Endangered
Bowhead whale	Western Arctic	*Balaena mysticetus*	Endangered
Fin whale	Northeast Pacific	*Balaenoptera physalus*	Endangered
Humpback whale	Western and Central North Pacific	*Megaptera novaeangliae*	Endangered
Right whale	North Pacific	*Eubalaena japonica*	Endangered
Sei whale	North Pacific	*Balaenoptera borealis*	Endangered
Sperm whale	North Pacific	*Physeter macrocephalus*	Endangered
Gray whale	Eastern Pacific	*Eschrichtius robustus*	Delisted
Steller sea lion	Western Alaska DPS	*Eumetopias jubatus*	Endangered
Steller sea lion	Eastern Alaska DPS	*Eumetopias jubatus*	Threatened

The mandatory protection provisions of the ESA have led to numerous administrative and judicial actions and has brought the issue of fisheries/sea lion interactions under intense scrutiny. Section 7(a)(2) of the ESA requires federal agencies to ensure that any action authorized, funded, or carried out by such agencies is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of its designated critical habitat. For federal fishery management actions, the action agency, NMFS Sustainable Fisheries Division, is required under Section7(a)(2) to consult with the Steller sea lion expert agency, NMFS PRD, to determine if the proposed action may adversely affect Steller sea lions or their critical habitat. If the proposed action may adversely affect Steller sea lions or its designated critical habitat, formal consultation is required. Formal consultation is a process between the action and expert agency that determines whether a proposed action is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat. The process begins with the action agency's assessment of the effects of their proposed action on listed species and concludes with the issuance of a "Biological Opinion" by the expert agency. A biological opinion is a document which includes: a) the opinion of NMFS PRD as to whether or not a federal action (such as federally authorized fisheries) is likely to jeopardize the continued existence of listed species or adversely modify designated critical habitat; b) a summary of the information on which the opinion is based; and c) a detailed discussion of the effects of the action on listed species or designated critical habitat. If the Biological Opinion concludes that the proposed action is likely to jeopardize the continued existence of threatened or endangered species or adversely modify critical habitat, then the expert agency recommends Reasonable and Prudent Alternatives to avoid the likelihood of "jeopardy" or "adverse modification" of critical habitat. The resulting legal requirements limit the Council from adopting FMP policies that result in a jeopardy finding for the Steller sea lions.

9.1.3 Consideration of marine mammals in groundfish fishery management

In order to fulfill their oversight responsibilities under the MMPA, NMFS PRD and U. S. Fish and Wildlife Service (USFWS) have developed appropriate survey methodologies to census the various species of marine mammals. The results of these surveys, and other factors that affect the status of each species, are published in an annual “Marine Mammal Stock Assessment” report that is available on the NMFS national website (www.nmfs.noaa.gov).

Some species are much more difficult to census accurately than others, so there is a great deal of variation in the uncertainty of various population estimates. In addition, the huge expanses over which many species traverse and the remoteness of their habitats make surveys logistically difficult and expensive. For budgetary and logistical reasons, surveys of most species are not carried out every year and survey effort is prioritized for species of management concern. As a result, population estimates for some species may be outdated and trend information may not exist.

NMFS PRD requires all commercial fisheries in the U.S. Exclusive Economic Zone to report the incidental take and injury of marine mammals that occur during their operations (50 CFR 229.6). In addition to self-reported records, which NMFS PRD considers to be negatively biased and under representing actual take levels, certified observers are required in some fisheries to provide independent monitoring of incidental take as well as other fishery data.

Management measures are in place in the BSAI and GOA groundfish fisheries to protect Steller sea lions. These protection measures were deemed necessary based on the hypothesis that the continued decline of the western stock of the Steller sea lion is due to nutritional stress and that groundfish fisheries contribute to this stress by competing with sea lions for their key prey species. Management measures were specifically developed to reduce competitive interaction between Steller sea lions and the groundfish fisheries (NMFS 2001a). Mitigation efforts have focused on protecting the integrity of food supplies near rookeries and haulouts. Competitive interactions with the fishery may have the greatest effect on juvenile Steller sea lions between the time they are weaned and the time they reach adult size and foraging capability as the diving capacity of juveniles (and thus available foraging space) is less than that of adults. Adult females may also be susceptible to nutritional stress due to reduced prey availability in the vicinity of rookeries because of the limited foraging distribution and increased energetic demands when caring for pups. Specifically, the intent of the protection measures was to avoid competition around rookeries and important haulouts with extra precaution in the winter, and to disperse the fisheries outside of those time periods and areas.

Section 118 of the MMPA (50 CFR 229.2) requires all commercial fisheries to be placed into one of three categories, based on the frequency of incidental take (serious injuries and mortalities) relative to the value of potential biological removal (PBR) for each stock of marine mammal. PBR is defined as the maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population. In order to categorize each fishery, NMFS PRD first looks at the level of incidental take from all fisheries that interact with a given marine mammal stock. If the combined take of all fisheries is less than or equal to 10 percent of PBR, each fishery in that combined total is assigned to Category III, the minimal impact category. If the combined take is greater than 10 percent of PBR, NMFS PRD then looks at the individual fisheries to assign them to a category. Category I designates fisheries with frequent incidental take, defined as those with takes greater than or equal to 50 percent of PBR for a particular stock; Category II designates fisheries with occasional serious injuries and mortalities, defined as those with takes between one percent and 50 percent of PBR; Category III designates fisheries with a remote likelihood or no known serious injuries or mortalities, defined as those with take less than or equal to one percent of PBR. Owners of vessels or gear engaging in Category I or II fisheries are required to register with NMFS PRD to obtain a marine mammal authorization in order to lawfully take a marine mammal incidentally in their fishing operation (50 CFR 229.4). In Alaska, this registration process has been integrated into other state and federal permitting programs to reduce fees and paperwork. Owners of vessels or gear engaging in Category III fisheries are not required to register with NMFS PRD for this purpose. Every year, NMFS PRD reviews and revises its list of Category I, II, and III fisheries based on new information and publishes the list in the Federal Register.

Under provisions of the MMPA, NMFS PRD is required to establish take reduction teams with the purpose of developing take reduction plans to assist in the recovery or to prevent the depletion of strategic stocks that interact with Category I and II fisheries. A “strategic” stock is one which: 1) is listed as endangered or threatened under the ESA, 2) is declining and likely to be listed as threatened under the ESA, 3) is listed as depleted under the MMPA, or 4) has direct human-caused mortality which exceeds the stock’s PBR.

The immediate goal of a take reduction plan is to reduce, within six months of its implementation, the incidental serious injury or mortality of marine mammals from commercial fishing to levels less than PBR. The long-term goal is to reduce, within five years of its implementation, the incidental serious injury and mortality of marine mammals from commercial fishing operations to insignificant levels approaching a zero serious injury and mortality rate, taking into account the economics of the fishery, the availability of existing technology, and existing state or regional FMPs. Take reduction teams are to consist of a balance of representatives from the fishing industry, fishery management councils, state and federal resource management agencies, the scientific community, and conservation organizations. Fishers participating in Category I or II fisheries must comply with any applicable take reduction plan and may be required to carry an observer onboard during fishing operations.

In 2002, all of the Alaska groundfish fisheries (trawl, longline, and pot gear in the BSAI and GOA) were listed as Category III fisheries (67 FR 2410). However, NMFS PRD has recently proposed that the BSAI groundfish trawl fishery be elevated to Category II status based on a review of Observer Program records of marine mammal incidental take from 1990-2000 (68 FR 1414). According to the records, total incidental take of all fisheries is greater than 10 percent of PBR for the Alaska stocks of western and central North Pacific humpback whales, resident killer whales, transient killer whales, and the western stock of Steller sea lions. Based on the incidental take of these species relative to their respective PBRs, and some other considerations in the case of humpback whales, NMFS PRD determined in their “Tier 2” analysis that the BSA groundfish trawl fishery posed a modest risk to these species. In addition, a number of state-managed salmon drift and set gillnet fisheries are listed in Category II, including those in Bristol Bay, Aleutian Islands, Alaska Peninsula, Kodiak, Cook Inlet, Prince William Sound, and Southeast Alaska. NMFS PRD has recently proposed reclassifying the Cook Inlet drift and set gillnet fisheries from Category II to Category III (68 FR 1414).

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9.2 Seabird Populations

Over 70 species of seabirds occur over waters off Alaska and could potentially be affected by direct and indirect interactions with the BSAI and GOA groundfish fisheries. Thirty-eight of these species regularly breed in Alaska and waters of the EEZ. More than 1,600 seabird colonies have been documented, ranging in size from a few pairs to 3.5 million birds (USFWS 2000). Breeding populations of seabirds are estimated at approximately 48 million birds and non-breeding migrant birds probably account for an additional 30 million birds (USFWS 1998). Most of the migrant birds are present only during the summer months (May through September) although some non-breeding albatross have been sighted at all months of the year (USFWS 1999). The distributions of species that breed in Alaska are well known in summer but for some species winter distributions are poorly documented or completely unknown.

9.2.1 Potential impacts of fisheries on seabird species

Potential fisheries impacts on a given seabird species could theoretically be measured by changes in survival or reproductive rates and ultimately by changes in the population. For all of these biological parameters, one would expect fluctuations in time and space as part of "normal" or natural conditions. The ability to distinguish these natural fluctuations from potential human-caused fluctuations requires reasonably accurate measurements of several parameters over a long time period and in many different areas. The USFWS surveys a number of large seabird colonies every year. Data is collected for selected species at geographically dispersed breeding sites along the entire coastline of Alaska. Some sites are scheduled for annual monitoring while other sites are monitored every three years. Although trends at sampling plots are reasonably well known at particular colonies, overall population estimates for most species are not precise enough to detect anything but the largest fluctuations in numbers. This is especially true for species that do not nest in dense concentrations. For some species, like the burrow and crevice-nesting alcids and storm-petrels, field methods for censussing populations are not available and require additional budgetary support for development. Population trends for those species that are regularly monitored are presented in an annual report entitled, "Breeding status, population trends, and diets of seabirds in Alaska", published by the USFWS (Dragoo et al. 2001).

Seabirds can interact with fisheries in a number of direct and indirect ways. Direct effects occur at the same time and place as the fishery action. Seabirds are attracted to fishing vessels to feed on prey churned up in the boat's wake, escaping fish from trawl nets, baited hooks of longline vessels, and offal discharged from trawl, pot, and longline vessels. In the process of feeding, seabirds sometimes come into contact with fishing gear and are caught incidentally. A direct interaction is usually recorded as the injury or killing of a seabird and is referred to as an "incidental take". Information on the numbers of birds caught incidentally in the various gear types comes from the North Pacific Groundfish Observer Program (Observer Program) and is reported in the annual Stock Assessment and Fishery Evaluation reports in the seabird section of "Ecosystem Considerations" appendix.

Another direct fishery effect is the striking of vessels and fishing gear by birds in flight. Some birds fly away without injury but others are injured or killed and are thus considered incidental take. The Observer

Program does not collect data on vessel strikes in a systematic way but there are some records of bird-strikes that have been collected on an opportunistic basis. These sporadic observations of vessel strikes from 1993-2000 have been entered into the Observer Notes Database, which is maintained by the USFWS, but have only received preliminary statistical analysis (seabird section of "Ecosystem Considerations for 2003", NPFMC 2002). Indirect effects refer to either positive or negative impacts on the reproductive success or survival of seabirds that may be caused by the fishery action but are separated in time or geographic location. The indirect effect which has received the most attention is the potential impact of fisheries competition or disturbance on the abundance and distribution of prey species that seabirds depend on, thus affecting seabird foraging success. Of particular note would be those effects on breeding piscivorous (fish-eating) seabirds that must meet the food demands of growing chicks at the nest colony. Reproductive success in Alaskan seabirds is strongly linked to the availability of appropriate fish (Piatt and Roseneau 1998, Suryan et al. 1998a, Suryan et al. 2000, Golet et al. 2000). Although seabird populations remain relatively stable during occasional years of poor food and reproduction, a long-term scarcity of forage fish leads to population declines. Other potential indirect effects on seabirds include physical disruption of benthic foraging habitat by bottom trawls, consumption of processing wastes and discarded offal, contamination by oil spills, introductions of nest predators (i.e., rats) to nesting islands, and ingestion of plastics released intentionally or accidentally from fishing vessels. Some of these potential impacts are related more to the presence of fishing vessels rather than the process of catching fish.

9.2.2 Statutory protection for seabirds

There are two major laws that protect seabirds and require the Council to address seabird conservation in their Fishery Management Plans (FMPs). The first is the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712), as amended over the years. This law pertains to all of the seabird species found in the BSAI/GOA area (66 FR 52282) and governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. The definition of "take" in the Migratory Bird Treaty Act is "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect" (50 CFR 10.12). In a fishery context, "take" refers to birds killed or injured during commercial fishing operations, whether in fishing gear or by striking some part of a vessel. Under the Migratory Bird Treaty Act, take of migratory birds is illegal, even if it is accidental or inadvertent, unless permitted through regulations (such as hunting regulations or permit exemptions). Thus far, only certain forms of intentional take have been legalized in these ways. There are currently no regulations to allow unintentional take. The USFWS and Department of Justice are vested with enforcement discretion, which has been used in lieu of a permitting program. Enforcement has focused on those who take birds with disregard for the law and the impact of their actions on the resource, particularly where effective conservation measures are available but have not been applied ("Fact sheet" on Migratory Bird Treaty Act, K. Laing, USFWS). Executive Order 13186 (66 FR 3853-3856), "Responsibilities of Federal Agencies to Protect Migratory Birds," which was signed by the President on January 10, 2001, directs federal agencies to develop and implement a "Memorandum of Understanding" with the USFWS to promote the conservation of migratory birds affected by their actions, including mitigation of activities that cause unintentional take. NMFS and USFWS are currently developing this framework document which will incorporate seabird protection measures designed for specific fisheries (K. Rivera, NMFS National Seabird Coordinator, personal communication).

The second law is the ESA which provides broad protection for species that are listed as threatened or endangered. Presently there are three species listed under the ESA that spend all or part of their time in the GOA or BSAI and that may be affected by the groundfish fisheries: short-tailed albatross (endangered), Steller's eider (threatened), and spectacled eider (threatened). Section 7(a)(2) of the ESA requires federal agencies to ensure that any action authorized, funded, or carried out by such agencies is not likely to jeopardize the continued existence of the species or result in the destruction or adverse modification of habitat important to the continued existence of the species (Critical Habitat). For ESA-listed seabirds, the USFWS is the agency responsible for conducting an assessment of the proposed action and preparing the appropriate Section 7 document, a “Biological Opinion”. If the Biological Opinion concludes that the proposed action is likely to jeopardize the continued existence of threatened or endangered species or adversely modify its Critical Habitat, then the agency must develop Reasonable and Prudent Alternatives to minimize or mitigate the effect of the action. Even if a “no jeopardy” determination is made, as has been done for all three listed species in the GOA or BSAI, the agency may require and/or recommend that certain mitigation measures be adopted. In addition, the agency may establish a threshold number of incidental takes that would trigger a new Section 7 consultation to reexamine the required mitigation measures. In the case of the short-tailed albatross, the number of incidental takes that could be reasonably expected, given the designated mitigation measures, has been adopted as a threshold value and is described in the Incidental Take Statement attached to the Biological Opinion (USFWS 1999). These provisions of the ESA, as applied to the short-tailed albatross, have played a major role in the development of seabird protection measures for the longline sector of the GOA or BSAI groundfish fisheries.

USFWS may designate Critical Habitat areas for each species under the ESA if it can determine that those areas are important to the continued existence of the species. Critical Habitat may only be designated in U.S. territory, including waters of the EEZ. Short-tailed albatross do not nest in U.S. waters but have been sighted throughout the GOA or BSAI areas. No Critical Habitat has been designated for this species. Spectacled and Steller’s eiders each have designated Critical Habitats in the BSAI where they concentrate in winter and during flightless molting periods (66 FR 9146 and 66 FR 8850 respectively; February 2001). Critical Habitat designations do not automatically restrict human activities like fishing. They do require the lead agency, in this case the USFWS, to monitor activities that may degrade the value of the habitat for the listed species.

9.2.3 Consideration of seabirds in groundfish fishery management

Seabird protection measures in the GOA and BSAI groundfish fisheries were initiated in the 1990s and have focused primarily on collecting seabird/fishery interaction data and on requiring longliners to use specific types of gear and fishing techniques to avoid seabird incidental take. This emphasis on longline gear restrictions has been driven by conservation concerns for the endangered short-tailed albatross as well as other species. As of 2004, longline vessels over 26 ft LOA are required to use either single or paired streamer lines (or in some cases for smaller vessels, a buoy bag line) to reduce incidental take of seabirds (see www.fakr.noaa.gov/protectedresources/seabirds.html for further information).

Observers collect incidental take data in the trawl and pot sectors of the fishery. USFWS and the trawl sector of the fishing industry are collaborating on research into minimizing the effects of the trawl “third wire” (a cable from the vessel to the trawl net monitoring device) on incidental take of seabirds. However, there have been no regulatory or FMP-level efforts to mitigate seabird incidental take in the trawl and pot sectors.

For species listed as threatened or endangered under the ESA, the USFWS may establish a threshold number of incidental takes that are allowed before mitigation measures are reviewed and perhaps changed. Although this is sometimes viewed as a “limit” on the number of birds (e.g., short-tailed albatross) that can be taken, the result of exceeding this threshold number is a formal consultation process between NMFS and USFWS, not an immediate shutdown of the fishery.

Another management tool that may affect incidental take of seabirds is the regulation of who is allowed to fish. Limited entry and rationalization programs such as Individual Fishing Quota and Community Development Quota programs may impact seabird incidental take if the number or size of fishing vessels changes because regulations on protective measures are based on the size of the vessel. Since different types of fishing gear are more prone to take different kinds and numbers of seabirds, allocation of total allowable catch among the different gear sectors can also have a substantial impact on incidental take.

Food web impacts can be addressed with several management tools. The Council has designated particular species and size classes of fish as being important prey for seabirds and marine mammals and has prohibited directed fisheries on these forage fish (GOA Amendment 39 and BSAI Amendment 36). The Council may also manage the allocation, biomass, and species of fish targeted by the industry through the total allowable catch-setting process. These factors impact the food web and could thus alter the availability of food to seabirds. While more information is available for the dynamics of fish populations than of invertebrate prey, food web interactions are very complicated and there is a great deal of scientific uncertainty regarding the specific effects of different management options.

Each of the management tools listed above requires reliable data to monitor the extent of fishery interactions and the effectiveness of mitigation efforts in accordance with management policy objectives. The Council established the Observer Program in order to collect fishery information. Beginning in 1993, the Observer Program was modified to provide information on seabird/fishery interactions. Observers are presently required on vessels 125 ft LOA or more for 100 percent of their fishing days and aboard vessels 60-124 ft LOA for 30 percent of their fishing days. Vessels less than 60 ft LOA do not have to carry observers.

Observers receive training in seabird identification, at least to the level of being able to place birds into the categories requested by the USFWS. Some of these categories identify individual species and others lump species under generalized groups, e.g., “unidentified alcids.” In many cases, birds that were caught as the gear was being deployed have soaked at depth for hours and have been eaten by invertebrates. By the time they are retrieved on board they may be identifiable only to a generalized group level. NMFS is currently working to improve the training of its observers in identifying birds from their feet and bills, which are often the only parts of the bird that are recognizable (S. Fitzgerald, Observer Program, personal communication). When the Observer Program data is analyzed and reported (as in the Ecosystem Considerations appendix in Stock Assessment and Fishery Evaluation reports), individual species with relatively few records are often lumped into larger categories. For example, the “gull” category contains many “unidentified gulls” but also various numbers of five different gull species that observers have identified to species. Similarly, the “alcid” group contains separate records of seven different alcid species.

For those vessels operating without observers, regulations require captains to report the taking of any ESA-listed species and to retain and deliver the body to USFWS for positive identification. Unfortunately, such self-reporting is unreliable due to the inability or unwillingness of some crews to identify and retain species of concern. Other existing fishery record-keeping and reporting requirements provide data on the distribution of fishing effort which could potentially be used in conjunction with directed research to analyze potential food web and seabird population impacts.

9.2.4 References

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